Dieter Koch

# Astronomical Dating of the Mahābhārata War

Version 2.00



German original title: "Zur Datierung des Mahābhārata-Krieges"
Translation into English: Dieter Koch
Editing and traditional Hindu horoscopes: Paul McCarthy

This book is online as a PDF file free of charge at:
http://www.gilgamesh.ch/KochMahabharata.pdf

A printed copy of this book can be ordered at:
http://www.lulu.com/content/17089496

Feedback and error reports are welcome by e-mail at
artizarrak at yahoo.com

**version 1.00 (12 July 2014):**

**updates in version 1.01 (21 July 2014):**

- Improvements in the chapter “How Old are the Astronomical Concepts of the Mahābhārata Epic?”

**updates in version 1.02(.01) (28 July 2014):**

- Appendix O: “Retrograde Mars in Jyeṣṭhā, Saturn Tormenting Rohiṇī” added

**updates in version 1.02(.02) (13 Sept. 2014):**

- Further improvements in chapter “How Old are the Astronomical Concepts of the Mahābhārata Epic?”, among which a new chapter: “The Pole Star Dhruva”
- Comment on Janamejaya copper grants added in chap. “The Clustering of Planets of 3102 BCE”.
- Additions in chap. “The Seven Planets Flew Together”
- Additions in chap. “Eclipses on the 13th of the Fortnight” (BN Achar’s theory)
- Additions in chap. “Two Suns at the End of the Age”
- Additions in chap. “Ketu, Dhūmaketu and Comets”
- New chapter “Eclipses in 3139 and 3138 BCE”.
- Appendices E and F “All Planets near the Moon... ” corrected. Some events were missing as a result of a software bug. The author apologises for any confusion that may have arisen from it. The error does not entail any other changes in the book.

**updates in version 1.03 (5 Jan. 2015):**

- **All translations of Sanskrit original texts reviewed, some errors corrected**
- New chapter: “Super-Conjunctions in (Ancient Indian) Astrological Texts”
- New chapter: “Super-Conjunctions and Eclipses in Ancient China”
- New chapter: “Super-Conjunctions and Era Cycles in Hellenism”
- Additions in chap. “Two Suns at the End of the Age”
- Minor corrections to the text and partial review by native English speaker Paul McCarthy in version 1.03.01 (6 Jan. 2015):
- version history (this page) corrected

**updates in version 1.04 (16 Feb. 2015):**

- Devanagari text added to Sanskrit quotations, Sandhi corrected in transliterations.
- Minor corrections by the author and partial review by a native English speaker (Paul McCarthy)

**updates in version 2.00 (10 Aug. 2015, final version):**

- final proofreading by a native English speaker (Paul McCarthy)
- Hindu astrological charts added (Paul McCarthy)

# Contents

# *How Old are the Astronomical Concepts of the Mahābhārata Epic?*

## Astronomical Concepts from the Bronze Age?

Numerous astronomical and calendrical statements in ancient Indian texts raise the question as to whether such texts can be dated on the basis of astronomical calculations. If, for example, a text states that an equinox or solstice is located in a particular lunar mansion, the question can be asked for what period this statement was valid. Due to lunisolar precession, such statements can be true only for the duration of a couple of centuries. Thus the epoch can be calculated in which this astronomical doctrine must have emerged. Calculations of this kind are very simple and the results will not leave much room for doubt.

Unfortunately, however, the dates obtained in this way are mostly totally at odds with dates that have been found on the basis of historical or linguistic considerations. For example, the astronomical and calendrical information contained in the Mahābhārata Epic is based on a lunar mansions system that has its initial point at the beginning of the lunar mansion Kṛttikā (the Pleiades). The reason for this primacy of Kṛttikā seems to be, according to some texts, that the vernal equinox was located near the Pleiades and that the full moon, when taking place on the autumnal equinox, was also seen near them. Astronomical calculations show that the vernal equinox could be attributed to the lunar mansion of the Pleiades only between about 3000 and 1500 BCE. In contrast, current Indology dates the final redaction of the Mahābhārata Epic to be between 400 BCE and 400 CE. The underlying astronomical theory thus seems to be over 1000 years older, perhaps even 2000 years older, than the text in which it is found. This raises the question how such a wide time gap could be explained.

It is not the intention of this study to challenge the late dating of the Mahābhārata Epic or other texts of the Vedic tradition, as given by the scientific establishment. However, the problem should be taken seriously. While it is understandable that historians and Indologists, who usually do not have deeper insight into astronomical and calendrical issues, give less weight to archaeoastronomical arguments and even tend to disregard them completely, astronomical dating does weigh very heavy from the point of view of the "strict" sciences. It is therefore necessary to discuss the problem duly, as has also been pointed out by authors such as Tilak, Sengupta, Elst, and others.

Let a less extreme example be studied first, such as David Pingree's statements concerning the dating of the Vedāṅgajyotiṣa, the oldest Indian astronomical treatise. According to this text itself, the solstices are located at the middle of Āśleṣā and the beginning of Dhaniṣṭhā. While it is not known exactly where the initial points of the *nakṣatras* were considered to be in ancient times, it is reasonable to assume the Lahiri *ayanāṃśa*, having the star Citrā (Spica) at 180°, as a good approximation. With the Lahiri *ayanāṃśa*, the principal stars of the *nakṣatras* fall nicely into their respective ecliptic section, when projected on the ecliptic in polar projection. Based on this reasonable assumption, the text would have to be dated to about 1400 BCE. This is a lot earlier than the date suggested by Pingree. He believes the text to have been composed about 400 BCE, on the basis of purely historical grounds, which, however, are not very certain. With regard to the possibility of an astronomical dating, he writes:

> Lagadha (the author of the Vedāṅgajyotiṣa; D.K.) has retained the Vedic list of twenty-seven *nakṣatras* beginning with Kṛttikā, but treats them not as constellations but as measurements of arcs on the ecliptic of 13;20° each beginning with the vernal equinox. This adaption means, of course, that the actual position of the equinoctial and solstitial colures with respect to the fixed stars can not be used for dating the JV.[1]

And in another paper, he says:

> We simply do not know where Lagadha would have placed the beginning of the equal nakṣatra Dhaniṣṭhā with respect to the fixed stars...[2]

It is true, of course, that the principal stars of the lunar mansions Dhaniṣṭhā (β *Delphini*) and Āśleṣā (ε *Hydrae* ?) are quite far off

[1] Pingree, *Jyotihśāstra*, p.10. His argumentation is also similar in: "The Mesopotamian Origin of Early Indian Mathematical Astronomy", p. 3; 10.

[2] Pingree, "The Mesopotamian Origin of Early Indian Mathematical Astronomy", p. 10.

from the ecliptic, and in fact it is not known with certainty in which way or using what projection they were linked to their respective lunar mansions. However, the rough placement of the lunar mansions is indicated by *other* stars that *are closer* to the ecliptic, e.g. by the Kṛttikās or Pleiades. The text states that the axis of the solstices is located at the *beginning* of Dhaniṣṭhā and the *middle* of Āśleṣā. From this, it must be concluded that the system of 27 *equal* lunar mansions was used. If Pingree is taken at his word, then Lagadha would have assumed the beginning of the equal *nakṣatra* Dhaniṣṭhā at the winter solstice in 400 BCE, i.e. at tropical ecliptic longitude 270°. The lunar mansion Kṛttikā would have begun 7 x 13°20' = 93°20' after Dhaniṣṭhā, thus at 270° + 93°20' = 363°20' = 3°20' in tropical ecliptic longitude, and it would have ended at 16°40'. Now, in the year 400 BCE, the Pleiades (Alcyone) were at tropical longitude 26°40', thus *10° after the end of Kṛttikā* relative to the above calculation, near the end of the lunar mansion Rohiṇī. This is surely anything but plausible. The Pleiades must have been located at least within the lunar mansion Kṛttikā. For this to be the case, one has to go further back in time by more than 700 years. The astronomical observations that formed the basis of Vedāṅgajyotiṣa must therefore have been made before 1100 BC.

Other arguments made by Pingree read as follows:

> ... nor do we know the accuracy with which he could have determined the sidereal longitude of the Sun at the winter solstice. Since a displacement of the beginning of the equal nakṣatra by some 10°, or an error of 10 days in computing the date of the winter solstice, or some combination of these two effects is all that is required to bring the date from the twelfth century to the fifth century B.C., we should not lend much weight to this chronological argument.[3]

But is it plausible to assume that ancient Indian stargazers contented themselves with an inaccuracy of 10 days in determining the date of a solstice? While the direct observation of the solstices with day-accuracy is difficult or actually impossible, there are also indirect means which could have provided far better accuracy than assumed by Pingree. For example, they could have counted 91 days from the equinoxes, which were a lot easier to determine by direct

---

[3] Pingree, "The Mesopotamian Origin of Early Indian Mathematical Astronomy", p. 10.

observation, or they could have examined as to how many days the length of the noon shadow did not seem to change and then assumed the solstice in the middle of that period. This method is described in Aitareyabrāhmaṇa 18:18. An explanation of the text has been given by Sengupta.[4] To assume an inaccuracy of +/–10 days is in fact anything but plausible, especially since the observations would no doubt have been repeated every year, and major errors would have been corrected. Let it not be forgotten that the Vedic calendar, which inserted leap months every two to three years, was completely dependent on careful astronomical observations. Also, the exact determination of the cardinal points of the year was of great significance for Vedic ritual. Rather, the question has to be asked how the position of the Sun in the lunar mansions on the solstices (or any other date) was determined. Observations of lunar eclipses must no doubt have played an important part here, because they allowed the position of the Sun to be determined with an accuracy of roughly one degree, or two lunar diameters. In any case, Pingree's answer to the problem is too simple.[5]

It therefore seems that the Vedāṅgajyotiṣa is actually based on astronomical observations that were made in the late 2nd millennium BCE. This does not necessarily mean that the text was composed in the same epoch. The composition may have been preceded by centuries of oral tradition. Besides, it is possible that the author did not make any observations of his own and did not update the tradition, even after it had become outdated, because his only goal was preserving an ancient sacred tradition unchanged. Considering the extremely conservative mentality of Hindu traditions, this is by no means improbable. Hence, the final redaction of the two extant recensions of the text may in fact have taken place in 400 BCE or even later.

---

[4] Sengupta, *Ancient Indian Chronology*, p. 155ff.

[5] Witzel does not really seem to understand the problem either when he says: "Further, lagaDha puts the winter solstice on the new moon of mAgha at the heliacal rising of dhaniSThA, which post-dates the establishment of the calendrical scheme with amAnta months." (Witzel, "Autochthonous Aryans?...", §30) Whatever may be the intended meaning of this statement, there is no mention of heliacal rising ("rising before the Sun" or the like) of Dhaniṣṭhā (β Delphini) in the Vedāṅgajyotiṣa. Besides, if the heliacal rising of that star had coincided with the winter solstice, then the text would have to be dated to 2000 BCE.

This explanation is not new. Max Müller already said:

> ... we may fairly grant to Colebrooke and others, that there was a real tradition which fixed these important points as they are fixed in the Jyotisha ; nay, we may believe that for sacrificial purposes these points were still supposed to be in the same position even at a time when, by the laws of nature, they had considerably receded from it.[6]

And Thibaut:

> For it is neither possible to derive from the given data, with any degree of accuracy, the time when the original observation was made ; nor, even if that could be done, would the result prove anything regarding the period when the works in question were composed, since it is quite clear that the place of the solstices having once been ascertained was adhered to and stated in works composed many centuries after it had ceased to be true.[7]

Even more glaring is the time gap between the historical dating of the Mahābhārata and the astronomical age of some astronomical concepts used in it. Even though the final redaction of the text was made only after 400 BCE, it will be shown in the next few chapters that the epic uses a list of *nakṣatras* that begins with Kṛttikā, which might be about 2000 years older. Indeed, this discrepancy can be explained only by the extreme conservatism of Indian spiritual culture. This conservatism can be illustrated by a side glance to the methods used in current Indian astrology. The list of the lunar mansions as used today does not start with Kṛttikā anymore, but with Aśvinī. The reason for this seems to lie in the fact that all astrological and astronomical texts of late antiquity assume the equinoxes and solstices at the initial points of Aries, Cancer, Libra and Capricorn, where the initial point of Aries coincides with the initial point of Aśvinī. Now, the vernal equinox has since moved further by more than 20 degrees. It has crossed Revatī and is currently located in the lunar mansion Uttarabhādrā. However, traditional Indian astrologers and calendar-makers do not care and do not even think about reforming their system. Caught in their conservatism, they continue to celebrate the winter solstice, the "northward course" of the sun (*uttarāyaṇam*), on the date when the sun enters sidereal Capricorn (*uttarāyaṇam* = *makarasaṃkrāntiḥ*), and thus not on 21st December, but only in mid-January.

---

[6] Müller, *On Ancient Hindu Astronomy and Chronology*, p. 21.

[7] Thibaut, *The Pañchasiddhântikâ. The Astronomical Work of Varâha Mihira*, p. xlix.

Although the majority of Hindu scholars does not care about the problem, there are people who are aware of it and seek a reform of the system. In the *Report of the Calendar Reform Committee* of 1955 it is noted that such a reform is desirable for the future:

> This recommendation (the Lahiri *ayanāṃśa*; D.K.) is to be regarded only as a measure of compromise, so that we avoid a violent break with the established custom. But it does not make our present seasons in the various months as they were in the days of Varahamihira or Kalidasa. It is hoped that at not a distant date, further reforms for locating the lunar and solar festivals in the seasons in which they were originally observed will be adopted.[8]

A similar recommendation was already made by S.B. Dikshit in 1896.[9] However, such proposals have been ignored, because the conservative forces have been too strong. Some individuals still tirelessly fight for a reform but are susceptible to fierce attacks. For example, Pandit A.K. Kaul, moderator of the Hindu Calendar Internet Forum, advertises a tropical calendar published by Darshaney Lokesh and TV Sivaraman.[10] Kaul writes:

---

[8] *Report of the Calendar Reform Committee*, p. 5.

[9] Dikshit, *Bharatiya Jyotish Sastra*, Part II, p. 576: "I have given all the reasons for using Sayana Panchagas for astrology as well as rituals etc. If because of any reasons whatsoever and in spite of the fact that Sayana Panchanga is the one recommended by all our shastras, it is difficult to convince the general public of a gap of 23 days between a sayana sankranti and a nirayana Grahalaghava/Surya Sidhanta Sankranti, then we may start using a fictitious Ayanamsha opposite the Star Chitra, instead of from the end of Revati division because in the latter case, there will be a difference of three days even then between Grahalaghava and Revati Sankrantis, which the general public may not like. The difference between the starting point of 180° opposite Chitra and that of Grahalaghava Sankrantis will be hardly a few hours which the general public will not understand. As such, it is the path of least resistance and may be adopted if at all nirayana panchangas are a necessary evil."

[10] Darshaney Lokesh, श्री मोहन कृति आर्ष तिथि पत्रक, (Sri Mohan Krity Aarsh Tithi Patrak, in Hindi),
http://www.reformedsanathancalendar.in/SMKATP_internet%20Edition.pdf .
There is also an English and Tamil version of the same calendar:
T. V. Sivaraman, *Reformed Sanathan Calendar*,
http://www.reformedsanathancalendar.in ; as PDF under:
http://www.reformedsanathancalendar.in/sanathancalendar2014.pdf .
Main page: http://www.reformedsanathancalendar.in .

> Uttarayana is nothing but Winter Solstice and it was the start of the same Tapah month that was known as Makar Sankranti later as per the puranas. We must therefore realign our calendar immediately to the seasons if we want the real Vedic dharma to flourish really.[11]

The discussion between reformers and traditionalists is extremely emotional, often even offensive. An objective discussion of the problem does not take place. Hence, coming back to the topic, if nowadays' traditionalists so fiercely oppose a correction of their outdated teachings, why should the same not have taken place in ancient times? Why should texts from the 4th century BCE not include astronomical concepts from the 3rd millennium BCE?

A very good example for a mixture of old and new astronomical concepts is given in chapter 2.8 of the Viṣṇupurāṇa. Experts agree that this work was compiled in post-Hellenistic times (3rd/4th cent. AD). In VP 2.8.28ff. (quoted on p. 41f.), it is stated that the solstices are at the initial points of Capricorn and Cancer and the equinoxes at the initial points of Aries and Libra. *This* statement clearly stems from post-Hellenistic times, from the first half of the 1st millennium CE. However, later in the same chapter, in VP 2.8.76-79 (quoted below on p. 27f.), it states that when the Sun is in the third quarter of Viśākhā and the full moon in the first quarter of Kṛttikā, then that is the autumnal equinox. This statement is only valid for the 2nd millennium BCE. Thus, there is obviously very old and very young material mixed together in this text.

Very old astronomical observations, as must be underlying here, not only precede the written sources by thousands of years, but in several cases, as will be shown, even go back to a time prior to the Aryan immigration into India, which is considered to have taken place in the 2nd millennium BCE. Thus, it has to be concluded that the Vedic astronomical tradition was either introduced into India by the Aryans, when they came from Andronovo, or otherwise its origins could be in the Indus culture. Both solutions seem possible. A considerable heritage from the Indus Civilisation must have been incorporated in the Vedic culture. The astronomical tradition could be part of it.

---

[11] http://groups.yahoo.com/group/hinducalendar/

## Vernal Point in the Lunar Mansion Kṛttikā

The list of *nakṣatras*, as known today and as found in astronomical works of the post-Hellenistic period, begins with *Aśvinī*. However, in lists given in the Purāṇas, the Mahābhārata, and in Brāhmaṇa texts, *Kṛttikā* appears in the first place (e. g. MBh 13.63(64).5ff.) Kṛttikā is more frequently mentioned than any other lunar mansion. It seems that Kṛttikā, as well as Maghā, which is approximately in square to Kṛttikā, were of exceptional importance. The reason seems to be that in ancient times the vernal equinox was in Kṛttikā and the summer solstice in Maghā; or otherwise the fact that the full moon, when it occurred in Kṛttikā, roughly coincided with the autumn equinox, and the full moon in Maghā with the winter solstice.[12] In principle, this explanation allows an astronomical dating of this calendrical system, although not necessarily a dating of the texts that refer to it. As has been said already, the doctrine could be a lot older that the written documents in which it first appears.

Whether the leading position Kṛttikā is to be explained from the fact that vernal point was located in it or alternatively from the fact that the autumnal full moon occurred in it, is irrelevant to the astronomical dating of the system. In the same epoch in which the vernal equinox was in Kṛttikā, the full moon in Kṛttikā also fell approximately on the autumnal equinox. The question becomes important only when one wants to know in what way Kṛttikā marked the beginning of the year. There is strong evidence that in ancient times a full moon marked the end and the beginning of a year. The Kṛttikā system might thus have begun the year in autumn. However, there is evidence of various Vedic calendar traditions, and also of calendars that had years begin in spring. However, this problem is irrelevant for the astronomical dating of texts and astronomical concepts as discussed in this chapter.

If the system of *equal nakṣatras* is considered, the vernal equinox could have been attributed to Kṛttikā sometime after 3000 BCE,

---

[12] vide e. g. Dikshit, *Bharatiya Jyotish Sastra*, p. 129; Sengupta in: Burgess, *The Sûrya Siddhânta*, p. xxxv ff.; Kuppanna Sastry in: Sarma, K. V. (ed.), *Vedāṅga Jyotiṣa of Lagadha...*, p. 12.

and before that to Rohiṇī. The time frame for Kṛttikā as equinoctial lunar mansion could perhaps have lasted until 1500 BCE. The situation is similar, if the principal stars (*yogatārās*) of the *nakṣatras* are considered, which in the case of Kṛttikā is the star cluster of the Pleiades. The vernal point was near Kṛttikā (the Pleiades) about 2340 BCE. Taking into account the positions of neighbouring *nakṣatra* stars, namely Bharaṇī and Rohiṇī, one could say that the vernal equinox could be attributed to the Pleiades between 2500 BCE and 1800 BCE. The rising of the Pleiades exactly in eastern direction, as mentioned in the Śatapathabrāhmaṇa, can be dated to 2900 BCE.

The *terminus post quem* for the Mahābhārata war as defined by this time frame is, unfortunately, very vague. The situation is made even worse by the fact that the old *nakṣatra* list beginning with Kṛttikā became a "frozen" tradition for hundreds or even thousands of years, and survived far beyond its astronomical expiration date until Late Antiquity. As a result, the old *nakṣatra* list neither provides a useful *terminus post quem* nor a useful *terminus ante quem* for the war. The war could even have occurred as early as the first half of the 3rd millennium BCE or as late as 800 BCE, as has been suggested by B.B. Lal.[13] The only thing that can be stated with certainty is that the list of the lunar mansions was created before 1500 BCE.

Hindu traditionalists do not like the idea that the great importance of Kṛttikā has to do with the position of the equinoctial axis in ancient times, because it defines a *terminus post quem* for the Mahābhārata War that contradicts their views. They believe that Kṛṣṇa died in the so-called *kaliyuga* year 3102 BCE and the war took place 36 years earlier in 3138 BCE. Besides, they do not admit that the equinoxes and solstices played an important role in the Vedic religion because then they would probably feel forced to reform their sidereal calendar and make it tropical.

For example, Kota Venkatachelam denies any connection between Kṛttikā and the spring equinox in ancient texts. He believes that the Vedic calendar functioned completely independently of the equinoxes and solstices. In today's Indian calendars, this is indeed the

[13] B. B. Lal, "Mahabharata and Archaeology", p. 52ff.

case. As has been stated previously, the winter solstice (*uttarāya-ṇam*) is celebrated in mid-January, at the ingress of the Sun into sidereal Capricorn, regardless of the actual date of the solstice, although this practice contradicts the very concept of the *uttarāyaṇa*, which refers to the "northward course" of the Sun.

Concerning the Kṛttikā *nakṣatra* list, Venkatachelam says:

> ... that the Krittikas are given the first place among the Nakshatras in the Karma-Kanda, not because they were considered to be the first among the Nakshatras in those ancient times, nor even because at the time of the composition of these Vedas, the vernal equinox was believed to have taken place when the sun was in the Krittikas. [14]

Instead, he explains the leading position of Kṛttikā by the fact that this lunar mansion is ruled by the fire god Agni, who receives all sacrifices and therefore is considered "the mouth of all the gods":

> ... all sacrifices are offered to Agni (Fire), he being considered the mouth of all the Gods and the first and the foremost among them ... As Krittikas are expressly stated to be the constellation presided over by Agni, and as all sacrifices to Agni ... are fraught with glory and success, the Krittikas are given the first place...[15]

This interpretation is seemingly supported by the following text Taittirīya-Brāhmaṇa I.1.2.1:

कृत्तिकास्वग्निमादधीत

एतद्वा अग्नेर्नक्षत्रं यत्कृत्तिकाः

*kṛttikāsvagnimādadhīta*
*etadvā agnernakṣatraṃ yatkṛttikāḥ*

| |
|---|
| In the Kṛttikās one should set the [sacrificial] fire (*agniḥ*).<br>For, these are the lunar mansion of the fire god (*agniḥ*), the Kṛttikās. |

...

मुखं वा एतन्नक्षत्राणां यत्कृत्तिकाः

*mukhaṃ vā etannakṣatrāṇāṃ yatkṛttikāḥ*

| |
|---|
| These are the mouth of the lunar mansions, the Kṛttikās. |

Venkatachelam's interpretation of the expression "mouth of the lunar mansions" (*mukhaṃ nakṣatrāṇām*) is easily refuted, though. In Śatapathabrāhmaṇa 6.2.2.18, it says:

[14] Venkatachelam, *The Plot in Indian Chronology*, p. 160.

[15] Venkatachelam, *The Plot in Indian Chronology*, p. 158ff.

तद्वै फाल्गुन्यामेव एषा ह संवत्सरस्य प्रथमा रात्रिर्यत्फाल्गुनी पौर्णमासी

योत्तरैषोत्तमा या पूर्वा मुखत एव तत्संवत्सरमारभते

*tadvai phālgunyāmeva eṣā ha saṃvatsarasya prathamā rātriryatphālgunī paurṇamāsī yottaraiṣottamā yā pūrvā mukhata eva tatsaṃvatsaramārabhate*

And therefore [the sacrificial animal should be slaughtered] in the Phalgunī [full moon night]: For, this is the first night of the year, namely the second [night] of the Phalgunī full moon, the first [Phalgunī night] being the last [night of the year]. Then the year starts again from its *mouth (or: beginning; mukhataḥ*).

Thus "mouth" (*mukham*) here does not refer to the sacrificial fire, rather it is used in the sense of "beginning" (see also TaiBr 1.1.2.8). Also, it must be noted that the two Phalgunī *nakṣatras* do not have Agni as their ruler, but Bhaga and Aryamā (TaiBr 1.1.2.4). Uttaraphalgunī ("the rear Phalgunī") is the first lunar mansion, and Pūrvaphalgunī ("the front Phalgunī") is the last one, as is also confirmed by Kauṣītaki-Brāhmaṇa 5.1.2ff.:

चातुर्मास्यानि प्रयुञ्जानः फाल्गुन्यां पौर्णमास्यां प्रयुङ्क्ते (2)

*cāturmāsyāni prayuñjānaḥ phālgunyāṃ paurṇamāsyāṃ prayuṅkte (2)*

He who performs the four-month [sacrifices] should perform [one sacrifice] on the Phalgunī full moon.

मुखं वा एतत्संवत्सरस्य यत्फाल्गुनी पौर्णमासी (3)

*mukhaṃ vā etatsaṃvatsarasya yatphālgunī paurṇamāsī (3)*

For, this is the mouth of the year, the Phalgunī full moon.

मुखमुत्तरे फल्गू (4) पुच्छं पूर्वे (5)

*mukhamuttare phalgū (4) pucchaṃ pūrve (5)*

Uttaraphalgunī is the mouth, Pūrvaphalgunī is the tail.

तद्यथा प्रवृत्तस्यान्तौ समेतौ स्याताम् (6)

एवमेवैतौ संवत्सरस्यान्तौ समेतौ (7)

*tadyathā pravṛttasyāntau sametau syātām (6)*
*evamevaitau saṃvatsarasyāntau sametau (7)*

As the two ends come together for him who returns,
just like that the two ends of the year come together.

तद्यत्फाल्गुन्यां पौर्णमास्यां वैश्वदेवेन यजेत (8)

मुखत एव तस्संवत्सरं प्रीणाति (9)

*tadyatphālgunyāṃ paurṇamāsyāṃ vaiśvadevena yajeta (8)*
*mukhata eva tas(!)saṃvatsaraṃ prīṇāti (9)*

| |
|---|
| That which is sacrificed on the Phalgunī full moon by means of the all-gods ceremony,<br>by that one pleases the year at its mouth (= beginning): |

अथो भैषज्ययज्ञा वा एते यच्चातुर्मास्यानि (10)

तस्मादृतुसंधिषु प्रयुज्यन्ते (11)

ऋतुसंधिषु हि व्याधिर्जायते (12)

*atho bhaiṣajyayajñā vā ete yaccāturmāsyāni (10)*
*tasmādṛtusaṃdhiṣu prayujyante (11)*
*ṛtusaṃdhiṣu hi vyādhirjāyate (12)*

| |
|---|
| Now those four-month [sacrifices] are sacrifices for the purpose of healing.<br>Therefore, they are performed at the transitions of the seasons.<br>For, illness is born at the transitions of the season. |

The *nakṣatra* Uttaraphalgunī is the "mouth" (*mukham*) of the year, and Pūrvaphalgunī is called its "tail" (*puccham*). In addition, reference is made to the seasons. Another confirmation of the interpretation of *mukham* as "beginning" can be found in Taittirīya-Brāhmaṇa 1.1.2.6f., where spring is called "the mouth of the seasons" (*mukham vā etad ṛtūnāṃ yad vasantaḥ*). The question why the beginning of the year is considered to be between the Phalgunī *nakṣatras* will be discussed shortly.

Venkatachelam is clearly mistaken in his assertion that not even one source explicitly links Kṛttikā to the spring equinox. There are very clear testimonies in Vedic sources, as long as one knows to interpret the astronomical details given within them.

In Śatapathabrāhmaṇa 2.1.2, a very old text, there are the following interesting statements:

कृत्तिकास्वग्नी आदधीत । एता वा अग्निनक्षत्रं यत्कृत्तिकास्... (1)

*kṛttikāsvagnī* (no Sandhi!) *ādadhīta | etā vā agninakṣatraṃ yatkṛttikās ... (1)*

| |
|---|
| In the Kṛttikās one should make two [sacrificial] fires (*agni*). For, the Kṛttikās are the lunar mansion of the fire god (*agni*). |

एकं द्वे त्रीणि । चत्वारीति वा अन्यानि नक्षत्राण्यथैता एव भूयिष्ठा यत्कृत्तिकास् । ... । तस्मात्कृत्तिकास्वादधीत (2)

*ekaṃ dve trīṇi | catvārīti vā anyāni nakṣatrāṇyathaitā eva bhūyiṣṭhā yatkṛttikās | ... | tasmātkṛttikāsvādadhīta (2)*

"One, two, three, four", like this [are counted] other lunar mansion stars. The Kṛttikās, however, are more [than four] ... Therefore one should make [two sacrificial fires] in the Kṛttikās.

एता ह वै प्राच्यै दिशो न च्यवन्ते । सर्वाणि ह वा अन्यानि नक्षत्राणि प्राच्यै दिशश्च्यवन्ते । तत्प्राच्यामेवास्यैतद्दिश्याहितौ भवतस्तस्मात्कृत्तिकास्वादधीत (3)

*etā ha vai prācyai diśo na cyavante | sarvāṇi ha vā anyāni nakṣatrāṇi prācyai diśaścyavante | tatprācyāmevāsyaitaddiśyāhitau bhavatastasmātkṛttikāsvādadhīta (3)*

These [Kṛttikās] do not swerve from the eastern direction. All other *nakṣatras do* swerve from the eastern direction. Therefore one makes one's two [sacrificial fires] in eastern direction. Therefore one should make [two sacrificial fires] in the Kṛttikās.

अथ यस्मान्न कृत्तिकास्वादधीत । ऋक्षाणां ह वा एता अग्रे पत्न्य आसुः । सप्तर्षीनु ह स्म वै पुरर्क्षा इत्याचक्षते । ता मिथुनेन व्यार्ध्यन्त । अमी ह्युत्तराहि सप्तर्षय उद्यन्ति पुर एता । अशमिव वै तद् । ... (4)

*atha yasmānna kṛttikāsvādadhīta | ṛkṣāṇāṃ ha vā etā agre patnya āsuḥ | saptarṣīnu ha sma vai purarkṣā ityācakṣate. tā mithunena vyārdhyanta | amī hyuttarāhi saptarṣaya udyanti pura etā. aśamiva vai tad... (4)*

Now [the reasons] why one should *not* make [sacrificial fires] in the Kṛttikās: Formerly they were the wives of bears. The Seven Ṛṣis were formerly called "bears". Those [Kṛttikās] were deprived of their union [with them]. For, those seven Ṛṣis rise in the north, [whereas] these [Kṛttikās rise] in the east.[16] This is inauspicious, as it were...

The statement of paragraph 3: "these [Kṛttikās] do not swerve from the eastern direction", can be interpreted as follows: Since the Kṛttikās are the only *nakṣatra* that rises exactly in the east, while all the others deviate from exact east, therefore they are of great importance. Why? Since they are close to the ecliptic, their position

[16] Achar believes that *udyanti* only refers to the Kṛttikās, because the stars of the Big Dipper or Seven Ṛṣis are circumpolar and therefore cannot really "rise". He therefore reads: *amī hyuttarāhi saptarṣayaḥ (santi), udyanti pura etāḥ*: "The Seven Ṛṣis are northern, whereas those (Pleiades) rise in the east."

in the east means that they are in the vicinity of the vernal point. Thus it is the equinox which gives them their outstanding importance. Thus they are also the “mouth or beginning of the *nakṣatras*”.

The fact that the Pleiades rose exactly in the east is astronomical information that can be dated by means of the precession of the vernal point, namely, as has been mentioned, near the year 2900 BCE.[17] Even if this is not the creation date of the Śatapathabrāhmaṇa, it seems that the astronomical doctrine from which it is derived goes back to that epoch.

Various objections have been made against this dating. The Indian astronomer K. L. Daftari argues that the Pleiades, because they are very faint, become visible above the horizon only at a height of 13°, wherefore they could not be seen rising in the east. He therefore assumes that the Pleiades were not in the east at the moment when they stood exactly on the horizon, because in that moment they were not visible, but rather at the moment when they became visible a few degrees *above* the horizon. He therefore draws the conclusion that the statement in Śatapathabrāhmaṇa must be dated only to the 18th century BCE.[18] Sengupta's argumentation is similar, but he assumes a minimum height of 7°30' for the Pleiades to be visible and dates the text to 2444 BCE.[19] Daftari refers to observations of his own. Sengupta does not refer to any source. However, as the Pleiades are not very bright, their visibility strongly depends on atmospheric conditions and the eye sight of the observer.

However, these objections are neither mandatory nor convincing. Since the height at which the Pleiades appear is so dependent on the atmospheric conditions, the direction in which they appear is variable and cannot be determined accurately. Also Daftari's assertion that a rising exactly in the east, thus near the east point on the horizon, can only be *calculated*, not observed, is only half the truth.

---

[17] Dikshit, *Bharatiya Jyotish Sastra*, p. 128f.; Sengupta, in Burgess, *The Sûrya Siddhânta*, p. xxxv f.; Achar, “On Exploring the Vedic Sky with Modern Computer Software”.

[18] Daftari, *The Astronomical Method...*, p. 104ff.

[19] Sengupta, *Ancient Indian Chronology* (1947), p. xxvi f., explanations on RV 4.5.7 and foot note. However, in his introduction in Burgess, *The Sûrya Siddhânta*, p. xxxv f., (1935), Sengupta still believes, it refers to a rising exactly in the east.

An experienced sky watcher does know certain things that cannot be seen. For example, the Moon is bright enough to already become visible just above the horizon. Thus when some day the Moon appeared exactly in the east on the horizon and, as she climbed higher, appeared in the Pleiades, then one knew that the Pleiades had also risen in the east. From this, one might have concluded that the Pleiades were at the vernal equinox, and that their lunar mansion was associated with the spring new moon and the autumn full moon. Since the Pleiades are not located exactly on the ecliptic, but a few degrees north of it, this conclusion would not have been fully correct, of course. Still, it might have been considered logical in ancient times.

Experienced sky watchers know that considerations of this kind are by no means advanced science, but rather impose themselves on the regular sky observer. They are even trivial compared to the task of building an observatory with sighting tools and determining the exact east-west direction. Even this is possible with very simple means. With the help of a gnomon and a cord, one can determine the east-west direction with a precision of 1° to 2° within a single sunny day.[20] Using a gnomon, one could also find out that the Pleiades culminated at the same height as the equinoctial Sun and that for this reason they had to rise exactly in the east.

To prove his case, Daftari also quotes *Baudhāyanaśrautasūtra* 25.3.5:

तदेतां प्राचीनवंशा शालां मापयन्ति । कृत्तिकाः खल्विमाः प्राचीं दिशं न परिजहति ।

तासां संदर्शनेन मापयेदित्येकं । श्रोणासंदर्शनेन मापयेदित्येकम्

*tadetāṃ prācīnavaṃśā śālāṃ māpayanti | kṛttikāḥ khalvimāḥ prācīṃ diśaṃ na parijahati | tāsāṃ saṃdarśanena māpayedityekaṃ | śroṇā-saṃdarśanena māpayedityekam*

Therefore a house is laid out east-facing with girders. The Kṛttikās (Pleiades) do not deviate from the eastern direction. When one sees these, then one ought to lay out a house. When one sees Śravaṇā, then one ought to lay out another one.

[20] The gnomon is installed and a circle drawn around it. Over the course of a day one observes the shadow of the gnomon and marks the two points at which the tip of the shadow touches the circle. The connecting line between the two points provides the east-west direction. The observation is most accurate near the summer solstice. Since at this time of the year the declination of the Sun does not significantly vary, the shadow makes practically the same motion for several days, and the observation can be repeated and improved.

This passage obviously alludes to the text in Śatapathabrāhmaṇa. The expression *na cyavante*, "they do not swerve", is replaced by the equivalent expression *na parijahati*, "they do not leave". The fact that there is explicit mention of a "seeing" (*saṃdarśaṇam*) of the Pleiades seems to support Daftari's view that the stars must have been *seen*, not calculated or inferred, to be rising exactly in an easterly direction. He also points out that the other star mentioned, namely Śravaṇā, could never rise in the east, whereas it could be observed in the east at some altitude above the horizon. This seems to be a strong argument, indeed. Let this be examined more closely!

*Baudhāyanaśrautasūtra* treats the building of houses that are to be oriented to the east. However, there are more accurate methods to determine the east-west direction than by means of the observation of stars. For example, one could simply use a gnomon. Two different interpretations of the text seem to be possible. Either the text wants that "a house is laid out" *in the moment* in which one *sees* one of the two stars. Or otherwise *saṃdarśanena* must be interpreted in the sense that the house should "face" towards the *rising direction* of one of the two stars. The latter is more likely. The text does not intend that the direction is determined from the rising direction of the Pleiades. The idea is rather that this orientation is to be chosen for the house *because* the Pleiades do not swerve from the east. In *Śatapathabrāhmaṇa*, it is the *altar* that is built in east-west direction, whereas here, it is a house.

The important question to be asked is why the Pleiades and the orientation of the altar or building towards the east are so important. The most obvious answer, as has been stated, is that the vernal equinox was near the Pleiades. However, if one follows Daftari and Sengupta, assuming that the Pleiades were in the east only at the moment when they became visible at an altitude of 13° or 7°30', then the connection between the Pleiades and the vernal equinox is completely lost. The equinoctial point is in the exact east only in the moment when it is exactly on the horizon, and a star that is near an equinoctial point is in the east only during its *rising*, i.e. when it crosses the horizon at the east point. If in ancient times the Pleiades were linked to the vernal equinox, then this was because they rose approximately in the east. However, if they stood in the exact east only far above the horizon, then their association with the vernal equinox was no longer given, and a full moon or a lunar eclipse near them did not take place on the autumn equinox. Their position in the east would have been completely meaningless. The considerations and dates given by Daftari and Sengupta must therefore be rejected.

But then, what is the meaning of the star or lunar mansion Śravaṇa in the above-quoted text from the Baudhāyanaśrautasūtra? Daftari believes it served the orientation to the east. However, this is mere conjecture that is not explicitly supported by the text. It is more likely that Śravaṇa is mentioned because the winter solstice was located in this lunar mansion (after Lahiri) in the period 1410 - 440 BCE. In fact, there are texts, as will be seen, that state that the winter solstice is at the beginning of Śravaṇa. It could be objected that if this interpretation were correct, astronomical traditions of two different epochs were confused by these sentences, the one dating from the 3rd millennium BCE (Kṛttikā), the other from perhaps 1000 BCE (Śravaṇa). Admittedly, this is unaesthetic. Still, this author considers it convincing. Mixing of different traditions does occur in Vedic texts.

However that may be, and whether one wants to date the observation of Kṛttikā in the east to 2900 BCE, 2400 BCE, or 1800 BCE, all proposed astronomical dates are more than 1000 years earlier than the generally accepted date of Śatapathabrāhmaṇa (750-600 BCE), which is based on linguistic and historical considerations. Since the latter are certainly well-founded, this is obviously a case where a very ancient astronomical tradition has been included in later texts.

Another argument against such very early dating comes from Pingree. In his view, the statement that the Pleiades do not deviate from the east does not mean that they are exactly in the east. Because, if they were, then the subsequent sentence, which states that all other *nakṣatras* do deviate from the east would be wrong. According to Pingree, at least parts of the lunar mansions Hasta, Viśākhā, and Śravaṇa were also rising in the east. He therefore believes that their rising in the east must be understood in contrast to the rising in the north of the Seven Ṛṣis.[21] In reality, however, the contrast that the text is intending is the following:

[21] Pingree, "Mulapin and Vedic Astronomy", p. 444f.

एता ह वै प्राच्यै दिशो न च्यवन्ते । सर्वाणि ह वा अन्यानि नक्षत्राणि प्राच्यै दिशश्च्यवन्ते (3)
*etā ha vai prācyai diśo na cyavante | sarvāṇi ha vā anyāni nakṣatrāṇi prācyai diśaścyavante ... (3)*

These [Kṛttikās] do not swerve from the eastern direction. All other *nakṣatras do* swerve from the eastern direction.

B.N. Achar has also pointed out, and rightly so, that precisely the stars that Pingree himself considers the principal stars or *yogatārās* of Hasta (δ *Corvi*), Viśākhā (ι *Librae*), and Śravaṇa (α *Aquilae*), deviated by more than 5° from the celestial equator, and thus from the east point, for the same epoch.[22] On the other hand, one could object to Achar that the *yogatārā* of Bharaṇī (35 *Arietis*), which precedes Kṛttikā, as well as the star Anurādhā (δ *Scorpionis*), which is in opposition to the Pleiades, *were* in fact located on the equator. The Pleiades were thus *not* the only *yogatārās* that rose exactly in the east.

However, it has to be kept in mind that the lunar mansions were primarily relevant for the observation of the Moon and the Sun and that the circle of the lunar mansions was actually the ecliptic. Thus if, instead of the principal stars or constellations of the *nakṣatras*, their respective sections on the ecliptic are considered, then there are only two points that are exactly in the east, namely the two equinoctial points. Furthermore, if there are 27 equal-sized lunar mansions on the ecliptic and the vernal equinox is assumed at the beginning of Kṛttikā, then of all lunar mansions only Kṛttikā rises exactly in the east. Of course, it is uncertain whether the idea of 27 lunar mansions, all being the same size, was already given in the 3rd millennium. The passage from the Vedāṅgajyotiṣa discussed further above seems to testify its existence at least for the 13th century BCE. More evidence for a high age of this concept will be given shortly.

Witzel has also dealt with the problem in his discussion with Achar, and he does not entirely reject such an early date.[23] On the one hand, he insists that the Śatapathabrāhmaṇa was composed in the

[22] Achar, "On the Astronomical Basis of the Date of *Śatapatha Brāhmaṇa*: A Re-examination of Dikshit's Theory"; idem, "On Exploring the Vedic Sky with Modern Computer Software".

[23] Witzel, "The Pleiades and the Bears viewed from inside the Vedic texts".

Iron Age. Linguistic considerations and the mention of iron in the text leave little room for doubt. However, he admits that the late dating of the text to approximately 750-600 BCE does not exclude that very old traditions were included in the text. He himself points out that immediately after the paragraph concerning the Pleiades rising in the east, another tradition is mentioned which is very, very old (see also RV 1.24.10):

> सप्तर्षीनु ह स्म वै पुरर्क्षा इत्याचक्षते (ŚB 2.1.2.4)
> *saptarṣīnu ha sma vai purarkṣā ityācakṣate* (ŚB 2.1.2.4)

| The Seven Ṛṣis were formerly called “the Bears”. |
| --- |

The constellation of the Big Dipper or “Great Bear” – *ṛkṣaḥ* = ἄρκτος = *ursus* – seems to go back to a Indo-European astronomical tradition.

Witzel’s assertion that the statement “the Pleiades do not swerve from the east” could still have been considered “valid” even in 500 BCE, at an azimuthal deviation of 13° from the east point, must be rejected. He concludes this from the fact that the older literature does not know more than four cardinal directions. It must be kept in mind, however, that a difference of only 1° is already equivalent to two full moon diameters; and 13° thus correspond to 26 full moon diameters. If Witzel were right, then the statement that the Pleiades “do not swerve from the east (*na cyavante*)” would not make any sense at all. Besides, the subsequent statement, according to which all other *nakṣatras* do deviate from the east, would become absurd, because in fact most *nakṣatras* would not “deviate” from the east either. What else could be the meaning of *na cyavante*, if not *accuracy*?[24]

In this study, the statement that the Pleiades do not deviate from the east has been interpreted in the sense that they rose exactly in the east. In contrast, Witzel and Achar (unlike Dikshit and Sengupta) believe, that the text refers to a “heliacal rising” of the Pleiades. However in reality, there is not the slightest indication of a heliacal rising in the text. There is no mention of a “morning rise”, “rising before the Sun”, “appearance before sunrise”, or the like. It also seems that Witzel either does not have a clear understanding of

---

[24] See also BN. Achar’s reply to Witzel’s article: “Comments on 'The Pleiades and the Bears viewed from inside the Vedic texts'”.

heliacal risings or that he wrote his article without adequate care. His following statement makes it obvious:

> The heliacal rising in kRttikAH of the sun thus took place in c. 2927 BCE at the vernal equinox in March.

Of course, there is no "heliacal rising in kRttikAH of the sun", only a heliacal rising of Kṛttikā. Furthermore when this occurs, the Sun itself cannot be in Kṛttikā, but must be at a certain distance from the Pleiades, otherwise they cannot become visible before sunrise. Now, in the year 2927 BCE, the heliacal rising of Kṛttikā did not occur on the vernal equinox, but only about a month later. If one wanted the heliacal rising of the Pleiades to occur on the spring equinox, then one would have to go further back in time to the year 5000 BCE.[25] However, as has been stated, the text is not referring of a heliacal rising.

The reason for the mention of the Pleiades in the east should have become obvious. The observation of the Pleiades as well as the full and new moons that took place near them might have played an important role in the intercalation of the Vedic lunisolar calendar:

1. The *autumnal* equinox might ideally have coincided with the full moon in the Pleiades. This full moon marked the month of Kārttika, the first month of the year; and the lunar mansion Kṛttikā, the Pleiades, thus marked the "mouth" of the year.

2. The *vernal* equinox was probably associated ideally with the new moon in the Pleiades. Although a new moon in the Pleiades could not be observed directly, the position of the Moon could be inferred by counting days and *nakṣatras*, and the equinox was observed from the direction of the sunrise. This new moon belonged to the month of Vaiśākha.

3. When the new crescent appeared in conjunction with the Pleiades, then the astronomers of that time might have known that the

---

[25] The following statements by Witzel are strange, too: "While the ZB (= Śata-pathaBrāhmaṇa; D.K.) quotation discussed by N. Achar and his predecessors indeed seems to point to a situation where kRttiKA nakSatra was situated at true east at the equinox, i.e. in 2927 BCE." (End of sentence!) "At vernal equinox in 2900 BCE the kRttikAs were at 90° azimuth". In reality the Pleiades in that epoch rose in the east *every day and during the whole year*, not only on the equinox or at their heliacal rising some time in spring.

vernal equinox would take place within one month. This new crescent could also have indicated the month of Kārttika. When the conjunction with the Pleiades took place three days after the new crescent, then an intercalary month could have been inserted.[26] However, whether or not this was actually done, is unknown.

The three points above are kept very vague intentionally. As has been mentioned, there were several different calendar traditions, and there is no need here to determine more exactly how the calendar was made.

The equinoxes as well as the calendar played an important role in the Vedic sacrificial religion. Therefore, it has to be concluded that the statement regarding the Pleiades being in the east is not only approximate, but that the *exact* east was intended. It is in the nature of rituals, also in India, that they must be done correctly and at the correct time, if they are to cause favourable results. An accurate determination of the dates was crucial.

So far concerning the statement in Śatapathabrāhmaṇa that the Kṛttikās do not swerve from the east. Let us turn to a different text from a later period, Taittirīya-Brāhmaṇa 1.5.2.7f.:

कृत्तिकाः प्रथमम् । विशाखे उत्तमम् । तानि देवनक्षत्राणि

*kṛttikāḥ prathamam | viśākhe uttamam | tāni devanakṣatrāṇi*

| |
|---|
| The [stars of] Kṛttikā are the first [lunar mansion], the two [stars of] Viśākhā the last one. These are the lunar mansions of the gods. |

अनुराधाः प्रथमम् । अपभरणीरुत्तमम् । तानि यमनक्षत्राणि

*anurādhāḥ prathamam | apabharaṇīruttamam | tāni yamanakṣatrāṇi*

| |
|---|
| The [stars of] Anurādhā are the first one, those of Apabharaṇī the last one. These are the lunar mansions of death. |

यानि देवनक्षत्राणि । तानि दक्षिणेन परियन्ति

*yāni devanakṣatrāṇi | tāni dakṣiṇena pariyanti*

| |
|---|
| The lunar mansions of the gods circle south [of the world of the gods]. |

[26] A similar intercalation rule can be found in the cuneiform text *Epinnu* (mul. apin). It has also been suggested that the disc of Nebra contains an intercalation rule which is based on new and full moons in the Pleiades. Historical connections with ancient Indian calendar rules need not be assumed, especially not when Mesopotamian and Indian calendars were so different. Similar astronomical methods might have been developed in different regions even without cultural exchange.

यानि यमनक्षत्राणि । तान्युत्तरेन

*yāni yamanakṣatrāṇi | tānyuttarena*

| |
|---|
| The lunar mansions of death [circle] north [of the world of death]. |

The last two lines have been translated in agreement with the commentators Sāyana and Bhāskara. The "world of the gods" obviously stands for the northern sky, the "world of death" for the southern sky. The ecliptic runs in the middle between the two. The southern lunar mansions, which are associated with death, make their daily rotation north of the world of death; and the northern lunar mansions, which are associated with the gods, perform their daily rotation south of the world of the gods. Whether this interpretation is correct or not need not be discussed. In any case, the text clearly refers to the halves of the year that run from equinox to equinox.[27]

In this text, it seems that the boundaries between the two halves are between Bharaṇī and Kṛttikā on the one hand and between Viśākhā and Anurādhā on the other. From this it can be surmised that it is a circle of 28 (not 27) lunar mansions, because otherwise the opposite point to the beginning of Kṛttikā would fall into the middle of Viśākhā. Of course, the statement made by the text is only valid if a system of equal-sized lunar mansions is assumed, which is not certain. The vernal equinox was near the Pleiades around the year 2340 BCE. Since Rohiṇī is very close, it should not be dated older than 2500 BCE. After about 1800 BCE, the vernal equinox is more likely to have been assigned to Bharaṇī – unless people held on to the old tradition. It is unlikely that this doctrine originated after this date.

---

[27] There is a similar passage in Śatapathabrāhmaṇa 2.1.3:

वसन्तो ग्रीष्मो वर्षस्ते देवा ऋतवः शरद्धेमन्तः शिशिरस्ते पितरो ... स (सूर्यो) यत्रोदगावर्तते देवेषु तर्हि भवति ...

यत्र दक्षिणावर्तते पितृषु तर्हि भवति

*vasanto grīṣmo varṣaste devā ṛtavaḥ śaraddhemantaḥ śiśiraste pitaro ... sa (sūryo) yatrodagāvartate deveṣu tarhi bhavati ... yatra dakṣiṇāvartate pitṛṣu tarhi bhavati,*

| |
|---|
| Spring, summer, and rain – these seasons are the gods; autumn, winter, and cold – these are the ancestors. When the Sun turns to north, he is amongst the gods...; when he turns to south, he is amongst the ancestors. |

Here, again, the axis between the ancestors and the gods is at the equinoxes.

The Mahābhārata mentions a doctrine according to which the two lunar mansions Kṛttikā and Maghā, the Pleiades and Regulus, were important *tīrthas*, i.e. holy "places of pilgrimage", and dates of important sacrifices:

कृत्तिकामघयोश्चैव तीर्थमासाद्य भारत

अग्निष्टोमातिरात्राभ्यां फलं प्राप्नोति पुण्यकृत्

*kṛttikāmaghayoścaiva tīrthamāsādya bhārata*
*agniṣṭomātirātrābhyāṃ phalaṃ prāpnoti puṇyakṛt (MBh 3.82.46)*

> If one approaches Kṛttikā or/and Maghā as a place of pilgrimage, then one receives, as a doer of pure deeds, fruit (= auspicious results) from Agniṣṭoma and Atirātra [sacrifices] (i. e. one reaches heaven).

This doctrine probably originated from the fact that in the period mentioned above, the vernal equinox was in Kṛttikā and the summer solstice in Maghā; or perhaps rather from the fact that the full moons that took place in the same lunar mansions ideally coincided with the autumnal equinox and the winter solstice.

An interesting text that mentions the equinoxes, which even Venkatachelam quotes, although he fails to recognize its real significance, is found in Viṣṇupurāṇa 2.8., and with some variations also in Brahmāṇḍapurāṇa 1.21 and Vāyupurāṇa 50:

प्रथमे कृत्तिकाभागे यदा भास्वांस्तदा शशी

विशाखानां चतुर्थेंऽशे मुने तिष्ठत्यसंशयम्

(कृत्तिकानां यदा सूर्यः प्रथमांशगतो भवेत्

विशाखानां तदा ज्ञेयश्चतुर्थांशे निशाकरः (B145, Vā197))

*prathame kṛttikābhāge yadā bhāsvāṃstadā śaśī*
*viśākhānāṃ caturthe'ṃśe mune tiṣṭhatyasaṃśayam (V76)*
*(kṛttikānāṃ yadā sūryaḥ prathamāṃśagato bhavet*
*viśākhānāṃ tadā jñeyaścaturthāṃśe niśākaraḥ (B145, Vā197))*

> When the Sun is in the first part of Kṛttikā, then the [full] moon stands in the forth (read: third)[28] part of Viśākhā without any doubt.

[28] This correction cannot be avoided, although all versions of the text have *caturthe* rather than *tṛtīye*.

विशाखानां यदा सूर्यश्चरत्यंशं तृतीयकम् (चरतेंऽशम् B Vā)

तदा चन्द्रं विजानीयात्कृत्तिकाशिरसि स्थितम्

*viśākhānāṃ yadā sūryaścaratyaṃśaṃ tṛtīyakam (carate'ṃśam B, Vā)*
*tadā candraṃ vijānīyātkṛttikāśirasi sthitam (V77, B146, Vā198))*

| |
|---|
| When the Sun enters the third part of Viśākhā,<br>then one should know that the [full] moon stands at the beginning of Kṛttikā. |

तदैव विषुवाख्योऽयं कालः पुण्योऽभिधीयते

तदा दानानि देयानि देवेभ्यः प्रयतात्मभिः

(विषुवं तं विजानीयादेवमाहुर्महर्षयः (B147; तदा विद्याद् Vā199)

तदा दानानि देयानि पितृभ्यो विषुवेषु च (B149; विषुवत्यपि Vā200))

*tadaiva viṣuvākhyo 'yaṃ kālaḥ puṇyo 'bhidhīyate*
*tadā dānāni deyāni devebhyaḥ prayatātmabhiḥ (V78)*
*(viṣuvaṃ taṃ vijānīyādevamāhurmaharṣayaḥ (B147; tadā vidyād Vā199)*
*tadā dānāni deyāni pitṛbhyo viṣuveṣu ca (B149; viṣuvatyapi Vā200))*

| |
|---|
| Then this is the holy time which is called the "equinox".<br>Then [people] of devoted nature give gifts to the gods (var. to the ancestors). |

(*Between the above two lines, B and Vā insert the following verse:*)

सूर्येण विषुवं विद्यात्कालं सोमेन लक्षयेत्

समा रात्रिरहश्चैव यदा तद्विषुवं भवेत्

*sūryeṇa viṣuvaṃ vidyātkālaṃ somena lakṣayet*
*samā rātrirahaścaiva yadā tadviṣuvaṃ bhavet (B148; Vā199/200)*

| |
|---|
| By means of the Sun the equinox must be known, the time must be indicated by means of the Moon.<br>Night and day are equal, when this equinox takes place. |

ब्रह्मणेभ्यः पितृभ्यश्च मुखमेतत्तु दानाजम्

दत्तदानस्तु विषुवे कृतकृत्योऽभिजायते (V79)

(ब्राह्मणेभ्यो विशेषेण मुखमेतत्तु दैवतम् (B149))

*brahmaṇebhyaḥ pitṛbhyaśca mukhametattu dānājam*
*dattadānastu viṣuve kṛtakṛtyo 'bhijāyate (V79)*
*(brāhmaṇebhyo viśeṣeṇa mukhametattu daivatam (B149))*

| |
|---|
| For Brahmins and ancestors, this is the beginning (mouth) that generates gifts.<br>Whoever has given gifts on the equinox, becomes one who has done [everything] that ought to be done. |

While the Viṣṇupurāṇa might have been composed in the Christian era, there can be no doubt that the astronomical observations underlying the above verses date to the first half until the middle of the 2nd millennium BCE. Besides, the work turns out to be a conglomerate of doctrines from very different epochs. For, right in the same chapter, VP 2.8.28ff., it is mentioned that the solstices are at the initial points of Capricorn and Cancer. These verses are post-Hellenistic and were obviously written in the first half of the 1st millennium CE. Astronomically speaking, there are 2000 years between this passage and the one quoted above.

What is interesting about the cited text is that the lunar mansions are divided into four parts and that a circle of 27 (not 28) equal lunar mansions seems to be used. For, in a circle of 27 lunar mansions, the first quarter of Kṛttikā stands in opposition to the third quarter of Viśākhā. (The fact that verse 76 mentions the fourth part must be an error, as becomes obvious from verse 77.) When the full moon takes place on the equinox, then the Sun and the Moon were found on this axis. Now, if it were known exactly where the starting point of the *nakṣatra* circle was assumed, these verses could be dated with a precision of 240 years. Unfortunately, this is not known. However, as has been stated, if the sidereal zodiac according to Lahiri is assumed, where the star Citrā (= Spica) is in the middle of the lunar mansion Citrā, then it results in a fairly reasonable distribution of the principal stars in their respective lunar mansions. Thus if the Lahiri zodiac is used as an approximation, then this astronomical observation from the Viṣṇupurāṇa can be dated to about 1885 – 1645 BCE.[29]

It is remarkable that according to this text, equal-sized lunar mansions seem to have been already known in such an early time. More testimonies will be shown that support this conclusion.

The following statement of Vṛddhagarga is also very interesting:

---

[29] If one uses Āryabhaṭa's *ayanāṃśa* (Revatī or ζ Piscium at the end of its lunar mansion), every dating will become later by about 270 years. In the current case, the time period 1610 – 1370 BCE would result.

कर्मसु कृत्तिकाः प्रथमं (नक्षत्रं) श्रविष्ठा तु संख्यायाः

*karmasu kṛttikāḥ prathamaṃ (nakṣatraṃ) śraviṣṭhā tu saṃkhyāyāḥ*

In the acts (i.e. sacrifices) the Kṛttikās are the first [lunar mansion], however in the reckoning it is Śraviṣṭhā (= Dhaniṣṭhā).[30]

Can this be explained by the fact that the Kṛttikās were near the vernal point and Dhaniṣṭhā near the winter solstitial point? Again, this statement causes problems if it is referred to the principal stars of the *nakṣatras*, or their *yogatārās*, but is easily solved by an equal *nakṣatra* system. The *yogatārā* of Dhaniṣṭhā is about 30° north of the ecliptic. How could the solstice be related to it? It does not help much to project it onto the ecliptic in polar projection, because the projection points of Kṛttikā and Dhaniṣṭhā were more than 100° apart in 3000 – 1000 BCE; in order to suitably allocate the cardinal points of the year to *yogatārās*, an angle of approximately 90° is required. Again, the problem is easily solved, if a system of equal-sized lunar mansions is assumed. The text can then be dated to the period 2370 – 1640 BCE.

Another interesting text is found in Maitryupaniṣad 6.14:

एतस्य (संवत्सरस्य) आग्नेयमर्धमर्धं वारुणम्। माघाद्यं श्रविष्ठार्धमाग्नेयं क्रमेणोत्क्रमेण सार्पाद्यं श्रविष्ठार्धं सौम्यम्।

*etasya (saṃvatsarasya) āgneyamardhamardhaṃ vāruṇam. māghādyaṃ śraviṣṭhārdhamāgneyaṃ krameṇotkrameṇa sārpādyaṃ śraviṣṭhārdhaṃ saumyam.*

Of this [year] the one half is [attributed] to Agni, the other half to Varuṇa. The [half] from Maghā to the middle of Śraviṣṭhā in [northern] course is the one that is [attributed] to Agni, the [half] from Āśleṣā to the middle of Śraviṣṭhā in opposite course is [attributed] to the Moon (sic!).

---

[30] According to Hopkins, "Epic Chronology", p. 34. Venkatachelam cites it as follows:

तेषां च सर्वेषां नक्षत्राणां कर्मसु कृत्तिकाः प्रथममाचक्षते । श्रविष्ठा तु संख्यायाः पूर्वा लग्नानामनुराधं पश्चिमं विद्यानां रोहिणी सर्वनक्षत्राणां मघाः सौर्याणां भोग्यानां चार्यमा

*teṣāṃ ca sarveṣāṃ nakṣatrāṇāṃ karmasu kṛttikāḥ prathamamācakṣate. śraviṣṭhā tu saṃkhyāyāḥ pūrvā lagnānāmanurādhaṃ paścimaṃ vidyānāṃ rohiṇī sarva-nakṣatrāṇāṃ maghāḥ sauryāṇāṃ bhogyānāṃ cāryamā*

(Venkatachelam, *The Plot in Indian Chronology*, p. 160).

This statement belongs into the same epoch, around 1890 BCE. Since the one semi-circle starts at the *initial point* of Maghā and ends *in the middle* of Śraviṣṭhā, it again appears that an equal system of 27 lunar mansions is used.

## Vernal Point in the Lunar Mansion Rohiṇī?

There is evidence of an even older astronomical layer in Vedic literature. It seems that the *nakṣatra* Rohiṇī, which immediately follows Kṛttikā, formerly also played a leading role among the lunar mansions. According to a myth, which is told in the Mahābhārata, Rohiṇī was the favourite wife of the moon god Soma, wherefore the other 26 wives of Soma became jealous.[31] In other passages in the Mahābhārata, Rohiṇī has a leading position, too.[32] In HV 1.35.4, Rohiṇī is referred to as the oldest (*jyeṣṭhā*) of the fourteen wives of Vasudeva (the father of Kṛṣṇa). Interestingly, before the vernal equinox entered Kṛttikā, it was in Rohiṇī. About the year 3200 BCE, the equinoctial point was located near Aldebaran, the chief star of Rohiṇī. Hence the question arises whether the Rohiṇī myth could go back to that very remote epoch.

Because this text, as well as other texts[33], call Rohiṇī the "oldest" (*jyeṣṭhā*) among the lunar mansions, ancient authors believed that Antares, the star of the *nakṣatra* Jyeṣṭhā, was a *second Rohiṇī*. However, this does not annul the facts presented above. Since Aldebaran and Antares are both close to the ecliptic and also are in a very precise opposition to each other, it follows that when Aldebaran-Rohiṇī was located near the spring equinox, then Antares-Rohiṇī was located near the autumnal equinox.

Still, it must be noted that in Mahābhārata and the Purāṇas, Rohiṇī plays a far less important role than Kṛttikā. Also it seems there are no lunar mansion lists that start with Rohiṇī. The astronomy and calendar calculation underlying our texts essentially originates from the 3rd and 2nd millennium BCE, not from the 4th millennium.

---

[31] MBh 9.34.40ff.; 12.329.45ff.

[32] MBh 2.52.27; 3.65.21; 3.94(96).24; 5.115.9; 13.134.4; HV 2.3.16; HV 3.36.28.

[33] MBh 3.219(229).8, quoted below on p. 43.

Some Indian scholars believe that the history of Indian astronomy is even older. In an ancient calendar, Mārgaśīrṣa was apparently the first month of the year. For example, Kṛṣṇa says in the Bhagavadgītā:

> मासानां मार्गशीर्षोऽहम्
>
> *māsānāṃ mārgaśīrṣo'ham (BhG 10.35c; vgl. BhP 11.16.27)*

| Of the months I am Mārgaśīrṣa. |
|---|

In the list of months in MBh 13.109.17ff., Mārgaśīrṣa appears in the first place. It must be noted, however, that the month names Caitra, Kārttika, Mārgaśīrṣa etc., which are derived from the names of *nakṣatras*, do not occur in the Brāhmaṇas and therefore must have appeared relatively late. Still, the month of Mārgaśīrṣa is also known under another name, Agrahāyaṇa, which means "beginning of the year". How can this be explained? Burgess says, that the reasons for it are unknown.[34] But Kuppanna Sastry in the introduction to his critical edition of the Vedāṅgajyotiṣa says:

> Agrahāyaṇa, an old name for the asterism *Mṛgaśīrṣa*, meaning 'beginning of the year', points to the fourth millennium B.C. when the sun was there at the vernal equinox.[35]

Strictly speaking, Agrahāyaṇa is not the name of the lunar mansion Mṛgaśīrṣā, but of the month of Mārgaśīrṣa, whose name is derived from the fact that its full moon ideally took place in this lunar mansion. If Kuppanna Sastry were right, then the reason for Mārgaśīrṣa being the first month of the year would have been the fact that the autumnal equinox ideally coincided with a full moon in Mṛgaśīrṣā. If so, the vernal point would have been located in the same lunar mansion.

The sequence Mṛgaśīrṣa – Rohiṇī – Kṛttikā seems to indicate a succession, indeed, and it was in this order that the vernal point moved through them. Then this would be a testimony of a truly ancient calendar tradition, which was able to survive for thousands of years only because of the extremely conservative mind-set of the Indian people. This possibility cannot be ruled out completely. However, clearer evidence would be desirable.

---

[34] Burgess, *The Sûrya Siddhânta*, p. 317.

[35] Sarma, K. V. (ed.), *Vedāṅga Jyotiṣa of Lagadha in its Rk and Yajus Recensions*, p. 11.

After all, this would also explain the passages quoted further above, Kauṣītakibrāhmaṇa 5.1.2ff. and Śatapathabrāhmaṇa 6.2.2.18, where the full moon in Uttaraphalgunī, which was assigned to the month of Phālguna (= Tapasya), marked the "mouth of the year", thus its beginning. If the winter solstice is assumed on the Phālguna full moon and the summer solstice in Uttaraphalgunī, then the vernal equinox falls into Mṛgaśīrṣā.

Sengupta believes that additional evidence for such an early period of Indian astronomy is given in the so-called *madhuvidyā* or "science of spring", which is mentioned in the Ṛgveda, time and again.[36] Specifically, it is mentioned that the three-wheeled car of the Aśvin twins is the "spring bringer" (*madhuvāhanaḥ*) and that it is harnessed and set in motion in the morning (ṚV 10.41.2; cf. 1.34.2; 1.157.3):

> प्रातर्युजं नासत्याधि तिष्ठतः प्रातर्यावाणं मधुवाहनं रथम्
>
> *prātaryujaṃ nāsatyādhi tiṣṭhataḥ prātaryāvāṇaṃ madhuvāhanaṃ rathaṃ (ṚV 10.41.2ab)*

> O ye Aśvins, mount the one which is harnessed at daybreak, which moves off at daybreak, which brings the spring!

Sengupta interprets this description as a heliacal rising of the Aśvins and he believes that it indicated spring. In agreement with tradition, he identifies the Aśvins as the three stars α, β and γ Arietis, however, he considers the possibility that, instead of faint γ Arietis, the brighter star α *Trianguli* could have formed part of it. He has the spring begin at a tropical solar longitude of 330°, thus one month before the equinox. Because he wants to have the solstices at the initial points of two of the six seasons, therefore the equinoxes inevitably fall into the middle of a season. As the principal star of the Aśvins, Sengupta chooses the star α Arietis, which rises last. Based on these assumptions, he dates the verse to 4000 BCE.[37] He considers this confirmation of a very, very high age of Vedic astronomy.

It must be objected, however, that there is no certainty that the heliacal rising of the Aśvins indicated the tropical solar longitude 330° and the Vedic beginning of spring. Instead, the rising of the Aśvins could have indicated the equinox (= tropical solar longitude 0°).

---

[36] Sengupta, *Ancient Indian Chronology*, p. 60ff.

[37] With rigorous calculation, this author arrives at 4400 BCE.

This would result in a considerably later dating of the text. It is unknown for what geographic latitude exactly the calculation must be made. However, at the latitude of Kurukṣetra in 2300 BCE, the two main stars of Aries made their heliacal rising on 10th April, the day of the vernal equinox, and α Trianguli rose heliacally only 3 days earlier. Thus, the *madhuvidyā* could well have been created in the Kṛttikā-Maghā period.

Abhyankar believes that the Ṛgveda is talking of the heliacal rising of the Aśvinī stars on the *winter* solstice, and therefore he dates it to 7000 BCE.[38] However, this extremely early date is not compulsory. There is no mention of winter in the verse, let alone of the winter solstice. In reality the above-quoted verse rather points to spring, hence must be dated to the later 3rd millennium BCE. The word *madhu* means either "spring" or the first month of the year or "honey, nectar". The idea of spring is supported by the following verses from Ṛgveda, which Sengupta quotes in this context (translation D.K.):

> मधु वाता ऋतायते मधु क्षरन्ति सिन्धवः
>
> माध्वीर्नः सन्त्वोषधीः
>
> *madhu vātā ṛtāyate madhu kṣaranti sindhavaḥ |*
> *mādhvīrnaḥ santvoṣadhīḥ || (ṚV 1.90.6)*

| |
|---|
| The winds [blow] sweetness for him who lives righteously; the rivers flow sweetness.<br>May the plants be full of sweetness for us! |

> मधु नक्तमुतोषसो मधुमत्पार्थिवं रजः
>
> मधु द्यौरस्तु नः पिता
>
> *madhu naktamutoṣaso madhumatpārthivaṃ rajaḥ |*
> *madhu dyaurastu naḥ pitā || (7)*

| |
|---|
| May there be sweetness at night and in the morning, may the dust of the earth be full of sweetness!<br>May father sky be sweetness for us! |

[38] Abhyankar, "A Search for the Earliest Vedic Calendar", p. 5ff. Abhyankar, "Antiquity of the Vedic Calendar", p. 64f. The latter article in fact says "700 BC", however this is a typo, as is also obvious from the abstract.

मधुमान्नो वनस्पतिर्मधुमाँ अस्तु सूर्यः ।

माध्वीर्गावो भवन्तु नः

*madhumānno vanaspatirmadhumāṁ astu sūryaḥ |*
*mādhvīrgāvo bhavantu naḥ || (8)*

| |
|---|
| May the tree be full of sweetness for us, may the sun be full of sweetness, may the cows be full of sweetness for us! |

These verses match the mildness of spring certainly better than winter.

The following text from the Uttaranārāyaṇa version of the *Puruṣa-sūktam* could also allude to the heliacal rising of Aśvinī as the "mouth" of the lunar mansions:

ह्रीश्च ते लक्ष्मीश्च पत्न्यौ अहोरात्रे पार्श्वे नक्षत्राणि रूपम्

अश्विनौ व्यात्तमिष्टं मनिषाण अमुं मनिषाण सर्वं मनिषाण

*hrīśca te lakṣmīśca patnyau ahorātre pārśve nakṣatrāṇi rūpam*
*aśvinau vyāttamiṣṭaṃ maniṣāṇa amuṃ maniṣāṇa sarvaṃ maniṣāṇa*

| |
|---|
| Hrī and Lakṣmī are your wives, day and night [your] flanks, the lunar mansions [your] shape,<br>the Aśvins [your] mouth, O ye who have thought the desired [thing] (or: the desired [one]), who have thought that [Lord], who have thought all things... |

Otherwise this statement could also be dated to the period when the vernal equinox was in Aśvinī, i.e. about 600 BCE to 300 CE (Lahiri *ayanāṃśa*). However, the verse does not mention any zodiac signs, hence it probably dates from the time *before* Hellenistic astrology found its way to India.

In the context of these extremely early datings, the following text Taittirīyasaṃhitā 7.4.8.1f. (cf. Tāṇḍyabrāhmaṇa 5.9) also has to be considered:

फल्गुनीपूर्णमासे दीक्षेरन्। मुखं वा एतत् (1) संवत्सरस्य यत्फल्गुनीपूर्णमासो। मुखत एव संवत्सरमारभ्य दीक्षन्ते। तस्यैकैव निर्या यत्साम्मेघ्ये विषूवान्त्सम्पद्यते।

*phalgunīpūrṇamāse dīkṣeran. mukhaṃ vā etat (1) saṃvatsarasya yatphalgunīpūrṇamāso. mukhata eva saṃvatsaramārabhya dīkṣante. tasyaikaiva niryā yatsāmmeghye viṣūvāntsampadyate.*

| |
|---|
| On a Phalgunī full moon they should consecrate themselves. For, this is the mouth of the year, the Phalgunī full moon. For, they consecrate themselves after beginning the year at its mouth. This [year] has one shortcoming [though] in that the central day [of the year] (or: the [autumnal] equinox) takes place in the cloudy season. |

चित्रापूर्णमासे दीक्षेरन्। मुखं वा एतत्संवत्सरस्य यच्चित्रापूर्णमासो। मुखत एव संवत्सरमारभ्य दीक्षन्ते। तस्य न का चन निर्या भवति।

*citrāpūrṇamāse dīkṣeran. mukhaṃ vā etatsaṃvatsarasya yaccitrāpūrṇamāso. mukhata eva saṃvatsaramārabhya dīkṣante. tasya na kā cana niryā bhavati. ... (2)*

On the Citrā full moon they should consecrate themselves. For, this is the mouth of the year, the Citrā full moon. For, they consecrate themselves after beginning the year at its mouth. This [year] has no shortcoming at all.

This text gives preference to a year that starts with the month of Madhu (Caitra), because then the *viṣuvān* falls into the correct season, namely into autumn (*śarad*), not into the rainy season (*sāmmeghyaḥ* = *varṣaḥ*). Here, the word *viṣuvān* might be used in its more original meaning and denote the central day of the year. In a Phālguna calendar, the central day of the year would fall on the beginning of the month of Bhādrapada, and therefore into the season of *varṣaḥ* or *sāmmeghyam*, i. e. the "rainy season"; but the text is of the opinion that it should rather fall into the season of *śarad*, or "autumn". This would only be the case in the Caitra calendar, because if the year is reckoned from Caitra, then the seventh month is Āśvina, which is assigned to the "autumn". Why did this have to be so? Presumably because the central day of the year had to fall in the same season as the autumnal equinox.

Abhyankar draws the conclusion that the text must go back to a time when the winter solstice coincided with the full moon in Citrā, which would have been the case in 6000 BCE.[39] However, winter is not mentioned or pointed to in the text, let alone the winter solstice. Besides, it is not wise to search for such early dates without any need. What date would result from the interpretation given above? As has been said, if the year began with the month of Caitra, then the central day of the year fell on the beginning of the month of Āśvina and therefore was assigned to the season of Śarad (autumn). If the autumnal equinox had to take place in the same season, then it had to occur in one of the *nakṣatras* that were correlated to the months of autumn, namely to Āśvina or Kārttika. The equinoctial full moon could therefore have been located anywhere between Revatī and Rohiṇī. With such a huge range for the possible position

[39] Abhyankar, "Antiquity of the Vedic Calendar", p. 64.

of the equinoctial point, a sensible dating of this text or its calendar is unfortunately not possible.

## Vernal Point in Bharaṇī and Aśvinī

In the system of *nakṣatras* that is used in the Mahābhārata, Kṛttikā is in the first position, and it was found that this system ultimately goes back to an era in which the vernal equinox was in Kṛttikā. However, there is also evidence for a younger astronomical system in the Mahābhārata that was created at a time when the winter solstice was in the *nakṣatra* Śraviṣṭhā/Dhaniṣṭhā:

> अहः पूर्वं ततो रात्रिर्मासाः शुक्लादयः स्मृताः
>
> श्रविष्ठादीनि (var. श्रवणादीनि) ऋक्षाणि ऋतवः शिशिरादयः
>
> *ahaḥ pūrvaṃ tato rātrirmāsāḥ śuklādayaḥ smṛtāḥ*
> *śraviṣṭhādīni* (var. *śravaṇādīni*) *ṛkṣāṇi ṛtavaḥ śiśirādayaḥ (MBh 14.44.2)*

> First is the day, then the night. The months begin with the bright [half], it is said.
> With Śraviṣṭhā (var. Śravaṇa) the lunar mansions begin, the seasons [begin] with Śiśira (cold season).

The beginning of the *nakṣatra* circle is thus assumed in Śraviṣṭhā. It seems that this verse is based on the astronomical system of Vedāṅgajyotiṣa, which is often consulted for the interpretation of calendrical and astronomical statements of the epic. Hence, this text and its underlying astronomy can be dated on the basis of the following verses of Vedāṅgajyotiṣa, which have already been discussed briefly on p. 6ff.:

> स्वराक्रमेते सोमार्कौ यदा साकं सवासवौ
>
> स्यात्तदादि युगं माघस्तपः शुक्लोऽयनं ह्युदक्
>
> *svarākramete somārkau yadā sākaṃ savāsavau*
> *syāttadādi yugaṃ māghastapaḥ śuklo'yanaṃ hyudak (VJ 5ff.)*

> When the Sun and the Moon with Śraviṣṭhā ascend the sky together,
> then begins the *yuga*, the [month of] Māgha or Tapas, the bright [fortnight],
> the northward path [of the Sun].

प्रपद्येते श्रविष्ठादौ सूर्याचन्द्रमसावुदक्

सार्पार्धे दक्षिणार्कस्तु माघश्रावणयोः सदा

*prapadyete śraviṣṭhādau sūryācandramasāvudak*
*sārpārdhe dakṣiṇārkastu māghaśrāvaṇayoḥ sadā*

> At the initial point of Śraviṣṭhā, the Sun and the Moon depart to north; but in the middle of Āśleṣā, the Sun [departs] to south. [The solstices are] always in [the months of] Māgha [and] Śrāvaṇa.

The correlation of the beginning of Śraviṣṭhā with the middle of Āśleṣā indicates an equal-spaced system of the 27 lunar mansions. If Lahiri *ayanāṃśa* is used as a plausible, although speculative, approximation, these verses must be dated to 1410 BC. Thus they are clearly younger than the equinox-Kṛttikā period. Here, the vernal equinox is already in the lunar mansion Bharaṇī.

The same theory is found in the following passage in *Parāśaratantra*:

श्रविष्ठाद्यात्पौष्णार्धान्तं चरतः शिशिरः। वसन्तः पौष्णार्धाद्रोहिण्यन्तम्। सौम्यादाश्लेषार्धान्तं

ग्रीष्मः। प्रावृडाश्लेषार्धाद्धस्तान्तम्। चित्राद्याज्ज्येष्ठार्धान्तं शरत्। हेमन्तो ज्येष्ठार्धाद्वैष्णवान्तम्।

*śraviṣṭhādyātpauṣṇārdhāntaṃ carataḥ śiśiraḥ. vasantaḥ pauṣṇārdhād-rohiṇyantam. saumyādāśleṣārdhāntaṃ grīṣmaḥ. prāvṛḍāśleṣārdhādd-hastāntam. citrādyājjyeṣṭhārdhāntaṃ śarat. hemanto jyeṣṭhārdhād-vaiṣṇavāntam.*[40]

> While [the Sun] runs from the beginning of Śraviṣṭhā to the middle of Revatī, it is winter (*śiśiraḥ*); spring (*vasantaḥ*) from the middle of Revatī to the end of Rohiṇī; from Mṛgaśīrṣa to the middle of Āśleṣā summer (*grīṣmaḥ*); rainy season (*prāvṛṣ*) from the middle of Āśleṣā to the end of Hasta; from the beginning of Citrā to the middle of Jyeṣṭhā autumn (*śarad*); the cool season (*hemantaḥ*) from the middle of Jyeṣṭhā to the end of Śravaṇa.

It is also interesting that the verse MBh 14.44.2, which was quoted at the beginning of this chapter, has two variants: *śraviṣṭhādīni* and *śravaṇādīni*. Apparently, even younger doctrines have been incorporated in the text, which originate from a time when the winter solstice was not in Śraviṣṭhā anymore but had already moved into the lunar mansion Śravaṇa. The solstice was in Śravaṇa between 1410 and 440 BCE, at the beginning of Śravaṇa around 440 BCE. Also, the following verse seems to stem from this more recent epoch:

[40] According to Iyengar, *Parāśaratantra*, p. 62; Sandhi modified by DK.

अति नक्षत्रवंशांश्च क्रुद्धो नक्षत्रसंपदा

( var. चकारान्यं च लोकं वै क्रुद्धो नक्षत्रसंपदा)

प्रति श्रवणपूर्वाणि नक्षत्राणि ससर्ज यः (var. चकार यः)

*ati nakṣatravaṃśāṃśca kruddho nakṣatrasaṃpadā*
(var. *cakārānyaṃ ca lokaṃ vai kruddho nakṣatrasaṃpadā*)
*prati śravaṇapūrvāṇi nakṣatrāṇi sasarja yaḥ (MBh 1.65(71).34)*
(var. *cakāra yaḥ*)

> [It was Viśvāmitra,] who, in addition to the host of the lunar mansions, put into rage by the perfection (or: splendour) of the lunar mansions, created other lunar mansions that began with Śravaṇa.
>
> (*Var.:* [It was Viśvāmitra,] who, put into rage by the perfection (or: splendour) of the lunar mansions, created another world and other lunar mansions that began with Śravaṇa.)

There is also the following verse, which is found in different versions in several Purāṇas:

श्रवणे चोत्तरां काष्ठां चित्रभानुर्यदा भवेत्

शाकद्वीपस्य षष्ठस्य उत्तरान्तोदितश्चरन्

*śravaṇe cottarāṃ kāṣṭhāṃ citrabhānuryadā bhavet*
*śākadvīpasya ṣaṣṭhasya uttarāntoditaścaran  VāP 50.127*

> When the Sun is in Śravaṇa [reaching] northern culmination,
> then he wanders rising in the northern regions of the sixth continent [called] Śakadvīpa.

श्रवणे चोत्तराषाढे चित्रभानुर्यदा भवेत्

शाकद्वीपस्य षष्ठस्य उत्तरातो दिशश्चरन्

*śravaṇe cottarāṣāḍhe citrabhānuryadā bhavet*
*śākadvīpasya ṣaṣṭhasya uttarāto diśaścaran  BndP_1,21.73*

> When the Sun is in Śravaṇa and Uttarāṣāḍhā,
> then he wanders in the northern regions of the sixth continent [called] Śakadvīpa.

श्रावणे चोत्तरां काष्ठां चित्रभानुर्यदा भवेत्

गोमेदस्य परद्वीपे उत्तरां च दिशं चरन्

*śrāvaṇe cottarāṃ kāṣṭhāṃ citrabhānuryadā bhavet*
*gomedasya paradvīpe uttarāṃ ca diśaṃ caran  MatsP_124.50*

> When the Sun is [reaching] northern culmination in [the month of] Śrāvaṇa,
> then he wanders in the most northern region on the continent of Gomeda.

The former two versions wrongly state that the Sun reaches his northern culmination in Śravaṇa. In reality, that would be his southern culmination. The third version is more correct in that it mentions the month of Śrāvaṇa rather than the lunar mansion Śravaṇa. But whatever may be the original wording of the text, it clearly points to an epoch where the winter solstice was in Śravaṇa or Śraviṣṭhā, the two lunar mansions whose full moons were assigned to the month of Śrāvaṇa. As has been stated already, the solstice was at the beginning of Śravaṇa around 440 BCE, and at the beginning of Śraviṣṭhā around 1400 BCE.

Another interesting passage is found in Harivaṃśa:

कुकुरस्य सुतो धृष्णुर्धृष्णोस्तु तनयस्तथा ।

कपोतरोमा तस्याथ तैत्तिरिस्तनयोऽभवत् ।।

*kukurasya suto dhṛṣṇurdhṛṣṇostu tanayastathā |*
*kapotaromā tasyātha taittiristanayo'bhavat || HV 1.37.18*

| |
|---|
| The son of Kukura was Dhṛṣṇu, and the scion of Dhṛṣṇu was Kapotaroman; the scion of the latter then was Taittiri. |

जज्ञे पुनर्वसुस्तस्मादभिजित्तु पुनर्वसोः ।

तस्य वै पुत्रमिथुनं बभूवाभिजितः किल ।।

*jajñe punarvasustasmādabhijittu punarvasoḥ |*
*tasya vai putramithunaṃ babhūvābhijitaḥ kila || 1.37.19*

| |
|---|
| From the latter, Punarvasu was born, and Abhijit from Punarvasu. This Abhijit got a twin pair of sons, |

आहुकश्चाहुकी चैव ख्यातौ ख्यातिमतां वरौ ।

इमां चोदाहरन्त्यत्र गाथां प्रति तमाहुकम् ।।

*āhukaścāhukī caiva khyātau khyātimatāṃ varau |*
*imāṃ codāharantyatra gāthāṃ prati tamāhukam || 1.37.20*

| |
|---|
| called Āhuka and Āhukī, the best of the glorious. About this Āhuka the following hymn is cited: |

श्वेतेन परिवारेण किशोरप्रतिमो महान् ।

अशीतिचर्मणा युक्तः स नृपः प्रथमं व्रजेत् ।।

*śvetena parivāreṇa kiśorapratimo mahān |*
*aśīticarmaṇā yuktaḥ sa nṛpaḥ prathamaṃ vrajet || 1.37.21*

| |
|---|
| "In white envelopment, similar to the young Sun, great, equipped with a [shield] of 80 animal skins, the king might march in front. ..." |

Punarvasu begets Abhijit.[41] The distance between the two lunar mansions is about 195° – just about as much as from new moon to full moon or from full moon to new moon. Abhijit fathers twins named Āhuka and Āhukī, where Āhuka is compared to the "young Sun". It is possible that the twins are an allusion to the Aśvins and the lunar mansion Aśvinī. At the time when the winter solstice was in the lunar mansion Abhijit, the vernal equinox fell into Aśvinī, to about 10° in sidereal Aries. The text then has to be dated to approximately 500 to 200 BCE.

Thus this study has arrived at the most recent astronomical layer of the epic. The final editing of the epic is usually assumed between 400 BCE and 400 CE. It seems, however, that the epic tradition is still completely untouched by Hellenistic influence. For example, the Mahābhārata knows only elements of the earlier Indian astronomy and astrology. One finds passages where the motions of the planets through the lunar mansions are described and conclusions about the fate of the country are drawn. On the other hand, there are absolutely no elements of Hellenistic astrology in Mahābhārata, which were later incorporated into Indian astrology. There is no mention of the signs of the zodiac, the ascendant and astrological houses, and no mention of natal horoscopy in general. The Mahābhārata does not know of any of these things. Its final version therefore must be older than the oldest works of ancient Indian horoscopy. It can be concluded that the astrological parts of the text must have found their final form in the last centuries BCE.

A good example for a post-Hellenistic definition of the zodiac, the equinoxes, and the solstices is found in Viṣṇupurāṇa 2.8.28ff.:

> अयनस्योत्तरस्यादौ मकरं याति भास्करः
>
> ततः कुम्भं च मीनं च राशे राश्यन्तरं द्विज
>
> *ayanasyottarasyādau makaraṃ yāti bhāskaraḥ*
> *tataḥ kumbhaṃ ca mīnaṃ ca rāśe rāśyantaraṃ dvija (VP 2.8.28)*

| |
|---|
| At the beginning of his northward course (*uttarāyaṇam*), the Sun enters Capricorn, then [he enters] Aquarius and Pisces, from one zodiac sign to the other, O twice-born one. |

[41] Cf. Brahmapurāṇa 15.47f. In Brahmāṇḍapurāṇa 2.71.119, however, the succession is reverse and Abhijit fathers Punarvasu. This seems to be an error, because in verse 121 it is again Abhijit who begets Āhuka and Āhukī. Cf. also Liṅgapurāṇa 1.69.35ff.; Kūrmapurāṇa 1.23.62.

त्रिष्वेतेष्वथ भुक्तेषु ततो वैषुवतीं गतिम्

प्रयाति सविता कुर्वन्नहोरात्रं ततः समम्

*triṣveteṣvatha bhukteṣu tato vaiṣuvatīṃ gatim*
*prayāti savitā kurvannahorātraṃ tataḥ samam (29)*

> After enjoying these three [zodiac signs], the Sun arrives at the equinox and makes day and night equal.

ततो रात्रिः क्षयं याति वर्धतेऽनुदिनं दिनम्

*tato rātriḥ kṣayaṃ yāti vardhate 'nudinaṃ dinam (30)*

> Then the night goes to decrease and the day grows daily.

ततश्च मिथुनस्यान्ते परां काष्ठामुपागतः

राशिं कर्कटकं प्राप्य कुरुते दक्षिणायनम्

*tataśca mithunasyānte parāṃ kāṣṭhāmupāgataḥ*
*rāśiṃ karkaṭakaṃ prāpya kurute dakṣiṇāyanam (31)*

> And then, at the end of Gemini, the Sun arrives at his highest culmination. When he has reached Cancer, he makes the southward course (*dakṣiṇāyanam*).

This definition, which is actually equivalent to the tropical zodiac, as found in Ptolemy's works, was valid for several centuries in India. It is found in Purāṇas and in all works of astronomy and astrology of the post-Hellenistic period, including the works of Sphujidhvaja, Varāhamihira, Āryabhaṭa and in Sūryasiddhānta.[42] "Vedic" astrologers do not like to hear all this, because they want to believe that Indian astrology as we know it today was revealed more than 5000 years ago by the holy sages of Vedic times and that their doctrines from the beginning were not tropical, but sidereal.

## Precession of the Equinoxes in Ancient Indian Astronomy

The above statements impressively demonstrate that the shift of the equinoxes and solstices over centuries and millennia has periodically led to corrections of Vedic calendars and the *nakṣatra* system.

---

42 Sphujidhvaja, *Yavanajātakam* 79.30; Varāhamihira, *Bṛhatsaṃhitā* 3.2; Āryabhaṭa, *Āryabhaṭīyam* 4.1; *Sūryasiddhānta* 14.7-10. See also Dikshit, *Bharatiya Jyotish Sastra*, Part I, p. 139.

The question arises whether ancient Indian sky watchers became aware of the phenomenon of precession and how great was their understanding of it. It is hard to imagine that they have not perceived it to a certain degree, and evidence will be presented that indeed they did perceive it. On the other hand, no theoretical discourse on precession is found in pre-Hellenistic sources, only some attempts to treat the phenomenon using the means of mythology.

A nice example of such a mythological treatise is given in the following episode from the Mahābhārata:

अभिजित्स्पर्धमाना तु रोहिण्या कन्यसी स्वसा (var. रोहिण्याः सा कनीयसी)

इच्छन्ती ज्येष्ठतां देवी तपस्तप्तुं वनं गता

*abhijitspardhamānā tu rohiṇyā kanyasī svasā* (var. *-ṇyāḥ sā kanīyasī*)
*icchantī jyeṣṭhatāṃ devī tapastaptuṃ vanaṃ gatā (MBh 3.219(229).8)*

| |
|---|
| Abhijit, the younger sister of Rohiṇī, was jealous.<br>Because she wanted to be the eldest (*jyeṣṭhā*), she went into the forest in order to practice austerities (*tapas*). |

तत्र मूढोऽस्मि भद्रं ते नक्षत्रं गगनाच्च्युतम्

कालं त्विमं परं स्कन्द ब्रह्मणा सह चिन्तय (var. इमाम्)

*tatra mūḍho 'smi bhadraṃ te nakṣatraṃ gaganāccyutam*
*kālaṃ tvimaṃ paraṃ skanda brahmaṇā saha cintaya* (var. *imām*) *(9)*

| |
|---|
| Here I am confused, if you please, about the bright star that has fallen from the sky.<br>Oh Skanda, think about that highest time together with Brahmā. |

धनिष्ठादिस्तदा कालो ब्रह्मणा परिनिर्मितः (var. परिकल्पितः)

रोहिण्याद्योऽभवत् पूर्वमेवं संख्या समाभवत् (var. रोहिणी ह्यभवत् )

*dhaniṣṭhādistadā kālo brahmaṇā parinirmitaḥ* (*var. parikalpitaḥ*)
*rohiṇyādyo 'bhavat pūrvamevaṃ saṃkhyā samābhavat* (var. *rohiṇī hyabhavat*) *(10)*

| |
|---|
| Then Brahmā meted out the time that begins with Dhaniṣṭhā<br>that was earlier than Rohiṇī. This is how the time sequence came about.<br>(*Or*: Formerly, [time] used to begin with Rohiṇī. This is how...)[43] |

[43] This variant is chosen by Sengupta, *Ancient Indian Chronology*, p. 160, and he translates: “and Rohiṇī ... became the first star”. Thus assuming that it refers to the position of Rohiṇī at the spring equinox, he dates it to 3050 BCE. However, in context, this makes little sense.

एवमुक्ते तु शक्रेण त्रिदिवं कृत्तिका गताः (var. एवमुक्तेन शक्रेण... गता)

नक्षत्रं शकटाकारं भाति तद्वह्निदैवतम् (var. नक्षत्रं सप्तशीर्षाभम्) (11)

*evamukte tu śakreṇa tridivaṃ kṛttikā gatāḥ* (var. *uktena śakreṇa ... gatā*)
*nakṣatraṃ śakaṭākāraṃ bhāti tadvahnidaivatam* (var. *nakṣatraṃ saptaśīrṣābham*) *(11)*

After Indra (Śakra) had commanded it, the Kṛttikās rose to the sky. The lunar mansion shines like a chariot (*var.* shines with seven heads). Its deity is the fire god.

The text is about a rivalry between the two *nakṣatra* sisters Abhijit and Rohiṇī. The point of contention between the two women is that Rohiṇī is the eldest (*jyeṣṭhā*) and that for this reason Abhijit is jealous of her sister (*icchantī jyeṣṭhatām*). According to another myth, which is also found in the Mahābhārata, Rohiṇī was formerly the favourite wife of the moon god Soma, and this also aroused the jealousy of his other wives.[44] In many other places in the Mahābhārata, Rohiṇī also holds a leading position.[45] In HV 1.35.4, Rohiṇī is referred to as the eldest (*jyeṣṭhā*) of the fourteen wives of Vasudeva, the father of Kṛṣṇa.

R. N. Iyengar interprets the text in the sense that Rohiṇī in ancient times was the name of the lunar mansion Jyeṣṭhā ("the eldest one") in sidereal Scorpio. P. C. Sengupta is of this opinion as well, and he appeals to Taittiriya-Samhita 4.4.10, where it is stated that there were two Rohiṇīs, the one being Rohiṇī-Aldebaran in Taurus, and the other Rohiṇī-Antares in Jyeṣṭhā. Antares and Aldebaran are in fact in almost precise opposition to each other. At a time when the vernal equinox was near Rohiṇī-Aldebaran, the autumnal equinox was near Rohiṇī-Antares. The two were a kind of equivalent to each other and had some priority over other lunar mansions. It is conceivable that the double role of Rohiṇī, namely her identification with both Aldebaran and Antares, as well as her precedence over other lunar mansions, goes back to that epoch when the equinoctial axis was between these two stars.

[44] MBh 9.34.40ff.; 12.329.45ff.

[45] MBh 2.52.27; 3.65.21; 3.94(96).24; 5.115.9; 13.134.4; HV 2.3.16; HV 3.36.28.

Abhijit was jealous of Rohiṇī and fell from the sky. Iyengar interprets this fall from the sky as the extinction of a star near Antares in Scorpio around 1400 BCE, as is allegedly attested by Chinese sources.

It can be objected, however, that the lunar mansion Abhijit and its star Vega are far off from Jyeṣṭhā or Antares, from where the star allegedly fell. Besides, Iyengar does not give an explanation of the last three lines. Like S. B. Dikshit, he thinks these lines are "not clear".[46] The text is certainly troublesome and only vaguely outlines the story. However, it seems to the author that the outline of the story is quite clear. Abhijit envies her elder sister Rohiṇī for her prominent position, and in her desire to surpass her, she leaves the firmament and goes into the forest to practice austerities. The resolution of the story is obvious: Her wish must be granted by the gods. Ancient Indian mythology is full of stories about characters who go into the forest, where they practice austerities in order to be granted a boon by the gods. The will of Abhijit must be fulfilled. The solution is that Brahmā reorganises the lunar mansions. He creates a new era that begins with the lunar mansion Śraviṣṭhā (= Dhaniṣṭhā). To Abhijit he assigns a position in the circle of lunar mansions that precedes Rohiṇī-Aldebaran: Abhijit becomes *Kṛttikā*, the *nakṣatra* that precedes Rohiṇī, and henceforth is *elder* than Rohiṇī. In other words, Abhijit, who originally was the 28th *nakṣatra* between Uttarāṣāḍhā and Śravaṇa in Capricorn, is removed from the circle of the *nakṣatras* and henceforth identified with Kṛttikā, which extends from sidereal 26°40' Aries to 10° Taurus and is marked by the Pleiades. Hopkins apparently understands the text in a similar way, for he says: "Abhijit is replaced by the Pleiades".[47]

What is the message behind this myth? Rohiṇī, the eldest of the *nakṣatras*, passes her primacy to Kṛttikā. Is it not reminiscent of the transition of the vernal equinox from Rohiṇī to Kṛttikā? When did this transition take place? The vernal equinox was located near the Pleiades/Kṛttikā about 2340 BCE.

---

[46] Iyengar, "Some Celestial Observations associated with Kṛṣṇa-Lore", p.4. His reference is: Dikshit, *Bharatiya Jyotish Sastra*, part I, p. 110.

[47] Hopkins, "Epic Chronology", p. 35; cf. p. 29.

Another myth that might refer to the effects of precession is given in the following verse from the Mahābhārata:

अति नक्षत्रवंशांश्च क्रुद्धो नक्षत्रसंपदा

( var. चकारान्यं च लोकं वै क्रुद्धो नक्षत्रसंपदा)

प्रति श्रवणपूर्वाणि नक्षत्राणि ससर्ज यः (var. चकार यः)

*ati nakṣatravaṃśāṃśca kruddho nakṣatrasaṃpadā*
(var. *cakārānyaṃ ca lokaṃ vai kruddho nakṣatrasaṃpadā*)
*prati śravaṇapūrvāṇi nakṣatrāṇi sasarja yaḥ (MBh 1.65(71).34)*
(var. *cakāra yaḥ*)

[It was Viśvāmitra,] who, in addition to the host of the lunar mansions, put into rage by the perfection (or: splendour) of the lunar mansions, created other lunar mansions that began with Śravaṇa.

(*Var.:* [It was Viśvāmitra,] who, put into rage by the perfection (or: splendour) of the lunar mansions, created another world and other lunar mansions that began with Śravaṇa.)

The transition from an older *nakṣatra* system that began at the winter solstice in Śraviṣṭhā to a new one that began with the winter solstice in Śravaṇa, is apparently interpreted as follows: An ascetic of the name of Viśvāmitra, who was gifted with great magical power, was put into a rage by the *nakṣatras* and therefore created a new world and a new sky with a new *nakṣatra* system. Why then was he put into rage by the lunar mansions? Perhaps because, as a result of precession, they at some point in time did not work anymore the way they should.

The following text Maitryupaniṣad 1.4 mentions a different symptom of the precession of the earth axis, namely the deviation of an ancient pole star from its position near the celestial pole:

अथ किमेतैर्वा अन्यानां शोषणं महार्णवानां शिखरिणां प्रपतनं ध्रुवस्य प्रचलनं व्रश्चनं वातरज्जूनां (var. स्थानं वा तरूणां; var. व्रश्चनं तरूणां) निमज्जनं पृथिव्याः स्थानादपसरणं सुराणामित्येतद्विधे (var. सुराणां सोऽहमित्येतद्विधे) संसारे किं कामोपभोगैर्यैरेवाश्रित-स्यासकृदिहावर्तनं दृश्यत इति

*atha kimetairvā, anyānāṃ śoṣaṇaṃ mahārṇavānāṃ, śikhariṇāṃ prapatanaṃ,* ***dhruvasya pracalanaṃ, vraścanaṃ vātarajjūnāṃ*** (var. *sthānaṃ vā tarūṇāṃ;* var. *vraścanaṃ tarūṇāṃ*)***, nimajjanaṃ pṛthivyāḥ, sthānādapasaraṇaṃ surāṇām****ity*(var. *surāṇāṃ so'hamity*)*etadvidhe saṃsāre kiṃ kāmopabhogairyairevāśritasyāsakṛdihāvartanaṃ dṛśyata iti (MaiUp 1.4)*

> But what am I talking of these! Moreover, there is also the drying-up of great oceans, the collapsing of mountains, **the swerving of the pole star, the cutting-through of the wind strings** (which tie the constellations to the pole star)**,** the drowning of the earth, **the running-away of the gods from their abode**, – in this kind of course of the world, how can one enjoy desires, when, as can be seen, whoever relies on them, must return again and again!

There is talk of the “swerving” or “running away” (*pracalanam*) of the pole star. Here it must be understood that in ancient times, our current pole star was not near the celestial north pole and that in its place there was another star near the celestial pole. The last polar star before the arrival of current Polaris was Thuban (*α Draconis*), which in the year 2800 BCE, was only 5 arc minutes from the celestial pole and was therefore called *Dhruva*, “the fixed one”. Due to the precession of the Earth’s axis (or the vernal equinox), Thuban gradually moved away from the celestial pole. In the year 2600 BCE, it was already 1° or two full moon diameters away from the celestial pole and, as a consequence, performed a circular motion with the same radius about it. In 2000 BCE, the radius was already 4½° or 9 lunar diameters. Eventually, the then astronomers must have noticed that Dhruva was “running away”. When exactly they noticed it is hard to say. It depends on how much attention they paid to the star and what methods they used to determine its height.

As has been insinuated previously, the next star that arrived at the north celestial pole was “Polaris”, the current pole star. The mention of Dhruva is therefore further proof of the high age of ancient Indian astronomy. Polaris arrived at the celestial north pole only in recent centuries. Before that, the celestial pole had been “empty” and not marked by a star. Furthermore, the above-cited text, which mentions a “swerving” of the pole star or Dhruva, is also proof that an effect of precession was noticed. That does not mean, however, that a theoretical understanding of the phenomenon was given. Instead, the phenomenon was interpreted as a natural disaster and was enumerated amongst a number of cosmic catastrophes. It was believed that the whole world order was about to enter into a chaotic state, that the wind strings that tied the stars to Dhruva and lead them in their daily circular motion were cut through, and that the gods, i.e. the stars, ran away from their abodes. Furthermore it was believed that at the same time the earth would be flooded and mountains collapse.

There are also other texts in Purāṇas that explain the daily rotation of the stars about the pole star (or the celestial pole) by the fact that they are tied to it by "wind strings" and that their circular motion is caused by the rotation of the pole star.[48] Some scholars believe that these texts also prove a scientific understanding of the precession of the equinox in Vedic times. However, if the texts are studied more closely, this turns out to be wishful thinking. In reality these texts only deal with the daily rotation of the sky, not with precession. Other than the above-cited text from Maitryupaniṣad, they are not aware of precession. This shall be examined shortly.

Moreover, there is the following statement by Vṛddhagarga, which could have to do with the precession of the equinox. It is found in Bhaṭṭotpala's commentary on Varāhamihira's *Bṛhatsaṃhitā* 3.4:

> यदा निवर्ततेऽप्राप्तो धनिष्ठामुत्तरायणे
>
> आश्लेषां दक्षिणेऽप्राप्तस्तदा विन्द्यान्महद्भयम्
>
> *yadā nivartate 'prāpto dhaniṣṭhāmuttarāyaṇe*
> *āśleṣāṃ dakṣiṇe 'prāptastadā vindyādmahadbhayam*

> When [the Sun] turns around on the winter solstice, without having reached Dhaniṣṭhā,
> [and] on the summer solstice, without having reached Āśleṣā, then one might find great danger.

Parāśara, also quoted by Bhaṭṭotpala in the same place, states:

> यद्यप्राप्तो वैष्णवमुदङ्मार्गं प्रपद्यते दक्षिणमाश्लेषां वा महाभयाय
>
> *yadyaprāpto vaiṣṇavamudaṅmārgaṃ prapadyate dakṣiṇamāśleṣāṃ vā mahābhayāya*

> When [the Sun], without having reached Śravaṇa, begins his way to north, or the one to south, [without having reached] Āśleṣā, [this indicates] great danger.

These statements obviously refer to the old doctrine that assumes the solstices on the axis of Śraviṣṭhā (= Dhaniṣṭhā) and Āśleṣā. That Parāśara mentions Śravaṇa instead of Śraviṣṭhā might be a correction by a copyist, because in another place, he says that winter starts

[48] Brahmāṇḍapurāṇa 1.22.2-9; Matsyapurāṇa 125.1-8; Viṣṇupurāṇa 2.9.1-4.

when the Sun is at the beginning of Śraviṣṭhā. In the above quotation, the original wording might have been Śraviṣṭhā, but in later times, after the solstitial point had entered Śravaṇa, the text was adapted to the new situation.[49]

The above-cited texts are formulated like astrological rules: If this and that happens in the sky, then great danger is indicated. The phenomenon they refer to seems to be the following: The solstices were once located in Dhaniṣṭhā and Āśleṣā, but in later times, as a result of precession, the Sun reached his turning points already *before* reaching the same lunar mansions.

It is obvious that after a certain date, this astrological forecast was valid for *every year*. But the two authors seemed to believe that the positions of the solstices were in principle fixed and that if the Sun reached its maximum declination "too early", then this was just a momentary anomaly and an evil omen. Thus, it the authors apparently were not aware that the effect was caused by a steady precession of the solstitial and equinoctial points. Still, their statements suggest, that they might have noticed that the solstices tended to occur a little too early.

It is also possible, that Parāśara and Garga were aware that the solstices had been elsewhere in ancient times, e.g. in the middle of Śraviṣṭhā and the beginning of Āśleṣā, as is stated in Maitryupaniṣad 6.14. They may have associated this change of position with a particular disaster that had occurred in the past. Here, the passage from the Maitryupaniṣad may be recalled where the "running away" of the former pole star from the true celestial pole was associated with various cosmic catastrophes. However, the authors apparently assumed that the solstices had a stable position in their own time, and they predicted mischief only in case that the solstices would change their positions again.

Here again, it remains to be noted that Parāśara and Garga need not necessarily have lived in the 2nd millennium BCE, when the solstices were located in the said *nakṣatras*. It is also possible that they only handed down an old doctrine, without verifying it by their own observations.

---

[49] R. N. Iyengar, *Parāśaratantra*, p. 63f.

The passage in Varāhamihira, where the commentator Bhaṭṭotpala quotes the above authors reads as follows:

आश्लेषार्धाद्दक्षिणमुत्तरमयनं रवेर्धनिष्ठाद्यम्

नूनं कदाचिदासीद्येनोक्तं पूर्वशास्त्रेषु

*āśleṣārdhāddakṣiṇamuttaramayanaṃ raverdhaniṣṭhādyam*
*nūnaṃ kadācidāsīdyenoktaṃ pūrvaśāstreṣu (BS 3.1)*

| |
|---|
| It is certain that there was a time when the southward course of the Sun began in the middle of Āśleṣā (i.e. at 23°20' in sidereal Cancer) and the northward course began at the initial point of Dhaniṣṭhā (i. e. at 23°20' in sidereal Capricorn). For, this is said in ancient scientific texts. |

साम्प्रतमयनं सवितुः कर्कटकाद्यं मृगादितश्चान्यत्

उक्ताभावो विकृतिः प्रत्यक्षपरीक्षणैर्व्यक्तिः

*sāmpratamayanaṃ savituḥ karkaṭakādyaṃ mṛgāditaścānyat*
*uktābhāvo vikṛtiḥ pratyakṣaparīkṣaṇairvyaktiḥ (2)*

| |
|---|
| At present, however, the [southward] course of the Sun begins at the initial point of Cancer and the other[, northward, path] at the initial point of Capricorn.<br>The untruth of what has been said [in ancient times indicates that] a change [has taken place]. Proof is achieved through direct observations: |

दूरस्थचिह्नवेधादुदये अस्तमयऽपि वा सहस्रांशोः

छायाप्रवेशनिर्गमचिह्नैर्वा मण्डले महति

*dūrasthacihnavedhādudaye astamaya 'pi vā sahasrāṃśoḥ*
*chāyāpraveśanirgamacihnairvā maṇḍale mahati (3)*

| |
|---|
| either from the fact that the Sun hits a distant mark at his rising or setting, or by marking the points on a circle at which the shadow [of the gnomon] enters or leaves. |

It is stated that the traditional positions of the solstices which were handed down of old are in contradiction to the positions that result from observations made in Varāhamihira's own time[50]. It is concluded that a change must have taken place. This change is of

[50] Verse 3 explains two methods how a solstice date can be determined:

1. A place is selected from which one wants to observe sunrises. From day to day the place on the horizon is observed where the Sun appears. During the southward course of the sun (*dakṣiṇāyana*), the points of rising daily wander a little step further south. Near the winter solstice, the motion ends and turns

course due to the precession of the equinox. In the subsequent verses, one would expect that Varāhamihira give a more detailed explanation of the phenomenon, e.g. his theory of precession or trepidation, and mention the speed at which the equinoxes and solstices move. However, what follows in his text is of a completely different nature. Varāhamihira continues:

> अप्राप्य मकरमर्को विनिवृत्तो हन्ति सापरां याम्याम्
>
> कर्कटकमसम्प्राप्तो विनिवृत्तश्चोत्तरामैन्द्रीम्
>
> *aprāpya makaramarko vinivṛtto hanti sāparāṃ yāmyām*
> *karkaṭakamasamprāpto vinivṛttaścottarāmaindrīm (4)*

| |
|---|
| When the Sun turns around before reaching Capricorn, then he destroys the west and the south,<br>when he turns around before reaching Cancer, [then he destroys] the north and the east. |

> उत्तरमयनमतीत्य व्यावृत्तः क्षेमसस्यवृद्धिकरः
>
> प्रकृतिस्थश्चाप्येवं विकृतगतिर्भयकृदुष्णांशुः
>
> *uttaramayanamatītya vyāvṛttaḥ kṣemasasyavṛddhikaraḥ*
> *prakṛtisthaścāpyevaṃ vikṛtagatirbhayakṛduṣṇāṃśuḥ (5)*

| |
|---|
| When the Sun turns around only *after* transgressing the [beginning of the] northward path, then he brings prosperity and the growth of crops;<br>and the same when he behaves according to his nature; [however] with unnatural behaviour the Sun brings danger and fear. |

The verses were translated according to a common understanding, assuming that *aprāpya* and *atītya* form a contrast: either the Sun turns around *before* reaching of Capricorn and Cancer, or *after* it.[51] The latter would be a good omen, the former a bad one. Now, for all years prior to about 500 CE, the solstice occurred *after* the ingresses

around, so that the points of rising wander in northward direction again. The same kind of observation can also be made with sunsets.

2. A gnomon (a vertical rod) is installed and a big circle is drawn around it. The circle should be large enough so that the shadow of the gnomon at noon on the winter solstice falls completely within the circle. And it should be small enough so that the tip of the shadow is relatively sharp where it enters and leaves the circle during the day. From day to day, the points at which the end of the shadow enters and leaves the circle are marked. On the solstices, the points reach a northern and a southern maximum.

The two methods are equivalent to each other and in principle provide the same dates.

[51] Cf. the translation by Ramakrishna Bhat, *Varāhamihira's Bṛhat Saṃhitā*, p. 23f.

of the Sun into the mentioned zodiac signs, but for all years after 500 CE it occurred *before* the same ingresses. From this a favourable astrological forecast would result for all years before 500 CE and an unfavourable one for all years after the same date. However, does this make sense?

On the other hand, it is astonishing that Varāhamihira does not say anything else about precession. Did he have a clear understanding of the phenomenon at all? Can we be sure that he inferred a *continuous motion* of the solstices? Why does he not specify any rate of precession? Did he know a rate at all? Did he have *any* idea how to interpret the phenomenon? It rather seems it was a mystery to him.

If the above interpretation of the verses 4 and 5 is correct, then they obviously deal with anomalies in the observation of the solstices. Apparently it was observed that the solstices sometimes occurred a bit too early or too late, and then such occurrences were interpreted as omens. Like Parāśara and Garga, Varāhamihira seems to have assumed that the position of the solstices was, in principle, well-defined and stable, *despite* the change that had taken place some time in the past. So did he believe that this change was the result of a cataclysm rather than the result of a continuous motion?

Unfortunately, Varāhamihira's text is linguistically often difficult. In the above translation, there is also a problem in logic, when it is stated that the Sun turns around only "after going beyond the solstice", *uttaramayanamatītya vyāvṛttaḥ*. Strictly speaking, this is absurd, especially when in verse 1 *uttaramayanam* can be understood only as winter solstice. It would be more logical, if Varāhamihira said "after going beyond the initial point of Capricorn" or *makarādimatītya vyāvṛttaḥ*. The author has pondered for a long time whether verses 3 and 4 could be interpreted differently. One possible solution would probably read as follows:

अप्राप्य मकरमर्को विनिवृत्तो हन्ति सापरां याम्याम्

कर्कटकमसम्प्राप्तो विनिवृत्तश्चोत्तरामैन्द्रीम्

*aprāpya makaramarko vinivṛtto hanti sāparāṃ yāmyām*
*karkaṭakamasamprāpto vinivṛttaścottarāmaindrīm (4)*

> Before the Sun reaches Capricorn, he turns around and ends the southward [path] of Yama (the god of the netherworld).
> And before he reaches Cancer, he turns and [ends] the northward [path] of Indra (the celestial king of the gods).

उत्तरमयनमतीत्य व्यावृत्तः क्षेमसस्यवृद्धिकरः

प्रकृतिस्थश्चाप्येवं विकृतगतिर्भयकृदुष्णांशुः

*uttaramayanamatītya vyāvṛttaḥ kṣemasasyavṛddhikaraḥ*
*prakṛtisthaścāpyevaṃ vikṛtagatirbhayakṛduṣṇāṃśuḥ (5)*

After the Sun has passed the northward path as a bringer of prosperity and growth of crop, he turns around and, in agreement with nature, goes the opposite path and brings danger and fear.

However, even with this translation, the text does not contain any further information concerning precession. Besides, one would have to conclude that Varāhamihira, other than all ancient authors, assumed the solstices and equinoxes not exactly at the initial points of the cardinal zodiac signs, but a little bit before them.

I am not sure of this alternative solution. In *Pañcasiddhāntikā* 3.21 Varāhamihira says:

आश्लेषार्धादासीद्यदा निवृत्तिः किलोष्णकिरणस्य

युक्तमयनं तदासीत्सांप्रतमयनं पुनर्वसुतः

*āśleṣārdhādāsīdyadā nivṛttiḥ kiloṣṇakiraṇasya*
*yuktamayanaṃ tadāsītsāṃpratamayanaṃ punarvasutaḥ*

When the turning point of the Sun was from the middle of Āśleṣā, then the solstitial half-year (*ayanaṃ*) was correct (*yuktam*)[52]; at present the solstitial half-year is from Punarvasu.

Translated like this, it seems to state that the former positions of the solstices were "correct", whereas their current positions (in Varāhamihira's lifetime) are "false" and the world is in a state of decay.

[52] Pingree's translation of *yuktamayanaṃ tadāsīt* as "then the ayana [-correction] was positive" is based on the assumption that *ayanam* here stands for *ayanāṃśaḥ* or *ayanacalanam*, and that Varāhamihira taught the trepidation model which had positive and negative *ayanāṃśa*. Unfortunately, this interpretation is both speculative and linguistically unnatural. For, in the very same line, *ayanam* appears a second time and, as is obvious from the preceding line, has the sense of *nivṛttiḥ*, i.e. "solstice" or "solstitial half-year". (Neugebauer/Pingree, *The Pañcasiddhāntikā of Varāhamihira*, Part 1, p. 44f.) Thibaut's solution: "then the ayana was right" is preferable, and accepted by this author. (Thibaut, *The Panchasiddântikâ*, translation p. 18) Kuppanna Sastry understands *yuktam* in a similar sense. However, his translation of the whole verse is very loose and far from the original text. E.g., he translates the words *yuktamayanaṃ tadāsīt* as "the requirement of the definition that the Sun and the Moon should be in different ayanas was satisfied". It is not plausible that Varāhamihira would have expressed this idea in such an abridged way. (Kuppanna Sastry, *Pañcasiddhāntikā*, p. 61)

The deviation of the solstices from the position they had held in ancient times, namely at the beginning of Dhaniṣṭhā and in the middle of Āśleṣā, would therefore have been a symptom of an inferior age.

In the opinion of Thibaut/Dvivedi and Pingree, the next verse 22 refers to trepidation theory, a particular model of precession which is based on the (wrong) assumption that in the course of thousands of years the vernal equinox oscillates to and from around sidereal 0° Aries with an amplitude of 23°20’. In Pingree’s edition, the text reads as follows:

> विपरीतायनपातो यदार्ककाष्ठां[श]शशिरविक्षेपः
>
> भवति तदा व्यतिपातो दिनकृच्छशियोगचक्रार्धे
>
> *viparītāyanapāto yadārkakāṣṭhāṃ[śa]śaśiravikṣepaḥ*
> *bhavati tadā vyatipāto dinakṛcchaśiyogacakrārdhe (PS 3.22)*

Pingree translates:

> When the falling away [from the mean position] of the ayana is reversed, then the correction [kṣepa] for the Sun and Moon [equals] the degrees of the maximum declination [kāṣṭhā] of the Sun [23;20°]. There is Vyatipāta if the sum [of the longitudes] of the Sun and the Moon is 180°.[53]

However, this translation does not do justice to the “if-then” structure of the verse. In fact, the last sentence, which mentions the *vyatipāta*, would belong to the “then” clause. Thibaut and Dvivedi try to account for this, but do not arrive at a convincing translation either.[54] Kuppanna Sastry interprets the verse in a completely different way, even without introducing the concept of precession or

[53] Neugebauer/Pingree, op. cit., part I, p. 44.

[54] Thibaut’s and Dwivedi’s emended text and translation are as follows:

विपरीतायनभागो यदार्ककाष्ठांशशशिरविक्षेपः

भवति तदा व्यतिपातो दिनकृच्छशियोगचक्रार्धे

*viparītāyanabhāgo yadārkakāṣṭhāṃśaśaśiravikṣepaḥ*
*bhavati tadā vyatipāto dinakṛcchaśiyogacakrārdhe (PS 3.22)*

> “When the degrees of the ayana are in the opposite direction (i. e., when the precession is retrograde), and the quantity to be added to the longitudes of sun and moon amounts to (as much as) the degrees of the sun’s greatest declination (i. e., when the degrees of precession amounts to 24); then the Vyatipâta takes place when the sum of the longitudes of sun and moon amounts to half a circle.” (Thibaut, *The Pañchasiddântikâ*; Sanskrit p. 9, right column; translation p. 18)

trepidation.[55] The text is thus fundamentally under debate and cannot be used to prove anything with certainty.

However, Pingree and Thibaut/Dvivedi might be mistaken when they interpret the expression *viparītāyanabhāgaḥ* (var. *-pātaḥ*) in the sense of "retrograde precession" or a "reversal of precession". The falsity of this solution becomes obvious when one researches the current definition of *vyatipātayoga* as well as its formulation in Sūryasiddhānta 11.2. The dictionary of Böhtlingk defines *vyatipātaḥ* as follows:

> *Bez. eines best. Joga, wenn nämlich Sonne und Mond in den entgegengesetzten Ajana stehen und dieselbe Declination haben, während die Summe ihrer Längen 180° beträgt.*[56]
>
> Designation of a certain *yoga*, viz. when the Sun and the Moon are in the opposite *ayanas* and have the same declination, while the sum of their longitudes amounts to 180°.

The Sūryasiddhānta defines the *vyatipātayoga* as follows:

> विपरीतायनगतौ चन्द्रार्कौ क्रान्तिलिप्तिकाः
>
> समास्तदा व्यतीपातो भगणार्धे तयोर्युतिः
>
> ***viparītāyana**gatau **candrārkau** krāntiliptikāḥ*
> *samās**tadā vyatīpāto bhagaṇārdhe** tayoryutiḥ (SS 11.2)*

| |
|---|
| When the Moon and the Sun are located in opposite *ayanas*, while the values of declination<br>are equal, then the *vyatipāta* is the sum of both at the middle of the zodiac. |

[55] Kuppanna Sastry's corrected text and his translation read as follows:

विपरीतायन[या]तो यदार्ककाष्ठां[ ]श[शी ]सविक्षेपः

भवति तदा व्यतिपातो दिनकृच्छशियोगचक्रार्धे

*viparītāyana[yā]to yadārkakāṣṭhāṃ[ ]śa[śī ]savikṣepaḥ*
*bhavati tadā vyatipāto dinakṛcchaśiyogacakrārdhe (PS 3.22)*

| |
|---|
| With the Moon approaching to meet the Sun, moving in a direction opposite to that of the Sun, when its true declination (i. e. the mean declination plus its latitude) becomes equal to the Sun's and when the sum of their longitudes is nearly six signs, then is the *Vyatīpāta* conforming to the definition, (i.e. the *Mahāvyatīpāta*). (Kuppanna Sastry, *Pañcasiddhāntikā of Varāhamihira*, p. 62f.) |

Apparently, he translates *viparītāyanayātaḥ* as "moving in a direction opposite to that of the Sun". However, this solution is not correct either, as will be obvious from my below explanations.

[56] Böhtlingk, *Sanskrit-Wörterbuch* (Petersburg 1871), vol. 6, col. 1434.

This wording is so similar to that of Pañcasiddhāntikā 3.22 that the correct reading and translation of the latter results almost automatically:

> विपरीतायनपातो यदार्ककाष्ठां[शः ]शशिसविक्षेपः
>
> भवति तदा व्यतिपातो दिनकृच्छशियोगचक्रार्धे
>
> ***viparītāyana****pāto yad****ārka****kāṣṭhāṃ[śaḥ ]****śaśi****savikṣepaḥ*
> *bhavati* ***tadā vyatipāto*** *dinakṛcchaśiyoga****cakrārdhe*** *(PS 3.22)*

| |
|---|
| When the position of the Sun (*arka-kāṣṭhā-aṃśa-*) falls into the opposite *ayana* (*viparīta-ayana-pātaḥ*) but has the same declination as the Moon (*śaśi-savikṣepaḥ*),<br>then this is the *vyatipātayoga*, at the middle of the circle of the yoga of the Sun and the Moon. |

By adding the syllable *[-śaḥ]* in the first line, the nonsensical accusative *-kāṣṭhām* is avoided. The term *vikṣepaḥ* is translated as "declination" because the common translation as "polar ecliptic latitude", which would always be 0 in case the Sun, does not make sense. The expression *viparītāyana-* might have the same meaning as in the verse in the Sūryasiddhānta, namely that the Sun and the Moon are in opposite *ayanas*.

Also interesting is Kuppanna Sastry's emendation of the text:

> विपरीतायन[या]तो यदार्ककाष्ठां[ ]श[शी ]सविक्षेपः
> *viparītāyana[yā]to yadārkakāṣṭhāṃ[ ]śa[śī ]savikṣepaḥ*

With these corrections, the verse is remarkably close to the wording of the Sūryasiddhānta's verse, although Kuppanna Sastry seems to be unaware of this. The accusative *kāṣṭhāṃ* remains strange, though. It cannot be an accusative of direction referred to by *-yāto*, because that role is already taken by *viparītāyana-*. If linked to *savikṣepaḥ*, one would rather expect the instrumental case *kāṣṭhayā*. But then, what is *kāṣṭhā* supposed to mean here? "Declination", as suggested by Kuppanna Sastry? However, the usual term for "declination" in Pañcasiddhāntikā rather seems to be *apakramaḥ* or *krāntiḥ*, as in Sūryasiddhānta. It might be preferable to avoid the accusative and emend it to *kāṣṭhāṃśaḥ*. Then the following solution is obtained, which gives good sense, too:

विपरीतायन[या]तो यदार्ककाष्ठां[शः ]श[शी ]सविक्षेपः

भवति तदा व्यतिपातो दिनकृच्छशियोगचक्रार्धे

*viparītāyana[yā]to yadārkakāṣṭhāṃ[śaḥ ]śa[śī ]savikṣepaḥ*
*bhavati tadā vyatipāto dinakṛcchaśiyogacakrārdhe (PS 3.22)*

When the Moon (*śaśī*) is located in the *ayana* that is opposed [to the *ayana* of the Sun] (*viparīta-ayana-yātaḥ*), when he has the same distance from the solstice as the Sun (*arka-kāṣṭhā-amśaḥ*) and has the same declination [as the Sun has] (*sa-vikṣepaḥ*),
then this is the *vyatipātayoga*, at the middle of the circle of the yoga of the Sun and the Moon.

It therefore seems that Varāhamihira never deals with precession or trepidation, neither here nor elsewhere in Pañcasiddhāntikā. Also, there is no direct evidence that he knew any model of precession at all. Of course, one could speculate that the Romakasiddhānta, which used Hipparchus' tropical year length and was known to Varāhamihira, also treated the topic of precession. However, this remains speculation. Moreover, Varāhamihira could have derived a precession rate from the different year lengths of the tropical Romakasiddhānta and the sidereal older Sūryasiddhānta. However, he does not do that. One gets the impression that Varāhamihira does not understand the phenomenon at all. It is not even certain that he interpreted the change in position of the solstices since ancient times as a continuous motion. Rather, he might have considered it a cataclysmic change in the past and been afraid of a comparable change in the future.

A form of precession or trepidation theory is found only in later texts, for the first time probably in the extant version of Sūrya-siddhānta, 3.9-12, which was not available to Varāhamihira yet. The verses are quoted for the first time by Govindaswāmin, who lived in the 9th century, in his commentary on the Uttarakhaṇḍa of Parāśarahorāśāstra. The following statement in Sūryasiddhānta 3.9a is of particular interest:

त्रिंशत्कृत्यो युगे भानां चक्रं प्राक्परिलम्बते

*triṃśatkṛtyo yuge bhānāṃ cakraṃ prākparilambate (SS 3.9a)*

600 times in an age [of 43,20,000 years] the zodiac is left behind in eastern direction.

This means that the zodiac oscillates to and from relative to the vernal point once every 7200 years. The amplitude of this oscillation is 27°, as is clear from the context. It is interesting to note that *the spring equinox is considered fixed and the sidereal zodiac movable*. This is not exactly what one would expect when today's Indian calendar tradition and astrology completely ignore the equinoxes and solstices.

## The Pole Star Dhruva

As has been previously noted, another piece of evidence in favour of the high antiquity of the Vedic astronomical tradition is given in reference to a pole star by the name of *Dhruva*. The pole star α Ursae Minoris, which today is located in the vicinity of the celestial north pole, has gradually grown into this role only after approximately 1000 CE. Close to that year, Polaris was still about 6°, or 12 full moon diameters, from the celestial pole and thus performed a distinct circular motion around it in the course of a day. At present, its distance from the pole has dwindled to almost only one lunar diameter. Since Vedic literature mentions a pole star already a lot earlier, e.g. in Maitryupaniṣad, in Mahābhārata, Harivaṃśa, and in older Purāṇic texts, all of which were composed before 500 CE, the question arises which alternative star could have served at a pole star in antiquity. The only possible candidate seems to be the star Thuban (α Draconis), which was near the celestial pole already in 2800 BCE (the exact year). By the year 1700 BCE, Thuban had again departed from the celestial pole and was 6° or 12 full moon diameters away from the pole. Since then, and before the arrival of the current pole star, the region of the celestial pole was empty. Hence it seems that the mentioned texts are testimonies of a very, very old tradition.

The most impressive testimony of an ancient pole star that had "run away" from the celestial pole has been discussed already. It is the following statement from Maitryupaniṣad:

अथ किमेतैर्वा अन्यानां शोषणं महार्णवानां शिखरिणां प्रपतनं ध्रुवस्य प्रचलनं व्रश्चनं वातरज्जूनां (var. स्थानं वा तरूणां; var. व्रश्चनं तरूणां) निमज्जनं पृथिव्याः स्थानादपसरणं सुराणामित्येतद्विधे (var. सुराणां सोऽहमित्येतद्विधे) संसारे किं कामोपभोगैर्यैरेवाश्रित-स्यासकृदिहावर्तनं दृश्यत इति

*atha kimetairvā, anyānāṃ śoṣaṇaṃ mahārṇavānāṃ, śikhariṇāṃ prapatanaṃ,* ***dhruvasya pracalanaṃ, vraścanaṃ vātarajjūnāṃ*** (var. *sthānaṃ vā tarūṇāṃ;* var. *vraścanaṃ tarūṇāṃ*)**, *nimajjanaṃ pṛthivyāḥ, sthānādapasaraṇaṃ surāṇām*** *ity*(var. *surāṇāṃ so'hamity*)*etadvidhe saṃsāre kiṃ kāmopabhogairyairevāśritasyāsakṛdihāvartanaṃ dṛśyata iti* *(MaiUp 1.4)*

But what am I talking of these! Moreover, there is also the drying-up of great oceans, the collapsing of mountains, **the swerving of the pole star, the cutting-through of the wind strings** (which tie the constellations to the pole star)**,** the drowning of the earth, **the running-away of the gods from their abode**, – in this kind of course of the world, how can one enjoy desires, when, as can be seen, whoever relies on them, must return again and again!

There is talk of a "swerving of the pole star" from its fixed place, and that in the context of various cosmic catastrophes. This seems to indicate that Vedic astronomers of very ancient times had noticed that a star that had formerly been located near the celestial north pole had left its position. As has been stated already, the most plausible candidate for this ancient pole star is the star Thuban. In the year 2800 BCE, it was located almost exactly at the celestial pole, and during the 3rd millennium it noticeably moved away from it. An alternative candidate would be the star κ Draconis, which had approached the pole in the second millennium and reached its minimum distance of 4°40' or 9 full moon diameters in the year 1326 BCE. However, was this close enough to talk about a pole star and its "swerving" from the celestial pole?

As R. N. Iyengar points out in his article on Dhruva,[57] the identification of Dhruva as the star Thuban (α Draconis) is also plausible on the basis of texts that identify Dhruva as a star in the tail of a constellation called Śiṃśumāra ("Dolphin"). This constellation seems to approximately correspond to Draco. The oldest of these texts is Taittirīyāraṇyaka 2.19. It is rendered here at length:

[57] Iyengar, "Dhruva the Ancient Indian Pole Star: Fixity, Rotation and Movement".

चतुर्जालं ब्रह्मकोशं यं मृत्युर्नावपश्यति तं प्रपद्ये देवान्प्रपद्ये देवपुरं प्रपद्ये परीवृतो वरीवृतो ब्रह्मणा वर्मणाऽहं तेजसा कश्यपस्य यस्मै नमस्तच्छिरो धर्मो मूर्धानं ब्रह्मोत्तरा हनुर्यज्ञोऽधरा विष्णुर्हृदयं संवत्सरः प्रजननमश्विनौ पूर्वपादावत्रिर्मध्यं मित्रावरुणावपरपादावग्निः पुच्छस्य प्रथमं काण्डं तत इन्द्रस्ततः प्रजापतिरभयं चतुर्थं स वा एष दिव्यश्शाक्वरश्शिशुमारस्तं ह य एवं वेदाप पुनर्मृत्युं जयति जयति स्वर्गं लोकं नाध्वनि प्रमीयते नाग्नौ प्रमीयते नाप्सु प्रमीयते नानपत्यः प्रमीयते लघ्वान्नो भवति ध्रुवस्त्वमसि ध्रुवस्य क्षितमसि त्वं भूतानामधिपतिरसि त्वं भूतानां श्रेष्ठोऽसि त्वां भूतान्युपपर्यावर्तन्ते नमस्ते नमस्सर्वं ते नमो नमश्शिशुकुमाराय नमः

*caturjālaṃ brahmakośaṃ yaṃ mṛtyurnāvapaśyati taṃ prapadye devān-prapadye devapuraṃ prapadye parīvṛto varīvṛto brahmaṇā varmaṇā 'haṃ tejasā kaśyapasya yasmai namastacchiro dharmo mūrdhānaṃ brahmottarā hanuryajño'dharā viṣṇurhṛdayaṃ saṃvatsaraḥ prajana-namaśvinau pūrvapādāvatrirmadhyaṃ mitrāvaruṇāvaparapādāvagniḥ pucchasya prathamaṃ kāṇḍaṃ tata indrastataḥ prajāpatirabhayaṃ caturthaṃ sa vā eṣa divyaśśākvaraśśiśumārastaṃ ha ya evaṃ vedāpa punarmṛtyuṃ jayati jayati svargaṃ lokaṃ nādhvani pramīyate nāgnau pramīyate nāpsu pramīyate nānapatyaḥ pramīyate laghvānno bhavati dhruvastvamasi dhruvasya kṣitamasi tvaṃ bhūtānāmadhipatirasi tvaṃ bhūtānāṃ śreṣṭho'si tvāṃ bhūtānyupaparyāvartante namaste namas-sarvaṃ te namo namaśśiśukumārāya namaḥ (TaiĀr 2.19)*

I take refuge with the fourfold brahma treasure (i.e. the knowledge of the four Vedas), on which death does not look down; I take refuge with the gods, I take refuge with the abode of the gods. I am enveloped and surrounded by sacred mantras (*brahma*) and protective formulas (*varma*) and by the spiritual fire of Kaśyapa – bow (*namaḥ*) to him! His head: Dharma is in his mouth, Brahmā (or: Brahma) his upper jaw, Yajña his lower jaw, Viṣṇu his heart, Saṃvatsara his penis, the two Aśvins his forelegs, Atri his middle, Mitra and Varuṇa his hind legs, Agni is the first knot in his tail, then Indra, then Prajāpati, and Abhayam ("the fearless") as the fourth. This is the celestial, mighty Śiśumāra. Whoever knows him like this, conquers the repetition of death and conquers the world of heaven. He is not destroyed by air, not destroyed by fire, not destroyed by water, not destroyed by childlessness; he becomes one who easily finds food. You are Dhruva, you are the abode of Dhruva, you are the commander of the beings, you are the best of the beings, the beings (*bhūtāni*) circle around you. Bow (*namaḥ*) to you, all bow to you, bow, bow to *śiśukumāra*, bow!

Iyengar identifies the fourth star, which is called Abhayam, i. e. "that which is fearless", with the pole star and thus with Dhruva and Thuban. This seems to make sense, even though it is difficult to identify the other stars mentioned in the text. Besides, the asso-ciation of the absolute with fearlessness and immovability is very common in ancient Indian philosophy. Also, Dhruva is called a star in the tail of Śiśumāra in several places in Purāṇas, e.g. in the following verse:

> उत्तानपादपुत्रस्तु तमाराध्य जगत्पतिम्
>
> स ताराशिशुमारस्य ध्रुवः पुच्छे व्यवस्थितः (var. सताराशिशुमारस्य)
>
> *uttānapādaputrastu tamārādhya jagatpatim*
> *sa tārāśiśumārasya dhruvaḥ pucche vyavasthitaḥ (VP 2.9.5)*
> *(var. satārāśiśumārasya)*

| |
|---|
| After Dhruva, the son of Uttānapāda, had propitiated that lord of the world, he was placed into the tail of the constellation Śiśumāra. |

Furthermore, the text from Taittirīyāraṇyaka mentions "beings" (*bhūtāni*) that circle about him. These obviously refer to the stars. The star about which all stars circled must have been the one that was closest to the celestial pole. In principle, this could have been Thuban or, alternatively, the star κ Draconis. After 1800 BCE, κ Draconis was closer to the pole than Thuban (at about 84°N), however for several centuries rivalled by the star Kochab (β Ursae Minoris) and its considerably fainter neighbour 5 Ursae Minoris. By 300 CE, Polaris (about 80°N) was closest to the celestial pole, however initially still rivalled by Kochab. The maximum declination ever reached by κ Draconis was 85°20'N near 1326 BCE and that of Kochab 83°28'N in 1057 BCE. Considering this situation, it is obvious that when Maitryupaniṣad says that the pole star „ran away", then this actually only matches Thuban, because only this star had come really close to the celestial pole and was an unrivalled pole star.

The role of Dhruva as the pole star is also evident from the following text, which appears in several older Purāṇas. Since it is very poorly preserved and has many variations, textual variants are also given:[58]

> एतच्छ्रुत्वा तु मुनयः पप्रच्छू रोमहर्षणम् B1
>
> (एवं श्रुत्वा कथां दिव्यामब्रुवँल्लौमहर्षणिम् M1)
>
> *etacchrutvā tu munayaḥ papracchū romaharṣaṇam B1*
> *(evaṃ śrutvā kathāṃ divyāmabruvam̐llaumaharṣaṇim M1)*

| |
|---|
| After hearing this, the saints asked Sūta |

[58] B = Brahmāṇḍapurāṇa 1.22; M = Matsyapurāṇa 125; V = Viṣṇupurāṇa 2.9; Vā = Vāyupurāṇa 51.

सूर्याचन्द्रमसोश्चारं ग्रहाणां चैव सर्वशः B2

*sūryācandramasoścāraṃ grahāṇāṃ caiva sarvaśaḥ B2*

| |
|---|
| about the course of the Sun, the Moon, and the planets, in every way. |

ऋषय ऊचुः

*ṛṣaya ūcuḥ*

| |
|---|
| The Ṛṣis said: |

भ्रमन्ति कथमेतानि ज्योतींषि दिवमण्डलम् B3 (रविमण्डले M2)

*bhramanti kathametāni jyotīṃṣi divamaṇḍalam B3 (ravimaṇḍale M2)*

| |
|---|
| "How do these lights revolve in the circle of the sky (M: of the Sun), |

अव्यूहेन च सर्वाणि तथैवासंकरेण वा B3

*avyūhena ca sarvāṇi tathaivāsaṃkareṇa vā B3*

| |
|---|
| both non-separated [from each other] and non-mixed-up [with each other]? |

कश्चिद्भ्रामयते तानि भ्रमन्ते यदि वा स्वयम् (कश्च भ्रामयते, भ्रमन्ति M3)

*kaścidbhrāmayate tāni bhramante yadi vā svayam B4*
*(kaśca bhrāmayate, bhramanti M3)*

| |
|---|
| Does anybody cause them to revolve? Or do they revolve by themselves? |

एतद्वेदितुमिच्छामस्तन्नो निगद सत्तम B4 (ततो निगद M3)

*etadveditumicchāmastanno nigada sattama B4 (tato nigada M3)*

| |
|---|
| This we want to know, tell it to us, O best one!" |

सूत उवाच

*sūta uvāca*

| |
|---|
| Sūta said: |

भूतसंमोहनं ह्येतद्वदतो मे निबोधत B5 (ब्रुवतो M4)

*bhūtasaṃmohanaṃ hyetadvadato me nibodhata B5 (bruvato M4)*

| |
|---|
| "The living beings are confused about this, learn it from me, I shall tell you |

प्रत्यक्षमपि दृश्यं च संमोहयति यत्प्रजाः B5 (वै प्रजाः M4)

*pratyakṣamapi dṛśyaṃ ca saṃmohayati yatprajāḥ B5 (vai prajāḥ M4)*

| |
|---|
| what, although clearly observable, confuses the creatures. |

योऽयं चतुर्दिशं पुच्छे शैशुमारे व्यवस्थितः B6

(योऽसौ चतुर्दशर्क्षेषु शिशुमारो व्यवस्थितः M5)

*yo 'yaṃ caturdiśaṃ pucche śaiśumāre vyavasthitaḥ B6*
*(yo 'sau caturdaśarkṣeṣu śiśumāro vyavasthitaḥ M5)*

| |
|---|
| The one there in [the middle of (?)] the four directions, who is located at the tail of the [constellation] Śiṃśumāra,<br>(M: That constellation Śiṃśumāra, which is located in [the middle of (?)] the 14 constellations,) |

उत्तानपादपुत्रोऽसौ मेढीभूतो ध्रुवो दिवि  B6

*uttānapādaputro 'sau meḍhībhūto dhruvo divi  B6*

| |
|---|
| that son of Uttānapāda, who is the “Fixed One” (Dhruva) in the sky, being the axial pillar [of the world], |

स वै भ्रामयते नित्यं चन्द्रादित्यौ ग्रहैः सह B7 (सैष भ्रमन् भ्रामयते M6)

(सैष भ्रमन्भ्रामयति चन्द्रादित्यादिकान्ग्रहान् V2)

*sa vai bhrāmayate nityaṃ candrādityau grahaiḥ saha B7 (saiṣa bhraman bhrāmayate M6)*
*(saiṣa bhramanbhrāmayati candrādityādikāngrahān V2)*

| |
|---|
| it is he who causes the Moon and the Sun together with the planets to revolve incessantly;<br>(V:  it is he who causes the planets, i. e. the Moon, Sun, etc., to revolve, by revolving himself;) |

भ्रमन्तमनुगच्छन्ति नक्षत्राणि च चक्रवत् B7

(अनुसर्पन्ति M6; अनु तं यान्ति V2)

*bhramantamanugacchanti nakṣatrāṇi ca cakravat B7*
*(anusarpanti M6; anu taṃ yānti V2)*

| |
|---|
| while he is revolving, the *nakṣatras* follow him like a wheel. |

ध्रुवस्य मनसा चासौ सर्वते (सर्पते?) ज्योतिषां गणः B8

(... मनसा यो वै भ्रमते ... M7; ... सर्पते भगणाः स्वयम् Vā8)

*dhruvasya manasā cāsau sarvate (sarpate?) jyotiṣāṃ gaṇaḥ B8*
*(... manasā yo vai bhramate ... M7; ... sarpate bhagaṇāḥ svayam Vā8)*

| |
|---|
| It is by the will of Dhruva that this host of the celestial lights moves (M: circulates), |

सूर्याचन्द्रमसौ तारा नक्षत्राणि ग्रहैः सह B8  (om. M)

*sūryācandramasau tārā nakṣatrāṇi grahaiḥ saha B8  (om. M)*

| |
|---|
| the Sun, the Moon,  the stars, the *nakṣatras* together with the planets. |

वातानीकमयैर्बन्धैर्ध्रुवे बद्धानि तानि वै B9  (बद्धः प्रसर्पति M7)

*vātānīkamayairbandhairdhruve baddhāni tāni vai B9*
*(baddhaḥ prasarpati M7)*

| |
|---|
| because they are tied to Dhruva by ties that have the appearance of winds. |

तेषां योगश्च भेदश्च कालश्चारस्तथैव च B9   (तेषां भेदश्च योगश्च तथा कालस्य निश्चयः M8)

*teṣāṃ yogaśca bhedaśca kālaścārastathaiva ca B9*
*(teṣāṃ bhedaśca yogaśca tathā kālasya niścayaḥ M8)*

| |
|---|
| This is their connection and difference and time and course. (M: and fixed time). |

This text is concerning the diurnal rotation of the sky. This rotation is explained in the fact that the pole star Dhruva, which rotates near the celestial pole and is even identified with the rotational axis of the sky (*meḍhībhūtaḥ*), through its own rotation causes all the stars to rotate. The text believes this to happen because the stars are tied to Dhruva with ropes, quite similar to a swing ride in which the passenger chairs are suspended from the rotating top.

It must be noted that in this text, Dhruva is not considered a mathematical point in the sky, but a visible star, just as in Maitryupaniṣad und Taittirīyāraṇyaka. However, Indologists date the text very late, namely to the first centuries CE. At that time, Thuban had moved away from the celestial pole for three millennia, and Polaris still had not become the new pole star. In the same epoch, around 500 CE, Indian astronomers defined Dhruva as a merely mathematical point, as can be seen in Sūryasiddhānta 12.73 (cf. also 12.44; 72):

भचक्रं ध्रुवयोर्बद्धमाक्षिप्तं प्रवहानिलैः

पर्येत्यजस्रं तन्नद्धा ग्रहकक्षा यथाक्रमम्

*bhacakraṃ dhruvayorbaddhamākṣiptaṃ pravahānilaiḥ*
*paryetyajasraṃ tannaddhā grahakakṣā yathākramam SS 12.73*

> The zodiac, because it is bound to the two *dhruvas* (i.e. the two celestial poles) and set in motion by the provector winds,
> revolves incessantly. The orbits of the planets are fixed at this [zodiac] in their order.

Thus the question arises whether the Purāṇic text was composed only after the year 1000 CE, when Polaris approached the celestial poles, or whether the text continues the age-old tradition that understood Thuban as a pole star, which is attested to in the above-cited passages from Maitryupaniṣad and Taittirīyāraṇyaka. In the latter case, the astronomical theory described in the text would originate from the 3rd millennium BCE. As a matter of fact, this cannot be ruled out. A considerable number of testimonies regarding the extreme conservatism of Indian scholars even in antiquity have been presented in the previous chapters.

Some Indian scholars believe that the cited Purāṇic text also mentions the precession of the Earth‘s axis (or the vernal equinox). Unfortunately, this view is not based on a careful study of the text, but primarily on the ambition to prove that ancient Indian astronomers had discovered precession earlier than Hipparchus and Ptolemy. Since this topic tends to inflame some people's passions and they propagate their views quite vociferously on the internet, this will be elaborated upon subsequently. In the author's view, there is no other pre-Siddhāntic text apart from Maitryupaniṣad 1.4 that makes mention of such phenomenon.

Readers who are not interested in this special problem can skip the rest of this chapter and continue on p. 95.

In his attempt to prove Vedic awareness of precession, Vinay Jha, an expert in ancient Indian calendar and ephemeris computation, points to the following verse, which is contained in the above text, but has several variants and is quoted by Jha as follows:[59]

> उत्तानपादपुत्रोऽसौ मेढीभूतो ध्रुवो दिवि
>
> स हि भ्रमन्भ्रामयते नित्यं चन्द्रादित्यौ ग्रहैः सह
>
> *uttānapādaputro'sau meḍhībhūto dhruvo divi*
> *sa hi bhramanbhrāmayate nityaṃ candrādityau grahaiḥ saha (VāP 51.6-7)*

He translates it as follows:

> Uttanpāda's son Dhruva is the fixed point in the Heavens, round which all planets including Sun and Moon, and Dhruva himself also moves round.

and comments it as follows:

> Dhruva has two motions: diurnal motion or rotation as well as trepidating precession round the axis joining terrestrial poles with celestial pole, as elaborated further in Vāyu Purāna as shown below.

To begin with, it must be objected that the precessional motion of the star Dhruva-Thuban (or any other pole star) is not about the celestial north pole, as Jha's translation and commentary seem to indicate, but *about the ecliptic pole* and almost exactly *through* the celestial north pole. If the verse is studied in its context, it becomes obvious that the subject of the text is nothing but the *diurnal* rotation of Dhruva about the celestial north pole and the rotation of the other stars about him. An allusion to the motion due to axial

---

[59] Vinay Jha, "Ayanamsha vs Precession", http://vedicastrology.wikidot.com/ayanamsha-vs-precession#toc10 .

Note that in Jha's quotation the second line has too many syllables. The word *nityam* belongs to a different variant. Jha refers to Vāyupurāṇa 51.7, where the word does not appear.

precession is extremely unlikely, especially when no explanation of it is given in the context. The text first asks the question of how the Sun, the Moon, and the planets "revolve" (*bhram-*) around the sky and who it is that causes them to circle or whether they are able to circle by themselves. The question is answered as follows: It is Dhruva, the pole star or the celestial north pole, to whom they are tied by wind strings and who sets them into circular motion by putting himself in circular motion. The subject is clearly the diurnal motion of the sky around the celestial north pole. If one wants to ascribe to this text a discourse on precession, then one deprives it of its clarity, conciseness, and beauty. Also to be noted: When the diurnal motion of the sky is described in the text with such clarity and detail, then how come the alleged mention of precessional motion appears only in a single word (*bhraman*) and without any further explanation?

The question might arise what exactly is the meaning of the verb *bhram-*, especially in the following verse:

> सैष भ्रमन्भ्रामयति चन्द्रादित्यादिकान्ग्रहान्
>
> *saiṣa bhramanbhrāmayati candrādityādikāngrahān V2*
>
> it is he who causes the planets, i. e. the Moon, Sun, etc., to revolve, by his own revolving;

Does Dhruva "rotate" on the spot and around himself or does he "move about" the celestial pole like the Sun, Moon, and the other stars? Or, could *bhraman* actually mean the same as *pracalanam* in Maitryupaniṣad 1.4, namely the "swerving" from the pole? However, his very name *dhruvaḥ*, "the fixed one", as well as the fact that he is called the axial pole (*meḍhībhūtaḥ*), indicate that he rotates on the spot. The following verse also proves that *bhram-* does not only mean "to move about something", but also "to rotate about oneself":

> मृत्पिण्ड इव मध्यस्थो ध्रुवो भ्रमति वै तथा
>
> *mṛtpiṇḍa iva madhyastho dhruvo bhramati vai tathā (VāyuP 50.148)*
>
> like a lump of clay standing in the middle [of a potter's wheel (*kulālacakra*, mentioned in context)], in the same way Dhruva turns.

The same can be seen from the following verse:

> अक्षे चक्रं निबद्धं तु ध्रुवे त्वक्षः समर्पितः
>
> *akṣe cakraṃ nibaddhaṃ tu dhruve tvakṣaḥ samarpitaḥ (VāyuP 51.65)*
>
> The wheel is fixed at the axle, and the axle is fixed at Dhruva.

सहचक्रो भ्रमत्यक्षः सहाक्षो भ्रमति ध्रुवः

*sahacakro bhramatyakṣaḥ sahākṣo bhramati dhruvaḥ (66)*

| The axle revolves with the wheel, and Dhruva revolves with the axle. |
|---|

The context of these verses will be studied shortly. Other than *pracalanam* in Maitryupaniṣad 1.4, the *bhramaṇam* of the pole star thus does not describe a "swerving" from the pole.

Jha correctly points out that in another text, Dhruva's motion is described as a *pradakṣiṇam*, i. e. a "circumambulation to the right". However, his conclusion that this *pradakṣiṇam* allegedly indicates the motion that is due to precession is incorrect. Strictly speaking, it is not true that the star Thuban ever stood exactly at the celestial north pole. As has been said, its closest approach to the pole was reached in the year 2800 BCE, and the deviation was about 5', which is a sixth of the diameter of the full moon. It is quite possible that this small deviation was not noticed and the star seemed to stand still forever. However, 100 years earlier or later, the deviation was already greater than half a degree or one full moon diameter. Depending on the methods of observation and their accuracy, this deviation and the circular motion of the star about the celestial pole could have been noticed already. After only a few centuries that motion must have become obvious. In other words: The "identification" of the star with the celestial pole was possible only for a very limited period of time. In principle, it *never* precisely coincided with the pole, but always "circumambulated" it. This "circumambulation" was given by the diurnal motion of the sky (or the earth), *not* by the precession. It is therefore quite understandable that in ancient texts the star would sometimes have been *identified* with the celestial pole and sometimes have been considered to "*circumambulate*" the pole.

Considering Dhruva's *pradakṣiṇam* in context, Jha refers to verse Vāyupurāṇa 50.100, at the end of the following passage[60]:

[60] M = MatsyaP 127; B = BrahmāṇḍaP 1.23; V = ViṣṇuP 2.12; Vā = VāyuP 52.

एते वाहा ग्रहाणां वै मया प्रोक्ता रथैः सह M12 Vā84

एते वाहा ग्रहाणां च ह्युपाख्याता रथैः सह B91  एते मया ग्रहाणां वै तवाख्याता रथा नव V24

*ete vāhā grahāṇāṃ vai mayā proktā rathaiḥ saha M12 Vā84*
*ete vāhā grahāṇāṃ ca hyupākhyātā rathaiḥ saha B91*
*ete mayā grahāṇāṃ vai tavākhyātā rathā nava V24*

I have explained these horses of the planets including their chariots.
(var. I have explained to you these nine chariots of the planets. V)

सर्वे ध्रुवे निबद्धास्ते निबद्धा वातरश्मिभिः M12 (Vā84 प्रबद्धा)

सर्वे ध्रुवनिबद्धास्ते प्रवृद्धा वातरश्मिभिः B92  सर्वे ध्रुवे महाभाग प्रबद्धा वायुरश्मिभिः V24

*sarve dhruve nibaddhāste nibaddhā vātaraśmibhiḥ M12 (Vā84 prabaddhā)*
*sarve dhruvanibaddhāste pravṛddhā vātaraśmibhiḥ B92*
*sarve dhruve mahābhāga prabaddhā vāyuraśmibhiḥ V24*

They are all bound to Dhruva, incited (var. bound) by wind reins[61].

एते वै भ्राम्यमाणास्ते यथायोगं वहन्ति वै M13  (Vā85 यथायोगे भ्रमन्ति)

तपन्ते ब्राम्यमाणास्तु यथायोगं भ्रमन्ति वै B92

*ete vai bhrāmyamāṇāste yathāyogaṃ vahanti vai M13*
*(Vā85 yathāyoge bhramanti)*
*tapante brāmyamāṇāstu yathāyogaṃ bhramanti vai B92*

These are set in revolving motion and they revolve (var. run) in due order.

वाय याभिरदृश्याभिः प्रबद्धा वातरश्मिभिः M13

वायव्याभिरदृश्याभिः प्रवृद्धा वातरश्मिभिः B93 (Vā85 प्रबद्धा)

*vāya yābhiradṛśyābhiḥ prabaddhā vātaraśmibhiḥ M13*
*vāyavyābhiradṛśyābhiḥ pravṛddhā vātaraśmibhiḥ B93 (Vā85 prabaddhā)*

They are incited (var. bound) by wind-like, invisible wind reins.

परिभ्रमन्ति तद्बद्धाश्चन्द्रसूर्यग्रहा दिवि M14 Vā86 V93

*paribhramanti tadbaddhāścandrasūryagrahā divi M14 Vā86 V93*

Bound by these, the Moon, the Sun, and the planets revolve in the sky.

भ्रमन्तमनुगच्छन्ति ध्रुवं ते ज्योतिषां गणाः B94 Vā86

यावत्तमनुपर्येति ध्रुवं च ज्योतिषां गणः M14

*bhramantamanugachanti dhruvaṃ te jyotiṣāṃ gaṇāḥ B94 Vā86*
*yāvattamanuparyeti dhruvaṃ ca jyotiṣāṃ gaṇaḥ M14*

As Dhruva is revolving, the hosts of celestial lights follow him.
(var. as far as the host of the celestial lights circumambulate after Dhruva.)

[61] The word *raśmiḥ* means “string, rope, rein; ray of light”.

यथा नद्युदके नौस्तु सलिलेन सहोह्यते B94 Vā87 (M15 उदकेन)

*yathā nadyudake naustu salilena sahohyate B94 Vā87 (M15 udakena)*

| |
|---|
| Just as a boat is carried with the flow on the water of a river, |

तथा देवगृहाणि स्युरुह्यन्ते वातरंहसा M15

तथा देवालया ह्येते ऊह्यन्ते वातरश्मिभिः B95 Vā87

*tathā devagṛhāṇi syuruhyante vātaraṃhasā M15*
*tathā devālayā hyete ūhyante vātaraśmibhiḥ B95 Vā87*

| |
|---|
| so the abodes of the gods are carried with wind speed (var. by wind reins). |

तस्मात्सर्वेण दृश्यन्ते व्योम्नि देवगणास्तु ते Vā87

सर्पमाणा न दृश्यन्ते व्योम्नि देवगणास्तु ते B95

तस्माद्यानि प्रगृह्यन्ते व्योम्नि देवगृहा इति M15

*tasmātsarveṇa dṛśyante vyomni devagaṇāstu te Vā87*
*sarpamāṇā na dṛśyante vyomni devagaṇāstu te B95*
*tasmādyāni pragṛhyante vyomni devagṛhā iti M15*

| |
|---|
| Therefore everybody sees the hosts (var. abodes) of the gods in the sky. (var. The hosts of the gods are seen in motion, as it were, in the sky.) (var. Therefore, because they are "held" (*pra-gṛh-yante*), they are called the "houses" (*gṛh-āḥ*) of the gods.) |

[ग्रहर्क्षताराधिष्ण्यानि ध्रुवे बद्धान्यशेषतः V25

*[graharkṣatārādhiṣṇyāni dhruve baddhānyaśeṣataḥ V25*

| |
|---|
| The orbits of the planets, *nakṣatras* and stars are all bound to Dhruva. |

[भ्रमन्त्युचितचारेण मैत्रेयानिलरश्मिभिः V25

*[bhramantyucitacāreṇa maitreyānilaraśmibhiḥ V25*

| |
|---|
| They revolve in proper course, O Maitreya, by wind reins. |

यावत्यश्चैव ताराः स्युस्तावन्तोऽस्य मरीचयः M16

यावत्यश्चैव ताराश्च तावन्तो वातरश्मयः B96 (Vā88 तारास्तु)

यावन्त्यश्चैव तारास्तास्तावन्तो वातरश्मयः V26

*yāvatyaścaiva tārāḥ syustāvanto 'sya marīcayaḥ M16*
*yāvatyaścaiva tārāśca tāvanto vātaraśmayaḥ B96 (Vā88 tārāstu)*
*yāvantyaścaiva tārāstāstāvanto vātaraśmayaḥ V26*

| |
|---|
| As many stars there are, just as many wind reins there are. |

→

सर्वा ध्रुवनिबद्धास्ता भ्रमन्त्यो भ्रामयन्ति च M16 (Vā88 तम्)

सर्वा ध्रुवे निबद्धाश्च भ्रमन्त्यो भ्रामयन्ति ताः B96

सर्वे ध्रुवे निबद्धास्ते भ्रमन्तो भ्रामयन्ति तम् V26

*sarvā dhruvanibaddhāstā bhramantyo bhrāmayanti ca M16 (Vā88 tam)*
*sarvā dhruve nibaddhāśca bhramantyo bhrāmayanti tāḥ B96*
*sarve dhruve nibaddhāste bhramanto bhrāmayanti tam V26*

| |
|---|
| All of them are bound to Dhruva; by their own revolving they cause them (var. him) to revolve.[62] |

तैलपीडं यथा चक्रं भ्रमते भ्रामयन्ति वै M17

तैलपीडा यथा चक्रं भ्रमन्तो भ्रामयन्ति ह B97 (V27 वै)

तैलपीदाकरं चक्रं भ्रमद्भ्रामयते यथा Vā89

*tailapīḍaṃ yathā cakraṃ bhramate bhrāmayanti vai M17*
*tailapīḍā yathā cakraṃ bhramanto bhrāmayanti ha B97 (V27 vai)*
*tailapīdākaraṃ cakraṃ bhramadbhrāmayate yathā Vā89*

| |
|---|
| Just as oil-crushers revolve and set a wheel in revolving motion, |

तथा भ्रमन्ति ज्योतींषि वातबद्धानि सर्वशः V17 B97 Vā89 (V27 वातविद्धानि)

*tathā bhramanti jyotīṃṣi vātabaddhāni sarvaśaḥ M17 B97 Vā89*
*(V27 vātaviddhāni)*

| |
|---|
| so revolve the celestial lights, bound by winds (var. incited by winds) all around. |

अलातचक्रवद्यान्ति वातचक्रेरितानि तु M18 B98 V28 Vā90

*alātacakravadyānti vātacakreritāni tu M18 B98 V28 Vā90*

| |
|---|
| Just like wheels of burning coals, they are set in motion by winds. |

→

[62] The verse is problematic. In M and B, it is apparently the stars (fem.) that are bound to Dhruva. By their own revolving they cause either "them" (*tāḥ*) or "him" (*tam*) to revolve, depending on the variant. The variant "them" does not seem to make any sense. The variant "him" is also problematic. Who is "he"? Dhruva? Does not only Dhruva set the stars in motion, but do the stars also set Dhruva in motion? Is it a mutual interaction?

On the other hand, in V it is the reins (mask.) that are bound to Dhruva. And by their own revolving, the reins cause "him" (*tam*) to revolve. This does not make any sense either. Or, do we have to read "them" (*tāḥ*) here, too? Thus, by their own revolving the reins cause the star to revolve?

यस्मात्प्रवहते तानि प्रवहस्तेन स स्मृतः M18

यतो ज्योतींषि वहते प्रवहस्तेन स स्मृतः B98

यस्माज्ज्योतींषि वहति प्रवहस्तेन स स्मृतः V28 (Vā90 वहते)

*yasmātpravahate tāni pravahastena sa smṛtaḥ M18*
*yato jyotīṃṣi vahate pravahastena sa smṛtaḥ B98*
*yasmājjyotīṃṣi vahati pravahastena sa smṛtaḥ V28 (Vā90 vahate)*

| Because he carries the celestial lights, therefore he (Dhruva) is known as the "carrier [wind]". |
|---|

एवं ध्रुवे नियुक्तोऽसौ भ्रमते ज्योतिषां गणः M19

एवं ध्रुवनिबद्धोऽसौ सर्पते ज्योतिषां गणः B99 Vā91

*evaṃ dhruve niyukto 'sau bhramate jyotiṣāṃ gaṇaḥ M19*
*evaṃ dhruvanibaddho 'sau sarpate jyotiṣāṃ gaṇaḥ B99 Vā91*

| Like this, the host of the lights revolves, bound to Dhruva. |
|---|

एष तारामयः प्रोक्तः शिशुमारे ध्रुवो दिवि M19

सैष तारामयो ज्ञेयः शिशुमारो ध्रुवो दिवि B99 Vā91

*eṣa tārāmayaḥ proktaḥ śiśumāre dhruvo divi M19*
*saiṣa tārāmayo jñeyaḥ śiśumāro dhruvo divi B99 Vā91*

| This Dhruva must be known as the constellation Śiśumāra in the sky. (B, Vā; This constellation Dhruva is in Śiśumāra, they say. (M)) |
|---|

यदह्ना कुरुते पापं तं दृष्ट्वा निशि मुञ्चति M20

(दृष्ट्वा तन्निशि मुञ्चते B100; दृष्ट्वा तं निशि मुच्यते Vā91)

*yadahnā kurute pāpaṃ taṃ dṛṣṭvā niśi muñcati M20*
*(dṛṣṭvā tanniśi muñcate B100; dṛṣṭvā taṃ niśi mucyate Vā91)*

| If one does an evil during the day and sees it at night, then one will be liberated from it (var. let it loose). |
|---|

शिशुमारशरीरस्था यावत्यस्तारकास्तु ताः M20

यावत्यश्चैव तारास्ताः शिशुमाराश्रिता दिवि B100 Vā92

*śiśumāraśarīrasthā yāvatyastārakāstu tāḥ M20*
*yāvatyaścaiva tārāstāḥ śiśumārāśritā divi B100 Vā92*

| And as many stars as there are in Śiśumāra in the sky. |
|---|

वर्षाणि दृष्ट्वा जीवेत तावदेवाधिकानि तु M21

तावन्त्येव तु वर्षाणि जीवताभ्यधिकानि तु B101 (जीवन्त्य- Vā92)

*varṣāṇi dṛṣṭvā jīveta tāvadevādhikāni tu M21*
*tāvantyeva tu varṣāṇi jīvatābhyadhikāni tu B101 (jīvanty- Vā92)*

| so many years and more one lives after having seen them. |
|---|

शिशुमाराकृतिं ज्ञात्वा प्रविभागेन सर्वशः M21

साकारः शिशुमारश्च विज्ञेयः प्रविभागशः B101

शाश्वतः शिशुमारोऽसौ विज्ञेयः प्रविभागशः Vā93

*śiśumārākṛtiṃ jñātvā pravibhāgena sarvaśaḥ M21*
*sākāraḥ śiśumāraśca vijñeyaḥ pravibhāgaśaḥ B101*
*śāśvataḥ śiśumāro'sau vijñeyaḥ pravibhāgaśaḥ Vā93*

and after knowing the shape of Śiśumāra with all its parts. (M)
(Together with his shape, Śiśumāra should be known with his parts. (B))
(That eternal Śiśumāra should be known with his parts. (Vā))

उत्तानपादस्तस्याथ विज्ञेयः सोत्तरो हनुः M22

औत्तानपादस्तस्याथ विज्ञेयो ह्युत्तरो हनुः B102 (उत्तान- Vā93)

*uttānapādastasyātha vijñeyaḥ sottaro hanuḥ M22*
*auttānapādastasyātha vijñeyo hyuttaro hanuḥ B102 (uttāna- Vā93)*

Now, Uttānapāda is to be known as his upper jaw.

यज्ञोऽधरस्तु विज्ञेयो Uttānapāda धर्मो मूर्धानमाश्रितः M22 Vā94 (यज्ञः परस्तु B102)

*yajño 'dharastu vijñeyo dharmo mūrdhānamāśritaḥ M22 Vā94*
*(yajñaḥ parastu B102)*

Yajña is to be known as his lower jaw, Dharma resides in his head.

हृदि नारायणः साध्या अश्विनौ पूर्वपादयोः M23 Vā94 (साध्यो ह्यश्विनौ B103)

*hṛdi nārāyaṇaḥ sādhyā aśvinau pūrvapādayoḥ M23 Vā94*
*(sādhyo hyaśvinau B103)*

Nārāyaṇa is to be realised in his heart, the two Aśvins in his fore legs.

वरुणश्चार्यमा चैव पश्चिमे तस्य सक्थिनी M23 B103 Vā95

*varuṇaścāryamā caiva paścime tasya sakthinī M23 B103 Vā95*

Varuṇa and Aryaman are his hind legs.

शिश्ने संवत्सरो ज्ञेयो मित्रश्चापानमाश्रितः M24

शिश्नं संवत्सरस्तस्य मित्रोऽपानं समाश्रितः B104

शिशुः संवत्सरस्तस्य मित्रोऽपाने समाश्रितः Vā95

*śiśne saṃvatsaro jñeyo mitraścāpānamāśritaḥ M24*
*śiśnaṃ saṃvatsarastasya mitro'pānaṃ samāśritaḥ B104*
*śiśuḥ saṃvatsarastasya mitro'pāne samāśritaḥ Vā95*

Saṃvatsara is to be known in his penis and Mitra is located at his anus.

→

पुच्छेऽग्निश्च महेन्द्रश्च मरीचिः कश्यपो ध्रुवः M24 Vā96 (मरीचः B104)
*pucche'gniśca mahendraśca marīciḥ kaśyapo dhruvaḥ M24 Vā96 (marīcaḥ B104)*

| |
|---|
| In his tail are Agni, Mahendra, Marīci, Kaśyapa, and Dhruva. |

एष तारामयः स्तम्भो नास्तमेति न वोदयम् M25

तारकाः शिशुमारस्य नास्तं याति चतुष्टयम् B105

तारकाः शिशुमारश्च नास्तमेति चतुष्टयम् Vā96

*eṣa tārāmayaḥ stambho nāstameti na vodayam M25*
*tārakāḥ śiśumārasya nāstaṃ yāti catuṣṭayam B105*
*tārakāḥ śiśumāraśca nāstameti catuṣṭayam Vā96*

| |
|---|
| This is the constellation of the pillar. It does not set nor rise. (M) |

नक्षत्रचन्द्रसूर्याश्च ग्रहास्तारागणैः सह M25 Vā97 B106
*nakṣatracandrasūryāśca grahāstārāgaṇaiḥ saha M25 Vā97 B105*

| |
|---|
| The *nakṣatras*, the Moon, the Sun, and the planets with the hosts of the stars |

तन्मुखाभिमुखाः सर्वे चक्रभूता दिवि स्थिताः M26

उन्मुखा विमुखाः सर्वे वक्रीभूताः श्रिता दिवि B106

उन्मुखाभिमुखाः सर्वे चक्रीभूताश्रिता दिवि Vā97

*tanmukhābhimukhāḥ sarve cakrabhūtā divi sthitāḥ M26*
*unmukhā vimukhāḥ sarve vakrībhūtāḥ śritā divi B106*
*unmukhābhimukhāḥ sarve cakrībhūtāśritā divi Vā97*

| |
|---|
| all look up at [Dhruva], standing in the sky in the form of a circle. |

ध्रुवेणाधिष्ठिताश्चैव ध्रुवमेव प्रदक्षिणम् M26 B106 (Vā98 -धिष्ठिताः सर्वे)
*dhruveṇādhiṣṭhitāścaiva dhruvameva pradakṣiṇam M26 B106 (Vā98 -dhiṣṭhitāḥ sarve)*

| |
|---|
| And commanded by Dhruva, in right-handed direction about Dhruva, |

परियान्ति सुरश्रेष्ठं मेढीभूतं ध्रुवं दिवि M27

परियान्तीश्वरश्रेष्ठं मेढीभूतं द्रुवं दिवि B107

प्रयान्तीह वरं श्रेष्ठं ... Vā98

*pariyānti suraśreṣṭhaṃ meḍhībhūtaṃ dhruvaṃ divi M27*
*pariyāntīśvaraśreṣṭhaṃ meḍhībhūtaṃ druvaṃ divi B107*
*prayāntīha varaṃ śreṣṭhaṃ ... Vā98*

| |
|---|
| they move about the best of the gods, who is the axle pole in the sky. |

→

आग्नीध्रकाश्यपानां तु तेषां स परमो ध्रुवः M27

अग्नीन्द्रकश्यपानां तु चरमोऽसौ ध्रुवः स्मृतः B107

ध्रुवाग्निकश्यपानां तु वरश्चासौ ध्रुवः स्मृतः Vā99

*āgnīdhrakāśyapānāṃ tu teṣāṃ sa paramo dhruvaḥ M27*
*agnīndrakaśyapānāṃ tu caramo 'sau dhruvaḥ smṛtaḥ B107*
*dhruvāgnikaśyapānāṃ tu varaścāsau dhruvaḥ smṛtaḥ Vā99*

Among Agni, Indra, and Kaśyapa, Dhruva is the highest (var. last; best).

एक एव भ्रमत्येष मेरोरन्तरमूर्धनि M28

एक एव भ्रमत्येष मेरुपर्वतमूर्धनि B108 Vā99

*eka eva bhramatyeṣa merorantaramūrdhani M28*
*eka eva bhramatyeṣa meruparvatamūrdhani B108 Vā99*

He alone revolves on the head of the mountain Meru (var. in the inner head/top of Meru).

ज्योतिषां चक्रमेतद्धि सदा कर्षत्यवाङ्मुखः Vā100

ज्योतिषां चक्रमादाय आकर्षंस्तमधोमुखः M28

ज्योतिषां चक्रमेतद्धि गदा कर्षन्नवाङ्मुखः B108

*jyotiṣāṃ cakrametaddhi sadā karṣatyavāṅmukhaḥ Vā100*
*jyotiṣāṃ cakramādāya ākarṣaṃstamadhomukhaḥ M28*
*jyotiṣāṃ cakrametaddhi gadā karṣannavāṅmukhaḥ B108*

He draws this wheel of the [celestial] lights looking down from above forever.

मेरुमालोकयत्येष पर्यन्ते हि प्रदक्षिणम् B108 (Vā100 प्रज्यातीह)

मेरुमालोकयन्नेव प्रतियाति प्रदक्षिणम् M28

*merumālokayatyeṣa paryante hi pradakṣiṇam B108 (Vā100 prajyātīha)*
*merumālokayanneva pratiyāti pradakṣiṇam M28*

Looking up at [mount] Meru (i.e. at the celestial pole), he makes a right-handed circumambulation.

It is the circumambulation in the last verse that Jha believes to refer to the precessional motion of the star, which is due to the axial precession of the earth. However, this assumption is completely unnecessary. As has been said, Dhruva perceptibly circled about the celestial north pole in the course of a day, except for a couple of centuries before and after 2800 BCE. And again to be kept in mind: When the text makes such great efforts to describe the daily rotation of the sky, then it certainly would not treat a motion of completely different nature such as precession in only a half-verse and without any further explanation.

In another passage referred to by Jha, the motion of the sky is compared to the rotation of a potter's wheel. Dhruva is said to stand in its centre, and the Sun circles around him in the periphery of the wheel once a day. In detail, the text is problematic because of its bad preservation. It seems to say that at the summer solstice the Sun has maximum speed because he is farthest away from the centre of the potter's wheel and from the axis of rotation. At the winter solstice, in contrast, the Sun is said to be closest to the axis of rotation and therefore slowest. Based on this theory, the text apparently attempts to explain why the days are long and the nights short around the summer solstice, and why it is reversed near the winter solstice. In detail, however, the explanations do not seem very logical. Besides, the text seems to confound the durations of day and night at the solstices. However all that may be, there is not even the slightest allusion to the precession of the earth's axis. The text reads as follows:[63]

प्रत्यहं चरते तानि सूर्यो वै मण्डलक्रमम् Vā140 (V om.) (मण्डलक्रमात् B86)

अहस्तु चरते नाभेः सूर्यो वै मण्डलं क्रमात् M69

*pratyahaṃ carate tāni sūryo vai maṇḍalakramam Vā140 (V om.) (maṇḍalakramāt B86)*
*ahastu carate nābheḥ sūryo vai maṇḍalaṃ kramāt M69*

| The Sun daily runs these [distances (*yojanāni*?)], in the course of a circle. |
|---|

कुलालचक्रपर्यन्तो यथ शीघ्रं निवर्तते Vā141 B87 (प्रवर्तते V32)

कुलालचक्रपर्यन्तो यथा चन्द्रो रविस्तथा M69

*kulālacakraparyanto yatha śīghraṃ nivartate Vā141 B87 (pravartate V32)*
*kulālacakraparyanto yathā candro ravistathā M69*

| Just as the rim of a potter's wheel turns around fast,<br>(var. Like the Moon, so the Sun is at the rim of the potter's wheel. (M)) |
|---|

→

[63] V = 2.8, Vā = Vāyupurāṇa 50, B = Brahmāṇḍapurāṇa 1.21, M = Matsyapurāṇa 124.

दक्षिणे प्रक्रमे सूर्यस्तथा शीघ्रं निवर्तते Vā141

(दक्षिणप्रक्रमे B88; प्रवर्तते B88 V32)

दक्षिणे चक्रवत्सूर्यस्तथा शीघ्रं निवर्तते M70

*dakṣiṇe prakrame sūryastathā śīghraṃ nivartate Vā141*
*(dakṣiṇaprakrame B88; pravartate B88 V32)*
*dakṣiṇe cakravatsūryastathā śīghraṃ nivartate M70*

| so the Sun turns around fast when he is at the summer solstice. |
|---|

(अतिवेगितया कालं वायुवेगगतिश्चरन् V33)

(*ativegitayā kālaṃ vāyuvegagatiścaran V33*)

| (for, moving at the speed of wind, he runs the time at excessive speed.) |
|---|

तस्मात्प्रकृष्टां भूमिं च कालेनाल्पेन गच्छति Vā142 M70 B88 V33

*tasmātprakṛṣṭāṃ bhūmiṃ ca kālenālpena gacchati Vā142 M70 B88 V33*

| Therefore he runs an extended [part of the] earth within a short time. |
|---|

सूर्यो द्वादशभिः शीघ्रं मुहूर्तैर्दक्षिणोत्तरे Vā142

(शैघ्र्यान् V34; दक्षिणायने M71 B89 V34)

*sūryo dvādaśabhiḥ śīghraṃ muhūrtairdakṣiṇottare Vā142*
*(śaighryān V34; dakṣiṇāyane M71 B89 V34)*

| On the summer solstice, the Sun [runs] very fast in 12 *muhūrtas*, (M, B) |
|---|

त्रयोदशार्धमृक्षाणामह्नाऽनुचरते रविः Vā143 (तु चरते B89) (तु चरते द्विज V34)

त्रयोदशार्धमृक्षाणां मध्ये चरति मण्डलम् M71

*trayodaśārdhamṛkṣāṇāmahnā ’nucarate raviḥ Vā143 (tu carate B89)*
*(tu carate dvija V34)*
*trayodaśārdhamṛkṣāṇāṃ madhye carati maṇḍalam M71*

| the Sun runs [a distance of] 13½ *nakṣatras* (= 180°) within a day, |
|---|

मुहूर्तैस्तावदृक्षाणि नक्तमष्टादशैश्चरन् Vā143 B90 V34

मुहूर्तैस्तानि ऋक्षाणि नक्तमष्टादशैश्चरन् M72

*muhūrtaistāvadṛkṣāṇi naktamaṣṭādaśaiścaran Vā143 B90 V34*
*muhūrtaistāni ṛkṣāṇi naktamaṣṭādaśaiścaran M72*

| and just as many *nakṣatras* he runs in 18 *muhūrtas* within a night.[64] |
|---|

[64] The intended idea is probably that on the summer solstice, the Sun makes a diurnal semi-arc (from horizon to horizon) in 18 *muhūrtas*, and a nocturnal semi-arc of 12 *muhūrtas*. However, the numbers 12 and 18 are confounded in all text versions. Or perhaps, the text does not refer to the beginning of the summer-solstitial half-year, but to its end. However, the wording of the text is not easily

कुलालचक्रमध्यस्तु यथ मन्दं प्रसर्पति Vā144 (-मध्ये तु B90; -मध्यस्थो M72 V35)

*kulālacakramadhyastu yatha mandaṃ prasarpati Vā144*
*(-madhye tu B90; -madhyastho M72 V35)*

| Just as [the lump of clay] in the centre of the potter’s wheel runs slowly, |
|---|

तथोदग्ग(?)मने सूर्यः सर्पते मन्दविक्रमः Vā144 (उदगयने B91 V35)

उदग्याने तथा सूर्यः सर्पते मन्दविक्रमः M73

*tathodag(g?)amane sūryaḥ sarpate mandavikramaḥ Vā144*
*(udagayane B91 V35)*
*udagyāne tathā sūryaḥ sarpate mandavikramaḥ M73*

| so the Sun runs in slow motion on the winters solstice. |
|---|

(त्रयोदशार्धमर्धेन ऋक्षाणां चरते रविः Vā145 (B M V om.))

(*trayodaśārdhamardhena ṛkṣāṇāṃ carate raviḥ Vā145 (B M V om.)*)

| (The sun runs 13 ½ *nakṣatras* in one half [of the sky].) |
|---|

तस्माद्दीर्घेण कालेन भूमिमल्पां निगच्छति Vā145

(तु गछति V36; स्वल्पानि गच्छति B91; सोऽल्पां प्रसर्पति M73)

*tasmāddīrgheṇa kālena bhūmimalpāṃ nigacchati Vā145*
*(tu gachati V36; svalpāni gacchati B91; so ’lpāṃ prasarpati M73)*

| Therefore he runs a short [part of the] earth in a long time. |
|---|

सूर्योऽष्टादशभिरह्नो मुहूर्तैरुदगायने M74 (VāP B V om.)

*sūryo 'ṣṭādaśabhirahno muhūrtairudagāyane M74 (VāP B V om.)*

| On the winter solstice, the Sun runs in 18 *muhūrtas* during the day. |
|---|

अष्टादशमुहूर्तैस्तु उत्तरायणपश्चिमम् Vā146 B92 (M om.)

अष्टादशमुहूर्तं यदुत्तरायणपश्चिमम् V36

*aṣṭādaśamuhūrtaistu uttarāyaṇapaścimam Vā146 B92 (M om.)*
*(aṣṭādaśamuhūrtaṃ yaduttarāyaṇapaścimam V36)*

| But in 18 *muhūrtas* at the winter solstice[65] |
|---|

→

reconcilable with this understanding. The same problem arises in the subsequent description of the winter solstice.

[65] *uttarāyaṇapaścimam*. It would seem to make more sense to translate this as: “at the end of the northward course (of the Sun)”, i.e. at the summer solstice. However, the context makes it clear that the verse intends the winter solstice. Thus strictly speaking, *uttarāyaṇapaścimam* seems to mean: „at the extreme point (*paścimam*) where the northward path begins“.

अहर्भवति तच्चापि चरते मन्दविक्रमः Vā146 B92 (M om.) (तत्रापि V37)
*aharbhavati taccāpi carate mandavikramaḥ Vā146 B92 (M om.)*
*(tatrāpi V37)*

| |
|---|
| is the day. And [the Sun] runs this [course] in slow motion. |

त्रयोदशार्धमर्धेन ऋक्षाणां चरते रविः V147 (मा(न्)द्येन B93)

त्रयोदशानां मध्ये तु ऋक्षाणां चरते रविः M74 त्रयोदशार्धमह्नैव ऋक्षाणां चरते रविः V38
*trayodaśārdhamardhena ṛkṣāṇāṃ carate raviḥ Vā147 (mā(n)dyena B93)*
*trayodaśānāṃ madhye tu ṛkṣāṇāṃ carate raviḥ M74*
*trayodaśārdhamahnaiva ṛkṣāṇāṃ carate raviḥ V38*

| |
|---|
| In 13 ½ *nakṣatras* the Sun runs during the day. |

मुहूर्तैस्तावदृक्षाणि नक्तमष्टादशैश्चरन् Vā147

(रात्रौ M74 V38; द्वादशभिश्चरन् M74 B93)
*muhūrtaistāvadṛkṣāṇi naktamaṣṭādaśaiścaran Vā147*
*(rātrau M74 V38; dvādaśabhiścaran M74 B93)*

| |
|---|
| But the same number of *nakṣatras* in 12 *muhūrtas* during the night. (M, B; in 18 *muhūrtas* Vā) |

ततो मन्दतरं ताभ्यां चक्रं भ्रमति वै यथा Vā148

(अधो मन्- V39; नाभ्याम् B94 V39; चक्रं तु भ्रमते पुनः M75)
*tato mandataraṃ tābhyāṃ cakraṃ bhramati vai yathā Vā148*
*(adho man- V39; nābhyām B94 V39; cakraṃ tu bhramate punaḥ M75)*

| |
|---|
| In an even slower circle than these two (: i. e. the circles of the winter and summer solstitial Sun, i. e. the tropics), (M) |

मृत्पिण्ड इव मध्यस्थो ध्रुवो भ्रमति वै तथा Vā148 B94 V39

मृत्पिण्ड इव मध्यस्थो भ्रमतेऽसौ ध्रुवस्तथा M75 (V om.)
*mṛtpiṇḍa iva madhyastho dhruvo bhramati vai tathā Vā148 B94 V39*
*mṛtpiṇḍa iva madhyastho bhramate 'sau dhruvastathā M75 (V om.)*

| |
|---|
| just as a lump of clay standing in the middle [of a potter's wheel], so revolves yonder Dhruva. |

त्रिंशन्मुहूर्तानेवाहुरहोरात्रं भुवो भ्रमन् Vā149 (ध्रुवो B95)

मुहूर्तैस्त्रिंशता तावदहोरात्रं भुवो भ्रमन् M76 (V om.)
*triṃśanmuhūrtānevāhurahorātraṃ bhuvo bhraman Vā149 (dhruvo B95)*
*muhūrtaistriṃśatā tāvadahorātraṃ bhuvo bhraman M76 (V om.)*

| |
|---|
| In 30 *muhūrtas*, they say, he revolves in a day and a night in the sky. |

उभयोः काष्ठयोर्मध्ये भ्रमते मण्डलानि सः Vā149 (cf. V41) (मण्डलानि तु M76 B95)

*ubhayoḥ kāṣṭhayormadhye bhramate maṇḍalāni saḥ Vā149 (cf. V41) (maṇḍalāni tu M76 B95)*

| |
|---|
| In the middle of the two orbits (i. e. of the winter and summer solstitial Sun) he revolves his circles. |

कुलालचक्रनाभिस्तु यथा तत्रैव वर्तते Vā150 B96 V40 (M om.)

*kulālacakranābhistu yathā tatraiva vartate Vā150 B96 V40 (M om.)*

| |
|---|
| Like the nave of the potter's wheel, so he turns around there, |

ध्रुवस्तथा हि विज्ञेयस्तत्रैव परिवर्तते Vā150 B96 (M om.) (हि मैत्रेय V40)

*dhruvastathā hi vijñeyastatraiva parivartate Vā150 B96 (M om.) (hi maitreya V40)*

| |
|---|
| that is how one must understand that Dhruva turns around there. |

उभयोः काष्ठयोर्मध्ये भ्रमते मण्डलानि तु Vā151 (भ्रमतो V41; सः B97; M om.)

*ubhayoḥ kāṣṭhayormadhye bhramate maṇḍalāni tu Vā151 (bhramato V41; saḥ B97; M om.)*

| |
|---|
| In the middle of the two orbits (i. e. of the winter and summer solstitial Sun) he revolves his circles. |

दिवा नक्तं च सूर्यस्य मन्दा शीघ्रा च वै गतिः Vā151 B97 V41 (M om.)

*divā naktaṃ ca sūryasya mandā śīgrā ca vai gatiḥ Vā151 B97 V41 (M om.)*

| |
|---|
| During the day and the night, the motion of the Sun is slow and fast. |

उत्तरे प्रक्रमे त्विन्दोर्दिवा मन्दा गतिः स्मृता Vā152 (V om.)

उत्तरक्रमणेऽर्कस्य दिवा मन्दगतिः स्मृता M77

उत्तरप्रक्रमे चापि दिवा मन्दा गतिस्तथा B98

*uttare prakrame tvindordivā mandā gatiḥ smṛtā Vā152 (V om.)*
*uttarakramaṇe 'rkasya divā mandagatiḥ smṛtā M77*
*uttaraprakrame cāpi divā mandā gatistathā B98*

| |
|---|
| On the winter solstice during the day, they say, the motion of the Sun is slow. |

तथैव च पुनर्नक्तं शीघ्रा सूर्यस्य वै गतिः Vā152 B98 (तस्यैव तु M77; V om.)

*tathaiva ca punarnaktaṃ śīghrā sūryasya vai gatiḥ Vā152 B98 (tasyaiva tu M77; V om.)*

| |
|---|
| During the night, however, the motion of the Sun is fast. |

→

दक्षिणे प्रक्रमे चैव दिवा शीघ्रं विधीयते Vā153 (V om.)

(दक्षिणप्रक्रमे वापि M78; दक्षिणप्रक्रमेणैव B99)

*dakṣiṇe prakrame caiva divā śīghraṃ vidhīyate Vā153 (V om.)*
*(dakṣiṇaprakrame vāpi M78; dakṣiṇaprakrameṇaiva B99)*

| |
|---|
| And on the summer solstice, his motion is fast during the day, |

गतिः सूर्यस्य नक्तं वै मन्दा चापि तथा स्मृता Vā153 (V om.)

(मन्दा चापि विधीयते M78; च मन्दा चैव गतिस्तथा B99)

*gatiḥ sūryasya naktaṃ vai mandā cāpi tathā smṛtā Vā153 (V om.)*
*(mandā cāpi vidhīyate M78; ca mandā caiva gatistathā B99)*

| |
|---|
| during the night, however, the motion of the Sun is slow, they say. |

एवं गतिविशेषेण विभजन्रात्र्यहानि तु M79 Vā 154 B100 (V om.)

*evaṃ gativiśeṣeṇa vibhajanrātryahāni tu M79 Vā 154 B100 (V om.)*

| |
|---|
| Like this dividing night and day by means of different motion, |

तजापि संचरन्मार्गं समेन विषमेण च B100 (M V om.) (तथा विचरते मार्गं Vā154)

*tajāpi saṃcaranmārgaṃ samena viṣameṇa ca B100 (M V om.)*
*(tathā vicarate mārgaṃ Vā154)*

| |
|---|
| he thus moves his way, in equality and difference. |

(*Instead of the last few verses, V has the following ones:*)

मन्दाह्नि यस्मिन्नयने शीघ्रा नक्तं तदा गतिः

शीघ्रा निशि यदा चास्य तदा मन्दा दिवा गतिः V42

*mandāhni yasminnayane śīghrā naktaṃ tadā gatiḥ*
*śīghrā niśi yadā cāsya tadā mandā divā gatiḥ V42*

| |
|---|
| On the solstice on which the motion is slow during the day, it is fast during the night.<br>And when his motion is fast during the night, then it is slow during the day. |

एकप्रमाणमेवैष मार्गं याति दिवाकरः

अहोरात्रेण यो भुङ्क्ते समस्ता राशयो द्विज V43 (सम्-अस्ता? समास् ता?)

*ekapramāṇamevaiṣa mārgaṃ yāti divākaraḥ*
*ahorātreṇa yo bhuṅkte samastā rāśayo dvija V43 (sam-astā? samās tā?)*

| |
|---|
| The Sun runs a course with one measure only,<br>if the zodiac signs it moves by day and night (= 180° each) are added together. |

षडेव राशयो भुङ्क्ते रात्रावन्यांश्च षड्दिवा V44

*ṣaḍeva rāśayo bhuṅkte rātrāvanyāṃśca ṣaḍdivā V44*

| |
|---|
| Six zodiac signs (= 180°) he moves by night, and other six by day. |

राशिप्रमाणजनिता दीर्घह्रस्वात्मता दिने

तथा निशायां राशीनां प्रमाणैर्लघुदीर्घता V45

*rāśipramāṇajanitā dīrghahrasvātmatā dine*
*tathā niśāyāṃ rāśīnāṃ pramāṇairlaghudīrghatā V45*

| The length and shortness results from the measure of the zodiac signs by day. And so also by night, shortness and length [result] from the measure of the zodiac signs. |
|---|

दिनादेर्दीर्घह्रस्वत्वं तद्भोगेनैव जायते V46

*dināderdīrghahrasvatvaṃ tadbhogenaiva jāyate V46*

| The length or shortness from the beginning of the day results from [the time] in which he moves through [six zodiac signs]. |
|---|

उत्तरे प्रक्रमे शीघ्रा निशि मन्दा गतिर्दिवा V46

दक्षिणे त्वयने चैव विपरीता विवस्वतः V47

*uttare prakrame śīghrā niśi mandā gatirdivā V46*
*dakṣiṇe tvayane caiva viparītā vivasvataḥ V47*

| On the winter solstice, the motion of the Sun is fast by night and slow by day. On the summer solstice, however, it is reverse. |
|---|

From this passage, Jha uses the following verse to support his argument:

त्रिंशन्मुहूर्तानेवाहुरहोरात्रं भुवो भ्रमन्

उभयोः काष्ठयोर्मध्ये भ्रमते मण्डलानि सः (VāyuP 50.149)

*triṃśanmuhūrtānevāhurahorātraṃ bhuvo bhraman*
*ubhayoḥ kāṣṭhayormadhye bhramate maṇḍalāni saḥ (VāyuP 50.149)*

He translates it as follows:

> Dhruva moves round the Day-night (ahorātra) in 30 muhurtas ;
> it moves round the Mandalas situated between both directions.

and comments it as follows:

> ... Dhruva is said to possess two different motions : one is its diurnal rotation (as a result of Earth's rotation), and the other is revolution of Dhruva round the circles ("mandalas").

Jha does not explain what kind of “mandalas” could be alluded to here in his opinion. Also, their connection with precession remains a mystery. However that may be, the translation given below for the same verse, which manages without precession, provides perfect sense in context:

त्रिंशन्मुहूर्तानेवाहुरहोरात्रं भुवो भ्रमन् Vā149 (B95 ध्रुवो)

उभयोः काष्ठयोर्मध्ये भ्रमते मण्डलानि सः Vā149

*triṃśanmuhūrtānevāhurahorātraṃ bhuvo bhraman Vā149 (B95 dhruvo)*
*ubhayoḥ kāṣṭhayormadhye bhramate maṇḍalāni saḥ Vā149*

In 30 *muhūrtas*, they say, he revolves in a day and a night in the sky (var. Dhruva revolves in a day and a night). In the middle of the two orbits (i.e. of the winter and summer solstitial Sun), he revolves his circles.

Dhruva is in the centre of the potter's wheel, and the Sun orbits it in narrower and wider orbits between the two tropics. The word *kāṣṭhā*, which Jha translates as "direction", is unfortunately ambiguous: Depending on the context, it may mean "region", "course, orbit" or "culmination". In the present context, the meaning "tropic circle" makes excellent sense, astronomically speaking.

Another passage not mentioned by Jha also deserves attention. It describes the chariot of the Sun, which is, again, bound to Dhruva by means of wind-like reins. During the northward course of the Sun, Dhruva pulls the reins tight, so that the Sun's daily circles become narrower, and during the southward course, he loosens the reins and the Sun's circles become wider. The solar chariot has one single shining wheel, which obviously stands for the solar disk.

At the same time, the components of the chariot are associated with different time units. The wheel rim itself is the year and the 5 or 6 spokes correspond to the 5 or 6 seasons of the Vedic year. Here the wheel is clearly identified with the annual cycle, i. e. with the Sun's yearly motion or the ecliptic. Moreover, the half-years or solstices (*ayane*) are compared to the two drawbars (*kūbarau*) of the solar chariot. Furthermore, the day is designated the hub of the wheel, which, however, would mean that the wheel is the celestial equator. In detail, the text is difficult to interpret and apparently not free of contradictions. However, there is nothing in it that would be indicative of precession. In fact, there is only talk of the year and smaller units of time, like seasons, days and nights, *muhūrtas* etc.

Again, this text is quoted in the different variants available to the author[66]:

[66] B = Brahmāṇḍapurāṇa 1.22; M = Matsyapurāṇa 125; V = Viṣṇupurāṇa 2.9; Vā = Vāyupurāṇa 51.

अतः सूर्यरथस्यापि संनिवेशं प्रचक्षते M37

(ततः सूर्यरथस्यथ B60) (निबोधत Vā54 B60)

*ataḥ sūryarathasyāpi saṃniveśaṃ pracakṣate M37*
*(tataḥ sūryarathasyatha B60) (nibodhata Vā54 B60)*

After that learn the construction of the solar chariot. (Vā B; after that they explain the... (M)).

स्थितेन त्वेकचक्रेण पञ्चारेण त्रिणाभिना M38 (संस्थितेनैकचक्रेण Vā54 B61)

*sthitena tvekacakreṇa pañcāreṇa triṇābhinā M38*
*(saṃsthitenaikacakreṇa Vā54 B61)*

With a single standing wheel, which has five spokes and three naves,

हिरण्मयेनाणुना वै अष्टचक्रैकनेमिना M38

हिरण्मयेन भगवांस्तथैव हरिपर्वणा(?) B61

हिरण्मयेन भगवान्पर्वणा तु महौजसा Vā55

*hiraṇmayenāṇunā vai aṣṭacakraikaneminā M38*
*hiraṇmayena bhagavāṃstathaiva hariparvaṇā(?) B61*
*hiraṇmayena bhagavānparvaṇā tu mahaujasā Vā55*

which is made of gold and has a powerful time period, (Vā; has the time period of Hari (B))
(which is made of gold, is subtle, and has eight wheels and one felly, (M))

अष्टापदनिबद्धेन षट्प्रकारैकनेमिना B62 (नष्टवर्त्मान्धकारेण Vā56 M om.)

*aṣṭāpadanibaddhena ṣaṭprakāraikaneminā B62*
*(naṣṭavartmāndhakāreṇa Vā56 M om.)*

[with a wheel] whose course is without darkness (Vā; which is bound by eight parts (B)), which has six modes and one felly:

चक्रेण भास्वता सूर्यः स्यन्दनेन प्रसर्पिणा M38 (प्रसर्पति Vā55 B62)

*cakreṇa bhāsvatā sūryaḥ syandanena prasarpiṇā M38*
*(prasarpati Vā55 B62)*

the lord Sun moves ahead, having a shining wheel as his chariot.

शतयोजनसाहस्रो विस्तारायाम उच्यते M39

दशयोजनसाहस्रो विस्तारायामतः स्मृता Vā56 (स्मृतः B63)

*śatayojanasāhasro vistārāyāma ucyate M39*
*daśayojanasāhasro vistārāyāmataḥ smṛtā Vā56 (smṛtaḥ B63)*

10,000 (var. 100,000) yojanas, they say, it is extended in width;

→

द्विगुणा च रथोपस्थादीषादण्डः प्रमाणतः M39

द्विगुनोऽस्य रथोपस्थादीषादण्डप्रमाणतः Vā56 (-दण्डः प्रमाणतः B63)

*dviguṇā ca rathopasthādīṣādaṇḍaḥ pramāṇataḥ M39*
*dviguno'sya rathopasthādīṣādaṇḍapramāṇataḥ Vā56 (-aḥ pram- B63)*

| the double of it from the middle of the chariot to the shaft. |
|---|

स तस्य ब्रह्मणा सृष्टो रथो ह्यर्थवशेन तु M40 B64 Vā57

*sa tasya brahmaṇā sṛṣṭo ratho hyarthavaśena tu M40 B64 Vā57*

| This his chariot was created by Brahmā according to his purpose and will. |
|---|

असङ्गः काञ्चनो दिव्यो युक्तः पवनगैर्हयैः M40 B64 (परमगैर् Vā57)

*asaṅgaḥ kāñcano divyo yuktaḥ pavanagairhayaiḥ M40 B64*
*(paramagair Vā57)*

| It has no obstacles, is golden and divine, harnessed with horses that go as fast as the wind, |
|---|

छन्दोभिर्वाजिरूपैस्तैर्यथाचक्रं समास्थितैः M41

(तु यतश्चक्रं ततः स्थितैः B65; तु यतः शुक्रस्ततः स्थितः Vā58)

*chandobhirvājirūpaistairyathācakraṃ samāsthitaiḥ M41*
*(tu yataścakraṃ tataḥ sthitaiḥ B65; tu yataḥ śukrastataḥ sthitaḥ Vā58)*

| with Vedic metres that have the shape of horses and are stationed where the wheel is (var. according to the wheel (B); where Venus is (Vā)). |
|---|

वारुणस्य रथस्येह लक्षणैः सदृशश्च सः M41

वारुणस्यन्दनस्येह लक्षणैः सदृशस्तु सः B65 Vā58

*vāruṇasya rathasyeha lakṣaṇaiḥ sadṛśaśca saḥ M41*
*vāruṇasyandanasyeha lakṣaṇaiḥ sadṛśastu saḥ B65 Vā58*

| It is similar to the chariot of Varuṇa in its features. |
|---|

तेनासौ चरति व्योम्नि भास्वाननुदिनं दिवि M42

तेनासौ सर्पते व्योम्नि भास्वता तु दिवाकरः B66 Vā58

*tenāsau carati vyomni bhāsvānanudinaṃ divi M42*
*tenāsau sarpate vyomni bhāsvatā tu divākaraḥ B66 Vā58*

| Using it, the Sun moves in the celestial space every day. (M)<br>(Using this shining [chariot], the Sun moves in the sky. (B Vā) |
|---|

अथाङ्गानि तु सूर्यस्य प्रत्यङ्गानि रथस्य च M42 (अथेमानि Vā59 अथैतानि B66)

*athāṅgāni tu sūryasya pratyaṅgāni rathasya ca M42*
*(athemāni Vā59 athaitāni B66)*

| Now the parts and subparts (Vā59: Now these subparts) of the chariot of the Sun |
|---|

संवत्सरस्यावयवैः कल्पितानि यथाक्रमम् M42 (कल्पितस्य B67 कम्पितानि Vā59)
*saṃvatsarasyāvayavaiḥ kalpitāni yathākramam M42*
*(kalpitasya B67 kampitāni Vā59)*

| |
|---|
| are made of the elements of the year in due order. |

अहर्नाभिस्तु सूर्यस्य एकचक्रस्य वै स्मृतः M43

(अहस्तु नाभिः B67 Vā60; सौरस्य B67; एकचक्रः स वै स्मृतः Vā60)
*aharnābhistu sūryasya ekacakrasya vai smṛtaḥ M43*
*(ahastu nābhiḥ B67 Vā60; saurasya B67; ekacakraḥ sa vai smṛtaḥ Vā60)*

| |
|---|
| The day is the nave of the Sun, which has one wheel, they say. |

अराः संवत्सरास्तस्य नेम्यः षड्तवः स्मृताः M43

अराः पञ्चर्तवस्तस्य नेमिः षड्तवः स्मृताः Vā60

अराः पञ्चार्त्तवांस्तस्य नेमिः षड्तवः स्मृतः B68
*arāḥ saṃvatsarāstasya nemyaḥ ṣaḍṛtavaḥ smṛtāḥ M43*
*arāḥ pañcartavastasya nemiḥ ṣaḍṛtavaḥ smṛtāḥ Vā60*
*arāḥ pañcārttavāṃstasya nemiḥ ṣaḍṛtavaḥ smṛtaḥ B68*

| |
|---|
| The spokes are the five seasons, the felly the six seasons, they say. (Vā B)<br>(The spokes are its years, the fellies the six seasons, they say. (M)) |

रथनीडः स्मृतो ह्यब्दस्त्वयने कूबरावुभौ Vā61 (ह्येष चायने B68)
*rathanīḍaḥ smṛto hyabdastvayane kūbarāvubhau Vā61 (hyeṣa cāyane B68)*

| |
|---|
| The inner seat of the chariot is the year, they say, the two half-years (*ayane*) are the two drawbars. |

मुहूर्ता बन्धुरास्तस्य शम्या तस्य कलाः स्मृताः Vā61 (रम्न्याश्चास्य B69)
*muhūrtā bandhurāstasya śamyā tasya kalāḥ smṛtāḥ Vā61*
*(ramnyāścāsya B69)*

| |
|---|
| The *muhūrtas* are its ropes, and the *kalās* the pins of the yoke. |

तस्य काष्ठा स्मृता घोणा दन्तपङ्क्तिः क्षणास्तु वै M45

तस्य काष्ठाः स्मृता घोणा ईषादण्डः क्षणास्तु वै Vā62

तस्य काष्ठा स्मृता घोणा अक्षदण्डः क्षणस्तु वै B69
*tasya kāṣṭhā smṛtā ghoṇā dantapaṅktiḥ kṣaṇāstu vai M45*
*tasya kāṣṭhāḥ smṛtā ghoṇā īṣādaṇḍaḥ kṣaṇāstu vai Vā62*
*tasya kāṣṭhā smṛtā ghoṇā akṣadaṇḍaḥ kṣaṇastu vai B69*

| |
|---|
| The *kāṣṭhās* are its nose, the *kṣaṇas* the axle bar (B; the shaft Vā; the row of teeth M). |

→

निमेषश्चानुकर्षोऽस्य ईषा चास्य कला (लवाः Vā62 B70) स्मृता M45

*nimeṣaścānukarṣo 'sya īṣā cāsya kalā (lavāḥ Vā62 B70) smṛtā M45*

| The *nimeṣas* are its axletree, and the *kalās* (var. *lavas*) its poles. |
|---|

रात्रिर्वरूथो धर्मश्च ध्वज ऊर्ध्वं व्यवस्थितः M44

रात्रिर्वरूथो घर्मोऽस्य ध्वज ऊर्ध्वसमुच्छ्रितः Vā63 (धर्मोऽस्य B70)

*rātrirvarūtho dharmaśca dhvaja ūrdhvaṃ vyavasthitaḥ M44*
*rātrirvarūtho gharmo'sya dhvaja ūrdhvasamucchritaḥ Vā63*
*(dharmo'sya B70)*

| The night is its frontal fender, and *dharma* its banner standing upright.<br>(The night is its frontal fender, the day its banner set upright. (Vā)) |
|---|

युगाक्षकोटी ते तस्य अर्थकामावुभौ स्मृतौ M46 Vā63 B71

अक्षकोट्योर्युगान्यस्य आर्तवाहाः कलाः स्मृताः M44 = अर्थावाहाः ?

*yugākṣakoṭī te tasya arthakāmāvubhau smṛtau M46 Vā63 B71*
*akṣakoṭyoryugānyasya ārtavāhāḥ kalāḥ smṛtāḥ M44 = arthāvāhāḥ ?*

| These are the two ends of its yoke and its axle and are considered to be *artha* and *kāma*.<br>(Of the two ends of its axle, the yokes are the *kalās* that are connected with the seasonal days. (M44)) |
|---|

सप्ताश्वरूपाश्छन्दांसि वहन्ते वायुरंहसा M46 (वामतो धुरम् Vā64 B71)

*saptāśvarūpāśchandāṃsi vahante vāyuraṃhasā M46*
*(vāmato dhuram Vā64 B71)*

| The seven horse-like shapes are the Vedic metres. They run with the speed of the wind: (They draw the yoke from the left side: Vā B) |
|---|

गायत्री चैव त्रिष्टुप्च जगत्यनुष्टुप्तथैव च (!) M47 (अनुष्टुभ्जगती तथा Vā64 B72)

*gāyatrī caiva triṣṭupca jagatyanuṣṭuptathaiva ca (!) M47*
*(anuṣṭubhjagatī tathā Vā64 B72)*

| Gāyatrī, Triṣṭubh, Jagatī, and Anuṣṭubh, |
|---|

पङ्क्तिश्च बृहती चैव ह्युष्णिक्चैव तु सप्तमी B72 Vā65 (सप्तमम् M47)

*paṅktiśca bṛhatī caiva hyuṣṇikcaiva tu saptamī B72 Vā65 (saptamam M47)*

| Paṅkti, Bṛhatī, and Uṣṇik as the seventh. |
|---|

चक्रमक्षे निबद्धं तु ध्रुवे चाक्षः समर्पितः M48 B73 (अक्षे चक्रं Vā65)

*cakramakṣe nibaddhaṃ tu dhruve cākṣaḥ samarpitaḥ M48 B73*
*(akṣe cakraṃ Vā65)*

| The wheel is bound to the axle, and the axle is fixed at Dhruva. |
|---|

→

सहचक्रो भ्रमत्यक्षः सहाक्षो भ्रमति ध्रुवः M48 Vā66 B73

*sahacakro bhramatyakṣaḥ sahākṣo bhramati dhruvaḥ M48 Vā66 B73*

| |
|---|
| The axle revolves with the wheel, and Dhruva revolves with the axle. |

अक्षः सहैव चक्रेण भ्रमतेऽसौ ध्रुवेरितः M49 Vā66

अक्षेण सह चक्रेशो भ्रमतेऽसौ ध्रुवेरितः B74

*akṣaḥ sahaiva cakreṇa bhramate 'sau dhruveritaḥ M49 Vā66*
*akṣeṇa saha cakreśo bhramate 'sau dhruveritaḥ B74*

| |
|---|
| That axle revolves with the wheel, set in motion by Dhruva.<br>(var. That lord of the wheel revolves with the axle, set in motion by Dhruva. (B)) |

एवमर्थवशात्तस्य संनिवेशो रथस्य तु M49 Vā67 B74

*evamarthavaśāttasya saṃniveśo rathasya tu M49 Vā67 B74*

| |
|---|
| The chariot is constructed according to his will, which has this purpose. |

तथा संयोगभागेन सिद्धो वै भास्करो रथः M50 (संसिद्धो Vā67 B75) (भासुरो B75)

*tathā saṃyogabhāgena siddho vai bhāskaro rathaḥ M50*
*(saṃsiddho Vā67 B75) (bhāsuro B75)*

| |
|---|
| Like this, the shining chariot is completed as a whole and in its parts. |

तेनासौ तरणिर्देवस्तरसा सर्पते दिवि Vā68

(देवो नभसः M50; देवो भास्वता B75; दिवम् M75)

*tenāsau taraṇirdevastarasā sarpate divi Vā68*
*(devo nabhasaḥ M50; devo bhāsvatā B75; divam M75)*

| |
|---|
| Using it, that Sun god moves fast in the sky. |

युगाक्षकोतिसंबद्धौ रश्मी द्वौ स्यन्दनस्य हि Vā68 (सन्नद्धौ B76)

युगाक्षकोटी ते तस्य दक्षिणे स्यन्दनस्य तु M51

*yugākṣakotisaṃbaddhau raśmī dvau syandanasya hi Vā68*
*(sannaddhau B76)*
*yugākṣakoṭī te tasya dakṣiṇe syandanasya tu M51*

| |
|---|
| The two reins of the chariot are tied to the two endpoints of yoke and axle.<br>(var. These two southern endpoints of yoke and axle [belong to] this chariot. M) |

→

भ्रमतो भ्रमतो रश्मी तौ चक्रयुगयोस्तु वै M51

ध्रुवेण भ्रमतो रश्मी विचक्रयुगयोस्तु वै Vā69

ध्रुवे तौ भ्राम्यते रश्मी च चक्रयुगयोस्तु वै B76

*bhramato bhramato raśmī tau cakrayugayostu vai M51*
*dhruveṇa bhramato raśmī vicakrayugayostu vai Vā69*
*dhruve tau bhrāmyate raśmī ca cakrayugayostu vai B76*

The two reins of the two yokes of the wheel revolve because of Dhruva. (var. are caused to revolve in Dhruva. (B))

भ्रमतो मण्डलान्यस्य खेचरस्य रथस्य तु B77 (भ्रमतो मण्डलानि स्युः Vā69)

*bhramato maṇḍalānyasya khecarasya rathasya tu B77*
*(bhramato maṇḍalāni syuḥ Vā69)*

The two of them revolve along the circles of this chariot that runs in the sky.

(*Instead, M has the following half-verse plus some additional verses :*)

मण्डलानि भ्रमन्तेऽस्य खेचरस्य रथस्य तु M52

*maṇḍalāni bhramante 'sya khecarasya rathasya tu M52*

The circles of this chariot that runs in the sky revolve

कुलालचक्रभ्रमवन्मण्डलं सर्वतोदिशम् M52

*kulālacakrabhramavanmaṇḍalaṃ sarvatodiśam M52*

like the revolution of a potter's wheel, in a circle that goes all around.

युगाक्षकोटी ते तस्य वातोर्मी स्यन्दनस्य तु M53

*yugākṣakoṭī te tasya vātormī syandanasya tu M53*

These two endpoints of yoke and axle of the chariot are two wind waves.

संक्रमेते ध्रुवमहो मण्डले सर्वतोदिशम् M53

*saṃkramete dhruvamaho maṇḍale sarvatodiśam M53*

They come together to Dhruva in a circle that goes all around.

भ्रमतस्तस्य रश्मी ते मण्डले तूत्तरायणे M54

*bhramatastasya raśmī te maṇḍale tūttarāyaṇe M54*

These his two reins revolve in a circle on the northward course.

वर्धेते दक्षिणेष्वत्र भ्रमतो मण्डलानि तु M54 (cf. Vā73 B80)

*vardhete dakṣiṇeṣvatra bhramato maṇḍalāni tu M54 (cf. Vā73 B80)*

They grow longer on the southward [course], while he is revolving in his circles (or: and they revolve in circles).

→

युगाक्षकोटीसम्बद्धौ द्वौ रश्मी स्यन्दनस्य तु M55 (-कोति- Vā68) (-कोटिसन्नद्धौ B76)

(cf. युगाक्षकोटी ते तस्य दक्षिणे स्यन्दनस्य तु M51 Vā70)

*yugākṣakoṭīsambaddhau dvau raśmī syandanasya tu M55 (-koti- Vā68) (-koṭisannaddhau B76)*
*(cf. yugākṣakoṭī te tasya dakṣiṇe syandanasya tu M51 Vā70)*

| |
|---|
| The two reins of the chariot are tied to the two endpoints of yoke and axle. (var. These two southern endpoints of yoke and axle [belong to] this chariot.) |

ध्रुवेण प्रगृहीतौ तौ रथौ यौ वहतो रविम् M55 (cf. Vā73)

ध्रुवेण प्रगृहीतौ वै तौ रश्मी नयतो रविम् B81

ध्रुवेण संगृहीतौ तु रश्मी वै नयतो रविम् Vā73

ध्रुवेण संगृहीते वै द्विचक्रश्वेतरज्जुवत् Vā70

ध्रुवेण प्रगृहीते वै विचक्रम तुरक्षवत् B78

भ्रमतो भ्रमतो रश्मी तौ चक्रयुगयोस्तु वै M51

ध्रुवेण भ्रमतो रश्मी विचक्रयुगयोस्तु वै Vā69

ध्रुवे तौ भ्राम्यते रश्मी च चक्रयुगयोस्तु वै B76

*dhruveṇa pragṛhītau tau rathau yau vahato ravim M55 (cf. Vā73)*
*dhruveṇa pragṛhītau vai tau raśmī nayato ravim B81*
*dhruveṇa saṃgṛhītau tu raśmī vai nayato ravim Vā73*
*dhruveṇa saṃgṛhīte vai dvicakraśvetarajjuvat Vā70*
*dhruveṇa pragṛhīte vai vicakrama turakṣavat B78*
*bhramato bhramato raśmī tau cakrayugayostu vai M51*
*dhruveṇa bhramato raśmī vicakrayugayostu vai Vā69*
*dhruve tau bhrāmyate raśmī ca cakrayugayostu vai B76*

| |
|---|
| The two reins are held by Dhruva and lead the Sun.<br>(var. They are held by Dhruva like white ropes at a double wheel.)<br>(var. The two reins at the wheel and the yoke revolve because of Dhruva.) |

भ्रमन्तमनुगच्छेतां ध्रुवं रश्मी तु तावुभौ Vā71 (B78)

*bhramantamanugacchetāṃ dhruvaṃ raśmī tu tāvubhau Vā71 (B78)*

| |
|---|
| These two reins follow Dhruva, while he revolves. |

→

युगाक्षकोती ते तस्य वातोर्मी स्यन्दनस्य तु Vā71

युगाक्षकोटी ते तस्य दक्षिणे स्यन्दनस्य हि B77

युगाक्षकोटिस्तत्तस्य रश्मिभिः स्यन्दनस्य तु B79

*yugākṣakotī te tasya vātormī syandanasya tu Vā71*
*yugākṣakoṭī te tasya dakṣiṇe syandanasya hi B77*
*yugākṣakoṭistattasya raśmibhiḥ syandanasya tu B79*

The two endpoints of yoke and axle of the chariot are two wind waves. (var. The two southern endpoints of yoke and axle [belong to] this chariot.) (var. The two reins of the chariot are tied to the two ends of yoke and axle.)

कीलासक्तो यथा रज्जुर्भ्रमते सर्वतोदिक्षम् Vā72 B79

*kīlāsakto yathā rajjurbhramate sarvatodikṣam Vā72 B79*

Just as a rope that is attached to a pole revolves all around,

ह्रसतस्तस्य रश्मी तौ मण्डलेषूत्तरायणे Vā72 B80

*hrasatastasya raśmī tau maṇḍaleṣūttarāyaṇe Vā72 B80*

so the reins become short in their circles during the northward course.

वर्धेते दक्षिणेष्वत्र भ्रमतो मण्डलानि तु M54

वर्धेते (वर्धते B80) दक्षिणे चैव भ्रमतो मण्डलानि तु Vā73 B80

*vardhete dakṣiṇeṣvatra bhramato maṇḍalāni tu M54*
*vardhete (vardhate B80) dakṣiṇe caiva bhramato maṇḍalāni tu Vā73 B80*

They grow long during the southward [course], while he is revolving in his circles.

युगाषकोतिसम्बद्धौ रश्मी द्वौ स्यन्दनस्य हि B81

*yugāṣakotisambaddhau raśmī dvau syandanasya hi B81*

The two reins of the chariot are bound to the two endpoints of yoke and axle.

ध्रुवेण संगृहीतौ तु रश्मी वै नयतो रविम् Vā73

*dhruveṇa saṃgṛhītau tu raśmī vai nayato ravim Vā73*

The two reins, held by Dhruva, lead the Sun.

आकृष्येते यदा तौ वै ध्रुवेण समधिष्ठितौ Vā74 B82

आकृष्येते यदा ते तु ध्रुवेण समधिष्ठिते M56

*ākṛṣyete yadā tau vai dhruveṇa samadhiṣṭhitau Vā74 B82*
*ākṛṣyete yadā te tu dhruveṇa samadhiṣṭhite M56*

When the two [reins] are pulled tightly by Dhruva, who stands over them (or: presides them),

तदा सोऽभ्यन्तरे सूर्यो भ्रमते मण्डलानि तु M56 B82 (सोऽभ्यन्तरं Vā74)

*tadā so'bhyantare sūryo bhramate maṇḍalāni tu M56 B82 (so'bhyantaraṃ Vā74)*

| then the Sun revolves in circles further inside (i. e. further to the north), |
|---|

अशीतिमण्डलशतं काष्ठयोरुभयोश्चरन् M57 Vā75

अशीतिर्मण्डलशतं काष्ठयोरन्तरं स्मृतम् B83

*aśītimaṇḍalaśataṃ kāṣṭhayorubhayoścaran M57 Vā75*
*aśītirmaṇḍalaśataṃ kāṣṭhayorantaraṃ smṛtam B83*

| running 180 circles between the two tropics. |
|---|

ध्रुवेण मुच्यमानेन पुना रश्मियुगेन च M57

ध्रुवेण मुच्यमानाभ्यां रश्मिभ्यां पुनरेव तु Vā75 B83

*dhruveṇa mucyamānena punā raśmiyugena ca M57*
*dhruveṇa mucyamānābhyāṃ raśmibhyāṃ punareva tu Vā75 B83*

| And when Dhruva loosens the reins again, |
|---|

तथैव बाह्यतः सूर्यो भ्रमते मण्डलानि तु M58 Vā76 B84

*tathaiva bāhyataḥ sūryo bhramate maṇḍalāni tu M58 Vā76 B84*

| then the Sun revolves in circles further outside (i.e. further to the south). |
|---|

उद्वेष्टयन्वै (स Vā76 B84) वेगेन मण्डलानि तु गच्छति M58

*udveṣṭayanvai (sa Vā76 B84) vegena maṇḍalāni tu gacchati M58*

| Coiling fast, he runs in circles. |
|---|

As has been stated, this text, which is very similar in content to the other ones quoted further above, clearly describes the daily motions of the Sun within a year. There is not the slightest clue to precession in it.

Finally, Jha refers to the mysterious doctrine of the *vīthīs* in Vāyupurāṇa 50, which in his view alludes to the trepidation theory. His argument is as follows:

> Verse-130 states that Sun's path during the Uttarāyana is called Nāgaveethee, and Sun's path during the Dakshināyana is called Ajaveethee. When Sun rises in three nakṣatras from moola to (poorva and uttara) āshādha, it is ajaveethee, and when the Sun rises in three nakshatras from Abhijit (i.e., Abhijit or Shravana or Dhanishthā), then it is Nāgaveethee.
>
> What does it mean? Uttarāyana and Dakshināyana are here defined not in terms of human Sunrise or Sunset, but divine Sunrise and Sunset. Divine Sunrise occurs when sāyana Sun has longitudes from -27 deg to +27 deg with respect to the mean reference point 270 deg for Mean Divine Sunrise

> or Uttrāyana-onset, i.e., from 243 deg (Moola) to 297 deg (Uttarāshādha) which is an evidence of both pendulum like motion of Dhruva as well as of trepidating ayanāmsha known as Dolāyana in contrast to circular motion of modern concept of ayanāmsha known as chakrāyana. Although exact degrees are not mentioned in these verses, no other explanation is possible excepting that based on trepidating Dolāyana, which puts nir-ayana Makara Samkrānti or Divine Sunrise always at 270 degrees and sāyana Makara Samkrānti from 243 deg to 297 deg...

Thus Jha believes that *ajavīthī* (the "path of the goats") and *nāgavīthī* (the "path of the snakes") represent the two sections of the ecliptic that lie on either side of the initial point of sidereal Capricorn and have the size of 27° each. According to the trepidation theory, which is a precursor of the theory of precession, the winter solstice oscillates within this range in a period of 7200 years. Since Jha defines *uttarāyaṇa* and *dakṣiṇāyana* sidereally, the two *vīthīs* always fall in opposite half-years or *ayanas*. And since the two *vīthīs* comprise 27° each, the solstitial point necessarily falls into some lunar mansion between Mūla and Dhaniṣṭhā. Jha therefore assigns the area of Mūla, Pūrvāṣāḍhā, and Uttarāṣāḍhā to *ajavīthī*, and the area of Abhijit, Śravaṇa and Dhaniṣṭhā to *nāgavīthī*. The text thus alludes to the trepidation theory, in Jha's opinion.

In reality, however, the text does not support this. The wording is as follows:

> नागवीथ्युत्तरा वीथी अजवीथी च दक्षिणा Vā 50.130
>
> *nāgavīthyuttarā vīthī ajavīthī ca dakṣiṇā Vā 50.130*

| |
|---|
| The *nāgavīthī* is northerly and the *ajavīthī* southerly. |

> मूलं चैव तथाषाढे ह्यजवीथ्युदयास्त्रयः Vā 50.130, B 1.21.76
>
> उभे आषाढमूलं तु अजवीथ्यादयस्त्रयः M 124.53
>
> *mūlaṃ caiva tathāṣāḍhe hyajavīthyudayāstrayaḥ Vā 50.130, B 1.21.76*
> *ubhe āṣāḍhamūlaṃ tu ajavīthyādayastrayaḥ M 124.53*

| |
|---|
| Mūla and the two Āṣāḍhās are the three risings of/in the *ajavīthī*. |

> अभिजित्पूर्वतः स्वातिर्नागवीथ्युदयास्त्रयः Vā 50.130 (स्वातिं M 124.54)
>
> *abhijitpūrvataḥ svātirnāgavīthyudayāstrayaḥ Vā 50.130*
> *(svātiṃ M 124.54)*

| |
|---|
| Abhijit ... before ... Svāti are the three risings of/in the *nāgavīthī*. |

Unfortunately, it is difficult to make sense out of the last line. The text is obviously corrupt. However, it is obvious that there is no mention of the triple Abhijit, Śravaṇa und Dhaniṣṭhā, and one would have to adjust the text considerably in order to make it accord with this idea. Jha's translation shows that he does "correct" the text somehow, but he does so silently without mentioning the problem:

> Northern veethee or path is Nāgaveethee and southern veethee is Ajaveethee. Sunrise (occurs) in any of three nakshatras from moola to both āshādhas which make up Ajaveethee. (And) sunrise (occurs) in any of three nakshatras likewise from Abhijit (to shravana and dhanishthā) which make up Nāgaveethee.

It must be noted that Jha suppresses the mention of Svāti, which obviously contradicts his interpretation.

The translation by T. V. Tagare is not acceptable either:

> When the sun rises during the rise of the three stars after Abhijit (i. e. Aśvinī, Bharaṇī and Kṛttikā) it is called Nāgavīthī.

The three *nakṣatras* mentioned by Tagare are located neither before nor after Abhijit. He obviously seeks help from the variant of Brahmāṇḍapurāṇa, where the line with Abhijit and Svāti is missing and the following line is given instead:

> अश्विनी कृत्तिका याम्यं नागवीथ्युदयास्त्रयः (B 1.21.77)
>
> *aśvinī kṛttikā yāmyaṃ nāgavīthyudayāstrayaḥ (B 1.21.77)*
>
> Aśvinī, Kṛttikā, and Bharaṇī are the three risings of *nāgavīthī*.

Matsyapurāṇa also has this line, but does not suppress the problematic line with Abhijit and Svāti. Matsyapurāṇa even goes as far as to divide the *whole* ecliptic into 9 *vīthīs* of three *nakṣatras* each. Here it becomes obvious that the doctrine of the *vīthīs* has nothing at all to do with trepidation.

Besides, it seems that the doctrine of the *vīthīs* originally had nothing to do with the risings of the Sun, as Jha and Tagare wrongly believe. The Sun is not even mentioned, and the talk of "sunrises" would not make much sense either, except perhaps, if the text were regarding heliacal risings of stars. In reality, the doctrine of the *vīthīs* seems rather to have to do with the *heliacal risings of Venus*. This can be concluded from Varāhamihira's Bṛhatsaṃhitā, where the *vīthīs* appear in chapter 9, the chapter on Venus. Bhaṭṭotpala in his commentary also gives quotations from older authors, where the *vīthīs* appear in connection with the orbit of Venus. Several different variants of the doctrine were already common in Varāhamihira's time, and he himself did not dare to give his own view, which one he considered to be correct. The nine *vīthīs* are divided into "northern", "southern", and "middle". If one chooses the system where the northern *vīthīs* start with Aśvinī and the southern *vīthīs* with Hasta, then it could be explained as follows: If Venus makes her heliacal rising in a "northern" *vīthī*, then her path as the morning star runs mainly north of the celestial equator and describes a large arc in the sky. On the other hand, if her heliacal rising takes place in the "southern" *vīthī*, then the path of the morning star runs mainly south of the equator and makes only a short arc.

## Of the Origin of the Lunar Mansions

The origin of the lunar mansions is obscure. Even the way of their use in ancient times is not fully understood. It is unknown when the division of the ecliptic into 27 equal-sized lunar mansions of 13°20' each was introduced. From the Brāhmaṇas it is clear that certain reference stars or star configurations were used to localise the lunar mansions. However, as has been said, some of these reference stars and constellations are far from the ecliptic, and it is not immediately obvious how they were used to indicate the lunar mansions or the positions of the planets, when both the Moon and the planets never drew near them.

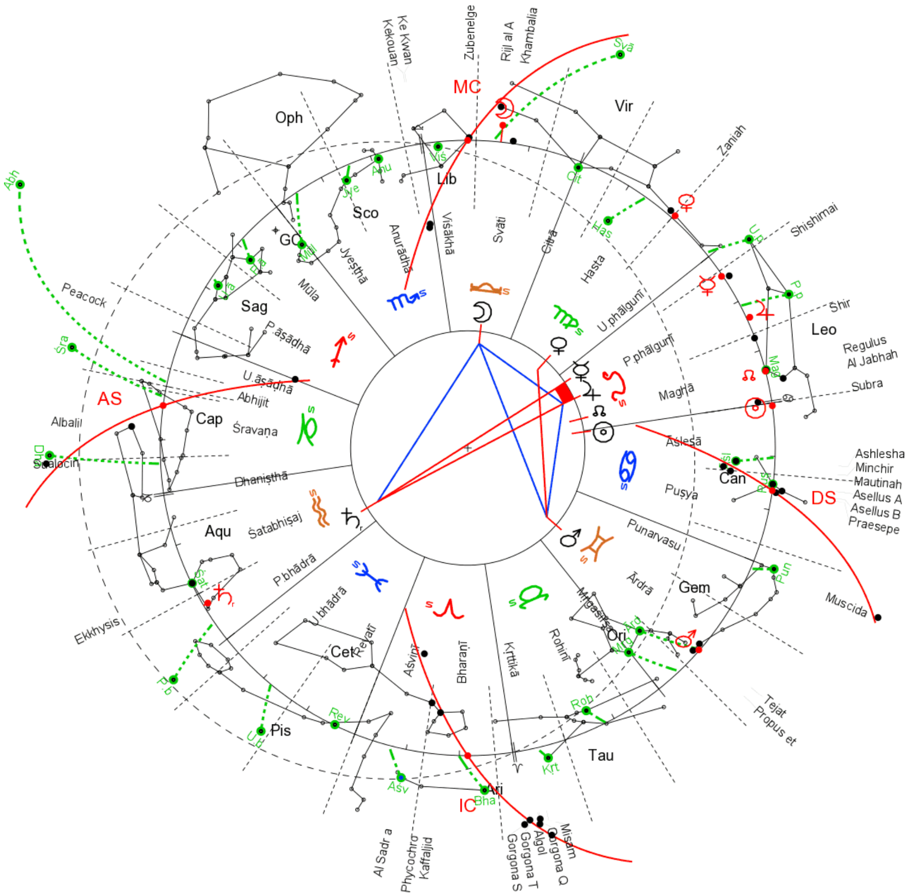
However, there seems to be some clue to their original use in the distribution of those reference stars. In ancient times, approximately between 2500 BCE and 1500 BCE, many of them were near the celestial equator. This applies in particular to the following stars, for which both the ecliptic latitude and the declination for the year 2000 BCE are provided:

| *Lunar mansion (star)* | *ecliptic latitude* | *declension* |
|---|---|---|
| 1 Aśvinī (β Arietis)[67] | 8°22' | –0°46' |
| 2 Bharaṇī (35 Arietis) | 10°58' | 6°39' |
| 4 Rohiṇī (α Tauri) | –5°44' | 0°29' |
| 5 Mṛgaśīrṣa (λ Orionis) | –13°54' | –1°53' |
| 6 Ārdrā (α Orionis) | –16°34' | –2°43' |
| 13 Hasta (δ Corvi) | –11°53' | 4°20' |
| 22 Śravaṇā (α Aquilae) | 29°29' | 7°22' |
| 23 Dhaniṣṭhā (β Delphini) | 32°24' | 8°43' |
| 25 Pūrvabhādrā (α Pegasi) | 19°35' | –1°44' |
| 26 Uttarabhādrā (γ Pegasi) | 12°34' | –4°58' |

Thus in 2000 BCE all these stars were a lot closer to the celestial equator than to the ecliptic. The remaining reference stars, however, with the exception of Svāti (Arcturus, α Bootis), are close to the ecliptic or a part of an ecliptic constellation. It becomes obvious that the circle of the lunar mansions was created from a mixed set of stars that were either in the range of the ecliptic or in the range the equator. Thus, the following conclusions can be drawn: The

[67] Reference stars according to Burgess, *The Sûryasiddhânta*, p. 243.

rough epoch in which the known reference stars were assigned to the lunar mansions was sometime after 2500 BCE and before 1500 BCE. However, it must be asked in what way were the equatorial stars used? Most likely, they served the purpose to determine the position of a celestial body in a lunar mansion *at its culmination*. One only had to observe, which reference stars culminated in the meridian near the time of culmination of the Moon or planet. *Even the reference stars themselves, when projected onto the ecliptic along the meridian (i.e. perpendicular to the equator), very nicely fall into their respective lunar mansions on the ecliptic, and in fact best within the period 2500 BCE to 1500 BCE. Since the nakṣatra system plays an important part in the Mahābhārata epic, this seems to be a valid* terminus post quem *for the astronomical observations mentioned in the Mahābhārata and thus for the great war itself. Dates before 2500 BCE are astronomically unlikely.*




This is a configuration near 2000 BCE, where the Moon stands in the lunar mansion Svāti and culminates at the same moment as the star Svāti. It becomes evident that the star Svāti is a marker of the *nakṣatra* Svāti, even though in ecliptic longitude it actually falls into the lunar mansion Citrā. If taken in ecliptic longitudes, the principal stars of the lunar mansions (*yogatārās*) often are far off from the ecliptic sections where they should be. However, if taken in polar projection along meridian circles, they very nicely fall into their ecliptic sections. This is particularly the case, if the ecliptic zero point is taken according to Lahiri, but only for the time period between about 2500 and 1500 BCE.

Besides, the graphic demonstrates that several reference stars that are far away from the ecliptic are rather close to the celestial equator (in 2000 BCE!), which is indicated by a hyphenated circle.

## Conclusions

Much evidence has been seen that since at least 3000 BCE, astronomy was practiced in India and without interruption survived until Hellenistic and post-Hellenistic times. For example, evidence for observations of the equinoxes and solstices throughout this whole period has been given, and thereby also evidence for the minimum age of the system of the lunar mansions. In earlier times there probably was no equal-spaced system yet, but only a system of fixed stars, which were used to observe the daily progress of the Moon in her journey around the sky. Furthermore, it has been shown that ancient Indian astronomers noticed in the 3rd millennium BCE, that the old pole star Thuban (α Draconis), which was very close to the north celestial pole around 2800 BC, "ran away" as a result of the precession of the earth's axis. Finally, the author has attempted to date astronomically the current system of reference stars (*yogatārā*) of the lunar mansions. The date found was roughly 2500 BCE to 1500 BCE. Since the *nakṣatra* system appears in the Mahābhārata epic, this seems to be a valid *terminus post quem* for the astronomical observations mentioned in the Mahābhārata and thus for the great war itself. Dates before 2500 BCE are astronomically unlikely.

While these findings are in stark contradiction with the fact that modern Indology dates the texts concerned to the 1st millennium BCE at the earliest, the evidence found is so numerous and consistent, and at the same time also astronomically unquestionable, that it cannot be just brushed aside. Presumably, the contradiction can be explained by the fact that Indian culture, whose extreme conservatism is notorious, has just preserved very old traditions for thousands of years and did not do away with them even long after they had become astronomically obsolete. Whether these ancient traditions ultimately come from Central Asia and were brought to India by the Aryans in the 2nd millennium BCE, or whether they were handed down from the Indus Civilization, has been left undecided. What is important is the fact that some ancient Indian astronomical observations since the 3rd millennium BCE have been preserved. This finding is important because it makes it very plausible that the astronomical information given in the Mahābhārata Epic does go back to real astronomical observations. It therefore does not seem unreasonable to assume that the Mahabharata War could be dated by means of astronomical calculations.

# *A Super-Conjunction*

According to the Epic, Kṛṣṇa played an important role in the Mahābhārata War and died 36 years later. The day of his death is considered to be the beginning of the Kali Age or *kaliyuga*. Tradition dates this event to be 17th/18th February 3102 BCE, suggesting that the war took place in 3139/3138 BCE. Unfortunately, this traditional dating of the war is in conflict not only with historical and archaeological facts, but also with various statements of astronomical nature made by the Mahābhārata itself.

Is it possible to date the war based on astronomical and calendrical allusions made in the epic? There have been countless attempts to do this, mostly by Indian authors, but their results have varied widely. It is even disagreed in which millennium the war took place. This in itself raises doubts about the possibility of dating the war astronomically.

However, it is obvious that a large number of papers on this subject are not very well-founded. Some of them are, from the outset, determined to find a date that is more or less consistent with the traditional dating of the *Kaliyuga* to 3102 BCE, ignoring the fact that this date itself is historically untenable. Other attempts are based on flawed astronomical considerations. However, although works of this kind dominate the subject of inquiry, it is not enough to reject the subject entirely. This work opines, the correct date for this war of wars was, in principle, given in 1931, by K.G. Sankar and was again reiterated in 1942, by K. L. Daftari. The only thing that remains to be done is to correct some of their findings and to present them in a more convincing way. The astronomical data provided by the Mahābhārata suggest that the great war took place not long before or after a conjunction of all planets which occurred in 1198 BCE.

## “The seven planets flew together...”

The Mahābhārata battle lasted for 18 days and is divided into the following phases, which should be kept in mind throughout this text:

अहानि युयुधे भीष्मो दशैव परमास्त्रवित्

अहानि पञ्च द्रोणस्तु ररक्ष कुरुवाहिनीम्

*ahāni yuyudhe bhīṣmo daśaiva paramāstravit*
*ahāni pañca droṇastu rarakṣa kuruvāhinīm (MBh 1.2.26)*

> Bhīṣma fought for ten days, the chief expert in weapons,
> Droṇa protected the army of the Kurus for 5 days.

अहनी युयुधे द्वे तु कर्णः परबलार्दनः

शल्योऽर्धदिवसं चैव गदायुद्धमतः परम्

*ahanī yuyudhe dve tu karṇaḥ parabalārdanaḥ*
*śalyo'rdhadivasaṃ caiva gadāyuddhamataḥ param (27)*

> Karṇa fought for 2 days, the tormentor of the force of the enemies,
> and Śalya for half a day. After that was the mace duel (in which Bhīma killed Duryodhana).

तस्यैव दिवसस्यान्ते हार्दिक्यद्रौणिगौतमाः

प्रसुप्तं निशि विश्वस्तं जघ्नुर्यौधिष्ठिरं बलम्

*tasyaiva divasasyānte hārdikyadrauṇigautamāḥ*
*prasuptaṃ niśi viśvastaṃ jaghnuryaudhiṣṭhiraṃ balam (28)*

> At the end of that day, Kṛtavarman, Aśvatthāman, and Gautama
> killed the forces of Yudhiṣṭhira, who were sleeping at night unsuspectingly.

It can be cited throughout the Mahābhārata that the great battle took place during a conjunction of all planets. For the sake of clarity, this work presents these in an order that makes their illustration most accessible, not exactly in the sequence they are occurred in the text.

In Bhīṣmaparva, the celestial configuration on the first day of the battle is described as follows:

एकादशैताः श्रीजुष्टा वाहिन्यस्तव भारत

पाण्डवानां तथा सप्त महापुरुषपालिताः

*ekādaśaitāḥ śrījuṣṭā vāhinyastava bhārata*
*pāṇḍavānāṃ tathā sapta mahāpuruṣapālitāḥ (MBh 6.16.44)*

These, O Bhārata, are your eleven glorious armies,
and the seven [armies] of the Pāṇḍavas are also under the command (or: protection) of great men.

उन्मत्तमकरावर्तौ महाग्राहसमाकुलौ

युगान्ते समुपेतौ द्वौ दृश्येते सागराविव

*unmattamakarāvartau mahāgrāhasamākulau*
*yugānte samupetau dvau dṛśyete sāgarāviva (MBh 6.16.45)*

The two armies resemble two oceans that flow together at the end of the age, that are churned up by wild sea monsters, and abound with huge crocodiles.

... (*two verses*) ...

मघाविषयगः सोमस्तद्दिनं प्रत्यपद्यत

दीप्यमानाश्च संपेतुर्दिवि सप्त महाग्रहाः

*maghāviṣayagaḥ somastaddinaṃ pratyapadyata*
***dīpyamānāśca saṃpeturdivi sapta mahāgrahāḥ** (MBh 6.17.2)*

On that day, the Moon entered the area of Maghā.
**The seven great planets burned in the sky and flew together.**

द्विधाभूत इवादित्य उदये प्रत्यदृश्यत

ज्वलन्त्या शिखया भूयो भानुमानुदितो दिवि

*dvidhābhūta ivāditya udaye pratyadṛśyata*
*jvalantyā śikhayā bhūyo bhānumānudito divi (3)*

The Sun was seen, split in two, as it were, as he rose.
With a burning crest (or: burning flame) rose the shining one again in the sky.

This text reveals several important things. First, it dates the war at the end of the Dvāpara age and the beginning of the Kali age. *Verse 2.17 mentions that all the seven planets meet in a conjunction. Perhaps the seven armies of the Pāṇḍavas have a symbolic connection with them. It would seem then that the seven planets fight on the side of the Pāṇḍavas.* The other information given is not of interest at this point, but will be considered later.

However, the conjunction raises some questions. To begin with, it may be asked whether a *mahāgrahaḥ* or "great *grahaḥ*" is the same as a *grahaḥ*, whether the translation "great planets" is justified at all and why the planets are designated as "great". The quotations on pp. 111ff. indicate that there is no difference between *grahas* and *mahāgrahas*. In one verse, the five *grahas* gather around the Moon, and in another one, the five *mahāgrahas* do the same. Furthermore, Rāhu (Svarbhānu) is called both a *grahaḥ* and a *mahāgrahaḥ*[68].In Harivaṃśa 31.37, Brahmā is surrounded by many divine beings, among which:

> नक्षत्रैश्च मुहूर्तैश्च खेचरैश्च महाग्रहैः
>
> *nakṣatraiśca muhūrtaiśca khecaraiśca mahāgrahaiḥ (HV 31.37)*
>
> by the *nakṣatras* and *muhūrtas* and *mahāgrahas* that run in the sky.

No other astronomical objects are mentioned in this context. Therefore, the *mahāgrahas* are obviously only referring to the planets, and certainly not to rare phenomena such as comets.[69] The attribute *mahā*-, i.e. "great" might be explained by the fact that the planets are considered beings *of great power*. Powerful demons are also sometimes called a *mahāgrahaḥ*. (MBh 3.219.28ff.)

Moreover, the question arises *which* of the seven planets can actually "fly together"? There are only five planets in the strict sense, Mercury, Venus, Mars, Jupiter, and Saturn. However, Rāhu is also considered to be a planet, as stated in MBh 2.11.20 (cf. HV 3.66.38):

---

[68] *svarbhānuḥ śrūyate grahaḥ* (MBh 6.13.40); *svarbhānuś ca mahāgrahaḥ* (HV 38.67).

[69] Attempts by B.N. Achar or M. Gupta, to explain these "seven great planets" as comets, contradict all common sense. Of course, there is a diminishing small probability that a chain of seven comets or a great comet broken in pieces could have appeared in the sky. However, by far the most obvious solution is that the verse refers to the planets. This was correctly pointed out by K.G. Sankar, K.L. Daftari, and P.V. Holay, as well as by the commentator Nīlakaṇṭha. Ancient astrologers also gave great importance to super-conjunctions and linked them with disastrous wars and natural catastrophes. This matter will be examined shortly.

शुक्रो बृहस्पतिश्चैव बुधोऽङ्गारक एव च

शनैश्चरश्च राहुश्च ग्रहाः सर्वे तथैव च

*śukro bṛhaspatiścaiva budho'ṅgāraka eva ca*
*śanaiścaraśca rāhuśca grahāḥ sarve tathaiva ca (MBh 2.11.20)*

> Venus and Jupiter, Mercury and Mars,
> Saturn and Rāhu are all the planets.

In modern Hindu astrology, Rāhu denotes the ascending lunar node. In the Mahābhārata, however, it is considered a planet which swallows the Sun and the Moon at times, thereby the cause of eclipses. Even eclipses that take place at the descending node are ascribed to Rāhu, not to Ketu. In the Mahābhārata, Ketu is considered to be a comet, not the descending lunar node. Ketu will be discussed at a later point.

Even the Sun and the Moon are "planets" in the wider sense of the word. In the *navagrahastotram*, an old "prayer to the nine planets", the Sun, the Moon, Rāhu, and Ketu (the comet) are venerated besides the five planets in the strictest sense. (p. 297 with footnote 175)

Returning to the Mahābhārata verse, the seven planets "fly together" while the Moon enters the lunar mansion Maghā. The "seven planets" could include the five planets plus the Sun and the Moon or the five planets plus Rāhu and Ketu (the comet). Or they could include the five planets together with Rāhu and the Moon or the Sun. Thus several different interpretations seem to be possible for this verse:

1. The conjunction could have taken place in the lunar mansion Maghā and included the five planets plus Rāhu and the Moon, but not the Sun. The planetary cluster could then have taken place in the evening in the western sky or in the morning in the eastern sky. However, Rāhu is only visible during eclipses, and a lunar eclipse is out of question here. Lunar eclipses can only take place during a full moon, when the Moon is in opposition to the Sun, but here the Moon is in conjunction with Mercury and Venus, which both always remain in close proximity to the Sun. Is it to be assumed that instead of Rāhu, the comet Ketu was part of the conjunction? Or, is the expression "the seven planets", to be taken literally and simply means "all planets"?

2. The conjunction could have taken place in Maghā and included the Moon and the Sun beside the five planets. If this was the case, then the conjunction would not have been visible. Ancient astronomers could have inferred such a conjunction then, only from the fact that the Moon and planets could not be seen throughout the night from evening until morning.
3. The conjunction did not take place in Maghā, but at a time when the Moon was in Maghā, and in addition to the five planets it included Rāhu and the comet Ketu. However, this solution is rather unlikely. In the next chapter it will be shown that the Mahābhārata often mentions that the planets clustered *either around the Moon or around the Sun*.
4. The conjunction did not take place in Maghā, but at a time when the Moon was in Maghā, and the cluster of the planets included the Sun and Rāhu. Again, the conjunction would not have been visible, but would have been inferred from the absence of all planets during the night.

More information is required from the epic, in order to make such a decision. In Karṇaparva, on the 16th day of the battle, the following description is given for occurrences in the sky and on earth:

प्रयाते तु ततः कर्णे योधेषु मुदितेषु च

चचाल पृथिवी राजन्रारास च सुविस्वरम्

*prayāte tu tataḥ karṇe yodheṣu muditeṣu ca*
*cacāla pṛthivī rājanrarāsa ca suvisvaram (MBh 8.26(37).33)*

| |
|---|
| Then, when Karṇa set out and the warriors rejoiced,<br>the earth quaked, O king, and she yelled very loudly. |

निश्चरन्तो व्यदृश्यन्त सूर्यात्सप्त महाग्रहाः

उल्कापातश्च संजज्ञे दिशां दाहस्तथैव च

तथाशन्यश्च संपेतुर्ववुर्वाताश्च दारुणाः

***niścaranto vyadṛśyanta sūryātsapta mahāgrahāḥ***
*ulkāpātaśca saṃjajñe diśāṃ dāhastathaiva ca*
*tathāśanyaśca saṃpeturvavurvātāśca dāruṇāḥ (34)*

| |
|---|
| **The seven planets were seen going forth from the Sun.**<br>A meteor shower occurred, and a burning of the [four] directions.<br>Lightning struck, and wild winds blew. |

मृगपक्षिगणाश्चैव बहुशः पृतनां तव

अपसव्यं तदा चक्रुर्वेदयन्तो महद्भयम्

*mṛgapakṣigaṇāścaiva bahuśaḥ pṛtanāṃ tava*
*apasavyaṃ tadā cakrurvedayanto mahadbhayam (35)*

Herds of wild animals and flocks of birds circumambulated your army to the right[70], indicating great danger (or: fear).

प्रस्थितस्य च कर्णस्य निपेतुस्तुरगा भुवि

अस्थिवर्षं च पतितमन्तरिक्षाद्भयानकम् (36)

*prasthitasya ca karṇasya nipetusturagā bhuvi*
*asthivarṣaṃ ca patitamantarikṣādbhayānakam (36)*

When Karṇa set out, his mares fell to the ground.
And a dangerous (or frightening) rain of bones fell from the sky.

The most interesting point in this, so far, is verse 34. While the previous text had mentioned all planets "flying together", now there is talk of the planets "*going forth from the Sun*" again. As this "going forth" from the Sun follows their "flying together", it can be concluded that the planets did not "fly together" around the Moon, but around the Sun. The text first talks about a heliacal setting of all planets and their conjunction with the Sun, and later about their subsequent heliacal rising and re-emergence from the light of the Sun. The "burning of the four directions" alludes to the rosy dawn in which the planets first appeared before sunrise.

Again, the seven planets that were seen to re-emerge from the Sun raise a question. The five planets in the stricter sense plus the Moon are only six. Where is the seventh? Is it Rāhu? However, Rāhu is not a *visible* planet. The text, however, states that the seven planets *were seen* (*vyadṛśyanta*) "to emerge from the Sun". Holay believes that the seventh planet was Uranus.[71] Unfortunately, this solution is untenable. While Uranus can be visible to the naked eye, under a very clear sky, when the planet is in opposition to the Sun, when one knows exactly where to find it and has very good eyesight, it is absurd to talk about a "heliacal rising" of Uranus shortly before

[70] Circumambulating a person (or a sacred object) in such a way that one has him or her (it) on one's right hand side is a sign of respect.

[71] Holay, "The Year of Kaurava-Pāṇḍava War", p. 65.

sunrise. A more likely solution for the seventh planet would be a comet (Ketu).

There is also another problem: If the Moon is counted among the planets that emerge from the Sun, then the question may arise whether the seven planets that "flew together" in Bhīṣmaparva also included the Moon. However, the two events, the "flying together" of the planets and their re-emergence from the Sun, are only 16 days apart. And when the Moon enters the light of the Sun, it does not take 16 days, but only two or three days to re-appear. It is also impossible that the Moon reappears twice within 16 days from the light of the Sun, because there cannot be two new moons within 16 days.

The best solution might be that *the seven planets include the five planets in the strictest sense plus Rāhu and the comet Ketu*. This solution is also indicated by the following verse:

तेऽपीडयन्भीमसेनं क्रुद्धाः सप्त महारथाः

प्रजासंहरणे राजन्सोमं सप्त ग्रहा इव

*te 'pīḍayanbhīmasenaṃ kruddhāḥ sapta mahārathāḥ*
*prajāsaṃharaṇe rājansomaṃ sapta grahā iva (MBh 7.112.22)*

> These seven great warriors angrily beset Bhīma,
> like the seven planets beset the Moon [at the end of the *yuga*] when all beings are gathered together, O King.

Since the seven planets cannot include the Moon, they must include Rāhu and the comet Ketu besides the planets in the strictest sense. This is also the solution chosen by the commentator Nīlakaṇṭha. He comments the verse concerning the "flying together" of the planets (MBh 6.17.2) as follows:

महाग्रहाः राहुकेत्वोरुपग्रहत्वात्सप्तैव

*mahāgrahāḥ rāhuketvorupagrahatvātsaptaiva*

> The "great planets" are seven because Rāhu and Ketu are counted among the planets.[72]

---

[72] Part 5/6, in the digital version p. 176f. The "coming forth" of the planets from the Sun (MBh 8.26.33 = 8.37.4) is commented as follows:

निःसरन्तो युद्धार्थमितिशेषः सूर्यात्सूर्यमारभ्य सूर्यादयोऽन्योन्यं युध्यंतीत्यर्थः

It could be objected that Rāhu is not a visible planet, and that the Mahābhārata says that the seven planets *"were seen"* (*vyadṛśyanta*) to emerge from the Sun. However, the exact number of planets may not be of much importance. It is reasonable to assume that what is meant by "the seven planets" is simply "all planets". The Moon and Rāhu might or might not be included therein, depending on the situation.

Be that as it may, the quoted passages describe a clearly identifiable astronomical phenomenon. The planets disappear in the glare of the Sun and later re-emerge from it again. This process is very nicely described in the following verse:

अत्र ज्योतींषि सर्वाणि विशन्त्यादित्यमण्डलम्

अष्टाविंशतिरात्रं च चङ्क्रम्य सह भानुना

निष्पतन्ति पुनः सूर्यात् सोमसंयोगयोगतः

*atra jyotīṃṣi sarvāṇi viśantyādityamaṇḍalam*
*aṣṭāviṃśatirātraṃ ca caṅkramya saha bhānunā*
*niṣpatanti punaḥ sūryāt somasaṃyogayogataḥ (MBh 5.108.15)*

**There all lights (= planets) enter the solar disk.**
**After wandering for 28 nights together with the Sun,**
**they fly out of the Sun again, conjoint in a conjunction with the Moon.**

All planets including the Moon first enter into the glare of the Sun. Twenty-eight nights later, the old moon is visible in the morning above the eastern horizon, and the planets, after having re-emerged from the Sun, form a conjunction with her crescent. Although this verse is not taken from the immediate context of the war, it does show clearly that Vedic astronomers assigned great importance to this particular celestial phenomenon.

In another passage, the celestial configuration on the first day of the battle is described as follows:

---

*niḥsaranto yuddhārthamitiśeṣaḥ sūryātsūryamārabhya sūryādayo 'nyonyaṃ yudhyaṃtītyarthaḥ*

'They come forth', i. e. for the purpose of fighting; 'from the Sun', i. e. after they have entered the Sun, the Sun and the other [planets] fight each other.

(Part 7-9, in the digital version p. 212)

उभे पूर्वापरे संध्ये नित्यं पश्यामि भारत

उदयास्तमने (-अस्तमये?) सूर्यं कबन्धैः परिवारितम्

*ubhe pūrvāpare saṃdhye nityaṃ paśyāmi bhārata*
*udayāstamane (-astamaye?) sūryaṃ kabandhaiḥ parivāritam (MBh 6.2.20)*

| |
|---|
| At both dawn and dusk, O Bhārata, at the rising and setting of the sun, I always see the Sun veiled by shining clouds. |

श्वेतलोहितपर्यन्ताः कृष्णग्रीवाः सविद्युतः

त्रिवर्णाः परिघाः संधौ भानुमावारयन्त्युत

*śvetalohitaparyantāḥ kṛṣṇagrīvāḥ savidyutaḥ*
*trivarṇāḥ parighāḥ saṃdhau bhānumāvārayantyuta (21)*

| |
|---|
| Lines of clouds in three colours, with white and red edges and a black back, accompanied by lightning, surround the Sun at dawn and dusk. |

ज्वलितार्केन्दुनक्षत्रं निर्विशेषदिनक्षपम् (var. निर्विवेश दिनक्षिपम्)

अहोरात्रं मया दृष्टं तत्क्षयाय भविष्यति

***jvalitārkendunakṣatraṃ nirviśeṣadinakṣapam*** (var. *nirviveśa dinakṣipam*)
*ahorātraṃ mayā dṛṣṭaṃ tatkṣayāya bhaviṣyati (22)*

| |
|---|
| **The indistinguishable [transition between] day and night, in which the Sun, the Moon, and the stars (= planets?) glow,**<br>(var. Sun, Moon, and stars (planets?) caught fire and entered at the end of the day *(syntactically odd construction in Sanskrit!)*)<br>– I have seen it day and night. This might indicate annihilation. |

अलक्ष्यः प्रभया हीनः पौर्णमासीं च कार्त्तिकीम्

चन्द्रोऽभूदग्निवर्णश्च समवर्णे नभस्तले

*alakṣyaḥ prabhayā hīnaḥ paurṇamāsīṃ ca kārttikīm*
*candro'bhūdagnivarṇaśca samavarṇe nabhastale (23)*

| |
|---|
| The Moon lost his [hare] sign and became devoid of light on the full moon in the month of Kārttika (or: in the *nakṣatra* Kṛttikā), and [became] fiery in colour at the firmament, which was of the same colour. |

The fact that both dawn and dusk are mentioned might indicate that particular attention was paid to heliacal risings and settings of celestial bodies. Verse 22 is difficult but seems to imply that the light of the Sun, the Moon, and "the stars" (*nakṣatrāḥ*) – likely the planets – could not be distinguished, as all planets and the Moon disappeared in the rosy light of dawn and dusk. It thus seems that this text also describes a conjunction of all planets in the light of the Sun. The phenomena regarding the Moon will be considered subsequently.

Later in the text, another description for the configuration before the battle is given:

उभे संध्ये प्रकाशेते दिशां दाहसमन्विते

आसीद्रुधिरवर्षं च अस्थिवर्षं च भारत

*ubhe saṃdhye prakāśete diśāṃ dāhasamanvite*
*āsīdrudhiravarṣaṃ ca asthivarṣaṃ ca bhārata (MBh 6.2.30)*

| |
|---|
| Both dawn and dusk were glowing, accompanied by a burning of the [four] directions.<br>There was a rain of blood and a rain of bones, O Bhārata. |

या चैषा विश्रुता राजंस्त्रैलोक्ये साधुसंमता

अरुन्धती तयाप्येष वसिष्ठः पृष्ठतः कृतः (31)

*yā caiṣā viśrutā rājaṃstrailokye sādhusaṃmatā*
*arundhatī tayāpyeṣa vasiṣṭhaḥ pṛṣṭhataḥ kṛtaḥ (31)*

| |
|---|
| And, O king, she who is praised in the three worlds and esteemed highly by the Sādhus,<br>Arundhatī, she has even taken [her husband] Vasiṣṭha on her back. |

रोहिणीं पीडयन्नेष स्थितो राजञ्छनैश्चरः

व्यावृत्तं लक्ष्म सोमस्य भविष्यति महद्भयम् (32)

*rohiṇīṃ pīḍayanneṣa sthito rājañchanaiścaraḥ*
*vyāvṛttaṃ lakṣma somasya bhaviṣyati mahadbhayam (32)*

| |
|---|
| Saturn's position tormented Rohiṇī, O king.<br>The [hare] sign of the Moon had disappeared. There will be great danger (or: fear). |

For the moment, information on Arundhatī and Vasiṣṭha (two stars in the Big Dipper) will be overlooked as will the phenomena pertaining to the Moon. However, the fact that both dawn and dusk are mentioned, again points to the great conjunction and the simultaneous heliacal rising of all planets. In order to detect such a conjunction, where all planets disappear in the light of the Sun, one has to go out in the evening and morning, and look for planets that are visible near the horizon, above the place where the Sun is about to appear, or disappeared a short while ago. If no planets are seen in the evening or in the morning, then a super-conjunction is taking place.

The rain of blood and bones is reminiscent of a verse in Karṇaparva (MBh 8.26(37).36), which was quoted above (p. 106) and describes a simultaneous heliacal rising of all planets. This rain of blood as well as the burning of the horizon might indicate that the observation of the sky was focused on the disappearance of the planets in the *evening glow*, and on their re-emergence from the *morning glow*. The planets had entered a "blood-like" environment. Apparently the blood-red sky was associated with the bloodshed of war. This astrological belief also appears in the story of the two demons, Sunda and Upasunda. When they kill each other and lie on the earth in puddles of their own blood, this is described as follows:

तौ गदाभिहतौ भीमौ पेततुर्धरणीतले

रुधिरेणावलिप्ताङ्गौ द्वाविवार्कौ नभश्च्युतौ

*tau gadābhihatau bhīmau petaturdharaṇītale*
*rudhireṇāvaliptāṅgau dvāvivārkau nabhaścyutau (MBh 1.204.193)*

> The two terrible ones, killed by [each other's] maces, fell to the ground, their limbs stained by blood ("redness"), like two suns that had fallen from the sky.

The reddish colour of the setting Sun was obviously compared to blood. The rain of bones, however, seems to refer to something else, perhaps it is referring to the meteorites which are also mentioned in some places.

## "... like the planets beset the Moon at the end of the age"

Further evidence which suggests a conjunction of all planets shall be considered. Several places throughout the Mahābhārata a single warrior surrounded, and attacked by several other warriors, is compared to the gathering of all planets around the Moon or the Sun. When on the 6th day of the battle Bhīma is surrounded by hostile relatives, the situation is described as follows:

स तैः परिवृतः पार्थो भ्रातृभिः कृतनिश्चयैः

प्रजासंहरणे सूर्यः क्रूरैरिव महाग्रहैः

*sa taiḥ parivṛtaḥ pārtho bhrātṛbhiḥ kṛtaniścayaiḥ*
*prajāsaṃharaṇe* ***sūryaḥ*** *krūrairiva mahāgrahaiḥ MBh 6.73(77).10*

> Bhīma was surrounded by these firmly determined brothers,
> like **the Sun** [is surrounded] by the violent great planets at [the time of] the destruction of the creation.

On the 9th day of the battle, the five sons of Draupadī pounce upon the demon Alambuṣa:

ते तु क्रुद्धा महेष्वासा द्रौपदेयाः प्रहारिणः

राक्षसं दुद्रुवुः सर्वे ग्रहाः पञ्च यथा रविम्

*te tu kruddhā maheṣvāsā draupadeyāḥ prahāriṇaḥ*
*rākṣasaṃ dudruvuḥ sarve grahāḥ pañca yathā **ravim** MBh 6.96(101).35*

| |
|---|
| These angry great archers, fighters [born] from Draupadī,<br>all ran to the Rakṣasa [Alambusa], like the five planets [run to] **the Sun**. |

वीर्यवद्भिस्ततस्तैस्तु पीडितो राक्षसोत्तमः

यथा युगक्षये घोरे चन्द्रमाः पञ्चभिर्ग्रहैः

*vīryavadbhistatastaistu pīḍito rākṣasottamaḥ*
*yathā yugakṣaye ghore **candramāḥ** pañcabhirgrahaiḥ (36)*

| |
|---|
| Then, the best of the Rakṣasas was tormented by these strong ones,<br>like the **Moon** [is tormented] by the five planets at the terrible end of the age. |

On the 10th day, when Bhīṣma fell, the following happened in the sky:

अपसव्यं ग्रहाश्चक्रुर् अलक्ष्माणं निशाकरम् (var. दिवाकरम्)

अवाक्शिराश्च भगवान् उदतिष्ठत (var. उपातिष्ठत) चन्द्रमाः

*apasavyaṃ grahāścakrur alakṣmāṇaṃ **niśākaram** (var. **divākaram**)*
*avākśirāśca bhagavān udatiṣṭhata (var. upātiṣṭhata) candramāḥ (MBh 6.108(113).12)*

| |
|---|
| The planets circumambulated the inauspicious **Moon** (var. **Sun**) to the right.<br>Lord Moon rose with his head bent down. |

The planets gather around the rising old moon's crescent, meaning, that they are rising heliacally. The Moon is going to die of course, as this is his last day of visibility before the new moon.

In Droṇaparva on the 13th day of the battle, Bhīma is "tormented" by seven sons of Dhṛtarāṣṭra. It is stated that:

तेऽपीडयन्भीमसेनं क्रुद्धाः सप्त महारथाः

प्रजासंहरणे राजन्सोमं सप्त ग्रहा इव

*te'pīḍayanbhīmasenaṃ kruddhāḥ sapta mahārathāḥ*
*prajāsaṃharaṇe rājan**somaṃ** sapta grahā iva (MBh 7.112(136).22; cf. HV 3.55.68)*

| |
|---|
| These seven angry great warriors tormented Bhīma,<br>like the seven planets [torment] the **Moon** at [the time of] the destruction of living beings. |

These verses allude to the super-conjunction at the end of a great age, where all things are "gathered together" and creation is dissolved (*pralayaḥ*). The gathering of the planets in the light of the Sun is obviously part of this "dissolution". In some cases, the planets gather around the Sun, in others around the Moon. But if all the planets gather around the Moon, including Mercury, which is always close to the Sun, then the Sun is not far away either. The description then refers to a super-conjunction either in the western evening sky with the first crescent of the Moon, shortly before the planets enter the light of the Sun; or it refers to a conjunction in the eastern morning sky with the last crescent of the Moon, just after the heliacal reappearance of the planets. However, the verse MBh 6.108(113).12 cited earlier, clearly points to a last crescent configuration in the morning.

The behaviour of the planets towards the Sun or the Moon, around which they gather, is not always hostile in nature. As Duryodhana visits Bhīṣma on the 8th day to ask him for more serious support in the fight against the Pāṇḍavas, the "planets" that surround him are friendly:

प्रदीपैः काञ्चनैस्तत्र गन्धतैलावसेचनैः

परिवव्रुर्महात्मानं प्रज्वलद्भिः समन्ततः

*pradīpaiḥ kāñcanaistatra gandhatailāvasecanaiḥ*
*parivavrurmahātmānaṃ prajvaladbhiḥ samantataḥ (MBh 6.93(98).30)*

There they surrounded him, the Great Being (Duryodhana) [73] with burning, golden lamps that were filled with fragrant oil.

स तैः परिवृतो राजा प्रदीपैः काञ्चनैः शुभैः

शुशुभे चन्द्रमा युक्तो दीप्तैरिव महाग्रहैः

*sa taiḥ parivṛto rājā pradīpaiḥ kāñcanaiḥ śubhaiḥ*
*śuśubhe candramā yukto dīptairiva mahāgrahaiḥ (31)*

As the king was surrounded by those beautifully shining golden lamps, he shone like the Moon when in conjunction with the shining great planets.

[73] Duryodhana is here addressed as *mahātmā*.

However, in most cases the conjunction is a connotation of war. In the following verse, which is taken from the description of the fight between Bhīma and Aśvatthāman on the 16th day, the conjunction of the planets is compared to the clashing of weapons:

ततो घोरं महाराज अस्त्रयुद्धमवर्तत

ग्रहयुद्धं यथा घोरं प्रजासंहरण अभूत्

*tato ghoraṃ mahārāja astrayuddhamavartata*
*grahayuddhaṃ yathā ghoraṃ prajāsaṃharaṇa abhūt (MBh 8.11(15).23)*

| |
|---|
| Then, O king, occurred the terrible battle of arms,<br>like the terrible battle of the planets at the dissolution of the creation. |

The battlefield itself is sometimes compared to a conjunction of all planets:

क्षिप्तैः काञ्चनदण्डैश्च नृपच्छत्रैः क्षितिर्बभौ

द्यौरिवोदितचन्द्रार्का ग्रहाकीर्णा युगक्षये

*kṣiptaiḥ kāñcanadaṇḍaiśca nṛpacchatraiḥ kṣitirbabhau*
*dyaurivoditacandrārkā grahākīrṇā yugakṣaye (MBh 7.131(155)118)*

| |
|---|
| The earth was shining with golden rods and king's umbrellas that were thrown [to the ground],<br>like the sky is strewn with planets, when the Moon and the Sun rise at the end of the age. |

This means that just before sunrise the old moon was visible in conjunction with the planets at their heliacal rising.

क्षिप्तैः कनकचित्रैश्च नृपच्छत्रैः क्षितिर्बभौ

द्यौरिवादित्यचन्द्राद्यैर्ग्रहैः कीर्णा युगक्षये

*kṣiptaiḥ kanakacitraiśca nṛpacchatraiḥ kṣitirbabhau*
*dyaurivādityacandrādyairgrahaiḥ kīrṇā yugakṣaye (MBh 7.136.8)*

| |
|---|
| The earth was shining of gold-bright king's umbrellas that were thrown [to the ground],<br>like the sky at the end of the age is sprinkled by the planets that are lead by the Moon and the Sun. |

And:

शरप्रहाराभिहतैर्महाबलैरवेक्ष्यमाणैः पतितैः सहस्रशः

प्रनष्टसंज्ञैः पुनरुच्छ्वसद्भिर्मही बभूवानुगतैरिवाग्निभिः

दिवश्च्युतैर्भूरतिदीप्तमद्भिर्नक्तं ग्रहैर्द्यौरमलेव दीप्तैः

*śaraprahārābhihatairmahābalairavekṣyamāṇaiḥ patitaiḥ sahasraśaḥ*
*pranaṣṭasaṃjñaiḥ punarucchvasadbhirmahī babhūvānugatairivāgnibhiḥ*
*divaścyutairbhūratidīptamadbhirnaktaṃ grahairdyauramaleva dīptaiḥ*
*(MBh 8.94(68).20)*

With the [warriors] of great power who could be seen hit by shots of arrows and fallen by the thousands,
who had lost consciousness, but were still breathing: the great earth appeared with smouldering fires, as it were, bright ones[74], that had fallen from the sky;
[or] like the immaculate night sky with the shining planets.

It seems those warriors dying, but still breathing, are compared to the glowing embers of fires that had fallen from the sky. Secondly, they are compared to the planets in the night sky. Most likely, those "extinguished fires", "fallen to the earth" were the planets themselves, which would indicate their heliacal setting.

Another interesting verse, which, however, is not included in the critical edition of the epic, describes the standard of Yudhiṣṭhira as follows:

ध्वजं तु कुरुराजस्य पाण्डवस्य महौजसः

दृष्टवानस्मि सौवर्णं सोमं ग्रहगणान्वितम्

*dhvajaṃ tu kururājasya pāṇḍavasya mahaujasaḥ*
*dṛṣṭavānasmi sauvarṇaṃ somaṃ grahagaṇānvitam (MBh 7.23.85)*[75]

The standard of the Kuru king, the Pāṇḍu son of great force,
I saw it like a golden moon followed by the host of the planets.

Arjuna's head dress (*uttamagātrabhūṣaṇam*) was described with similar words, and Aśvatthāman's adornment (*aṅgabhūṣaṇam*), as well. They "shine like the Sun, the Moon, and the glowing planets" (*divākarendujvalanagrahatviṣāṃ* MBh 8.66(90).13; *arkachandra-grahapāvakatviṣam* MBh 8.15(20).38).

---

[74] The grammar is difficult. Instead of *dīptam adbhir*, the author reads *dīptimadbhir*. Otherwise, he does not know what *dīptam* would refer to and what role the "waters" would play.

[75] Given in the edition by Krishnacharya and Vyasacharya.

An allusion to this kind of adornment is also found in the following verse. On the 5th day, Bhīma hits Duryodhana with 10 arrows in the chest (not fatally injuring him):

> तस्य काञ्चनसूत्रस्तु शरैः परिवृतो मणिः
>
> रराजोरसि वै सूर्यो ग्रहैरिव समावृतः
>
> *tasya kāñcanasūtrastu śaraiḥ parivṛto maṇiḥ*
> *rarājorasi vai sūryo grahairiva samāvṛtaḥ (MBh 6.69(73).19)*

| |
|---|
| When his adornment, which was fastened with threads of gold, was surrounded by arrows,<br>it shone from his breast like the Sun when surrounded by the planets. |

Also of interest is the following verse. The five Pāṇḍavas were once surrounded by 3000 elephants from the enemy's army:

> ते वृताः समरे पञ्च गजानीकेन भारत
>
> अशोभन्त नरव्याघ्रा ग्रहा व्याप्ता घनैरिव
>
> *te vṛtāḥ samare pañca gajānīkena bhārata*
> *aśobhanta naravyāghrā grahā vyāptā ghanairiva (MBh 9.24(25).24)*

| |
|---|
| When in battle these five [Pāṇḍavas] were surrounded by the elephant battle line, O Bhārata,<br>they shone beautifully, the tiger men, like the planets when they are surrounded by clouds. |

Obviously, the five planets, like the Pāṇḍavas, who were gathered in one place, must have been in conjunction.

Besides, it must be asked whether the five Pāṇḍavas should generally be interpreted as representing the five planets. Later it shall be seen that Kṛṣṇa was identified with the Sun and Balarāma with the Moon. Thus, the solar system would be complete.

## The "Gathering Together" of All Beings in their Origin

The idea that all planets come together in conjunction at the end of an age is probably related to the idea that all beings return to God at the end of an age and later re-emerge from him. It seems, however, that this process does not always result in total destruction from which everything is recreated. For example, at the end of *dvāpara-yuga* and the beginning of *kaliyuga*, all armies of the world at that point were allegedly destroyed during the great Mahābhārata war. Hardly anybody survived even from the winning party. Chaos ruled everything: The castes mixed, the seasons were disrupted, children were born deformed, and monstrous beings came into the world. However, complete destruction of the world did not take place. This is evident by the unbroken succession of rulers in the Hastināpura dynasty. Yudhiṣṭhira, who was abdicated after the death of Kṛṣṇa at the end of the *dvāparayuga*, was succeeded by Parīkṣit, the first king of the Kali Age. The cataclysm at the beginning of the *kaliyuga* apparently is not as radical as the one that takes place at the end of a *mahāyuga*, when the *kaliyuga* ends and a new *kṛtayuga* begins.

In Harivaṃśa, the following verses are found:

प्रजाः क्षयं प्रयास्यन्ति सार्धं कलियुगेन ह

क्षीणे कलियुगे तस्मिंस्ततः कृतयुगं पुनः

प्रपत्स्यते यथान्यायं स्वभावादेव नान्यथा

*prajāḥ kṣayaṃ prayāsyanti sārdhaṃ kaliyugena ha*
*kṣīṇe kaliyuge tasmiṃstataḥ kṛtayugaṃ punaḥ*
*prapatsyate yathānyāyaṃ svabhāvādeva nānyathā (HV 1.41.169)*

> The creatures will go into destruction together with the Kali age.
> When this Kali age has been destroyed, then a new Kṛta age
> will emerge, according to the rule, by nature, not otherwise.

The context of this verse treats the incarnations of Viṣṇu on the earth at the end of each *yuga*. And in Viṣṇupurāṇa it says:

कृतं त्रेता द्वापरश्च कलिश्चैव चतुर्युगम्

प्रोच्यते तत्सहस्रं च ब्रह्मणो दिवसं मुने (var. ब्रह्मणां)

*kṛtaṃ tretā dvāparaśca kaliścaiva caturyugam*
*procyate tatsahasraṃ ca brahmaṇo divasaṃ mune (VP 1.3.15) (var. brahmaṇāṃ)*

> Kṛtam, Tretā, Dvāparaḥ und Kaliḥ [form] a [period] of four ages.
> One thousand of them is called a day of Brahmā, O sage.

ब्रह्मणो दिवसे ब्रह्मन्मनवस्तु चतुर्दश

भवन्ति परिणामं च तेषां कालकृतं श्रृणु

*brahmaṇo divase brahmanmanavastu caturdaśa*
*bhavanti pariṇāmaṃ ca teṣāṃ kālakṛtaṃ śṛṇu (VP 1.3.16)*

> In one day of Brahmā, O Brahmin, 14 Manus
> appear. Listen [to learn] their change that is caused by time (Kāla).

सप्तर्षयः सुराः शक्रो मनुस्तत्सूनवो नृपाः

एककाले हि सृज्यन्ते संह्रियन्ते च पूर्ववत्

*saptarṣayaḥ surāḥ śakro manustatsūnavo nṛpāḥ*
*ekakāle hi sṛjyante saṃhriyante ca pūrvavat (VP 1.3.17)*

The Seven Ṛṣis, the gods, Śiva, Manu, his sons, and the kings
are created and destroyed at the same time, as they were formerly.

The four ages Kṛta, Tretā, Dvāpara, and Kali, constitute a "great age" (*mahāyugam*, *caturyugam*). One thousand of them form a "Day of Brahmā", the "Creator God". A day of Brahmā also contains 14 Manu periods (*manvantaram*), each of which contains 71 "great ages". Manu is the name of the ruler of one of these 14 periods. At the end of a Manu period, the Manu dies, and a new one takes office. The verse quoted above actually seems to indicate that the divine beings are destroyed and recreated at the beginning of each Manu period.

However all that may be in detail, it is obvious that the super-conjunction of all planets has something to do with this reabsorption of everything into God and its re-emanation from him at the end of each age. Everything, including the planets, are absorbed into God and re-emerge from him.

The Viṣṇupurāṇa has the following verses:

एकान्तिनः सदा ब्रह्मध्यायिनो योगिनश्च ये

तेषां तु परमं स्थानं यत्तत्पश्यन्ति सूरयः

*ekāntinaḥ sadā brahmadhyāyino yoginaśca ye*
*teṣāṃ tu paramaṃ sthānaṃ yattatpaśyanti sūrayaḥ (VP 1.6.39)*

The yogis who contemplate B*rahma*, having one goal only,
to them [belongs] that highest abode that is seen by the sages.

गत्वागत्वा निवर्तन्ते चन्द्रसूर्यादयो ग्रहाः

अद्यापि न निवर्तन्ते द्वादशाक्षरचिन्तकाः

*gatvāgatvā nivartante candrasūryādayo grahāḥ*
*adyāpi na nivartante dvādaśākṣaracintakāḥ (VP 1.6.40)*

The Moon, the Sun, and the other planets go there again and again and return [at the end of each *yuga*].
Even today, those who meditate on the 12 syllables, do not return.

The last line refers to the spiritual liberation that ends the cycle of birth and death.

It seems, however, that the planets unite in a super-conjunction at the end of each *yuga*, not only at the end of a day of Brahmā and not only at the end of a Manu period or a great age (*mahāyuga*). In Harivaṃśa, where Viṣṇu appears as his dwarf *avatāra*, it says:

ते पीडयन्तः पवनं क्रुद्धाः सप्त महारथाः

प्रजासंहरणे घोराः सोमं सप्त ग्रहा इव

*te pīḍayantaḥ pavanaṃ kruddhāḥ sapta mahārathāḥ (HV 3.55.68)*
*prajāsaṃharaṇe ghorāḥ somaṃ sapta grahā iva*

> The seven angry warriors oppressed the wind god,
> like the seven planets violently [oppress] the moon god when all living beings are reabsorbed.

The collective emergence of the planets at the end of an age is also repeatedly mentioned in Harivaṃśa, when an earlier *avatāra* of Viṣṇu, the man-lion Nṛsiṃha appears. This avatāra allegedly came during the *kṛtayuga*, the "golden age". When Nṛsiṃha was attacked by the demons, it is said that:

तैरासीद्गगनं चक्रैः संपतद्भिः समावृतम् ।

युगान्ते संप्रकाशद्भिश्चन्द्रसूर्यग्रहैरिव

*tairāsīdgaganaṃ cakraiḥ saṃpatadbhiḥ samāvṛtam |*
*yugānte saṃprakāśadbhiścandrasūryagrahairiva HV 3.45.9*

> The sky was covered by these discuses that flew together,
> like [the sky is covered] by the Moon, Sun, and planets that appear together (i.e. in conjunction) at the end of a yuga.

The discus was used as a weapon. Similarity can be drawn from the fact that the discuses occur massed-together as do the planets at the end of the age. The text continues:

तानि चक्राणि वदनं प्रविशन्ति विभान्ति वै

मेघोदरदरीं घोरां चन्द्रसूर्यग्रहा इव

*tāni cakrāṇi vadanaṃ praviśanti vibhānti vai*
*meghodaradarīṃ ghorāṃ candrasūryagrahā iva HV 3.45.10*

> These discuses enter his (Nṛsiṃha's) mouth radiantly,
> into the terrifying abyss of his clouded belly, like the Moon, the Sun, and the planets.

तानि चक्राणि सर्वाणि मृगेन्द्रेण महात्मना

निगीर्णानि प्रदीप्तानि पावकार्चिःसमानि वै

*tāni cakrāṇi sarvāṇi mṛgendreṇa mahātmanā*
*nigīrṇāni pradīptāni pāvakārciḥsamāni vai HV 3.45.11*

| |
|---|
| These discuses were all swallowed by the lion, the great being, and were burning like flames of fire. |

Later, the text continues as follows:

ये ग्रहाः सर्वलोकस्य क्षये प्रादुर्भवन्ति वै

ते ग्रहा गगने हृष्टा विचरन्ति यथासुखम्

*ye grahāḥ sarvalokasya kṣaye prādurbhavanti vai*
*te grahā gagane hṛṣṭā vicaranti yathāsukham HV 3.46.7*

| |
|---|
| The planets that appear at the destruction of the whole world,<br>these planets happily wander through the sky as they please. |

अयोगतश्च तारासु (var. चचाराशु) सर्वेष्वृक्षेषु सङ्गताः

सग्रहं सहनक्षत्रं प्रजज्वाल नभो नृप

*ayogataśca tārāsu (*var. *cacārāśu) sarveṣvṛkṣeṣu saṅgatāḥ*
*sagrahaṃ sahanakṣatraṃ prajajvāla nabho nṛpa HV 3.46.8*

| |
|---|
| As they were no longer in conjunction, they joined the stars [and] all lunar mansions.<br>The sky with the planets and lunar mansions began to shine, O King. |

Thus at the time the world reaches destruction, the planets are swallowed up by Nṛsiṃha, who represents the Sun, and shortly thereafter proceed to their combined heliacal rising. They go forth from a conjunction, then separate and wander separately "as they please".

विवर्णत्वं च भगवान्गतो दिवि दिवाकरः

कृष्णः कबन्धश्च महाँल्लक्ष्यते स्म नभस्तले

*vivarṇatvaṃ ca bhagavāṅgato divi divākaraḥ |*
*kṛṣṇaḥ kabandhaśca mahāṁllakṣyate sma nabhastale HV 3.46.9*

| |
|---|
| When the venerable Sun became colourless in the sky,<br>he was called Kṛṣṇa ("the black one"), Kabandha ("the [cloud] vessel") and Mahān ("the great one") in the firmament. |

→

अमुञ्चच्चासितां सूर्यो धूमवर्तिं भयावहाम्

गगनस्थश्च भगवानभीक्ष्णं परितप्यते (var. परिविष्यते)

*amuñcaccāsitāṃ sūryo dhūmavartiṃ bhayāvahām |*
*gaganasthaśca bhagavānabhīkṣṇaṃ paritapyate (*var. *pariviṣyate) HV 3.46.10*

| |
|---|
| And the Sun emitted a black, terrifying column of smoke.<br>And the venerable one, standing in the firmament, is set on fire (*var.* has a halo) again and again. |

सप्त धूमनिभा घोराः सूर्या दिवि समुत्थिताः

सोमस्य गगनस्थस्य ग्रहाः तिष्ठन्ति शृङ्गगाः

*sapta dhūmanibhā ghorāḥ sūryā divi samutthitāḥ |*
*somasya gaganasthasya grahāḥ tiṣṭhanti śṛṅgagāḥ HV 3.46.11*

| |
|---|
| Seven terrifying smoke-like suns appeared in the sky.<br>The planets stand near the horns of the Moon, which stands in the firmament. |

The seven suns probably represent the seven planets including the Moon and Rāhu. The planets make their rise heliacally and stand in conjunction with the crescent of the old moon in the eastern morning sky. As has been explained previously:

ते पीडयन्तः पवनं क्रुद्धाः सप्त महारथाः

प्रजासंहरणे घोराः सोमं सप्त ग्रहा इव

*te pīḍayantaḥ pavanaṃ kruddhāḥ sapta mahārathāḥ (HV 3.55.68)*
*prajāsaṃharaṇe ghorāḥ somaṃ sapta grahā iva*

| |
|---|
| The seven angry warriors oppressed the wind god,<br>like the seven planets violently [oppress] the moon god when all living beings are reabsorbed. |

Returning to HV 3.46, the text continues:

वामे च दक्षिणे चैव स्थितौ शुक्रबृहस्पती

शनैश्चरो लोहिताङ्गो लोहितार्कसमद्युतिः

*vāme ca dakṣiṇe caiva sthitau śukrabṛhaspatī*
*śanaiścaro lohitāṅgo lohitārkasamadyutiḥ HV 3.46.12*

| |
|---|
| On the left and right side stand Venus and Jupiter,<br>Saturn and Mars, who shines like a red Sun. |

समं समभिरोहन्ति दुर्गाणि गगनेचराः

शृङ्गाणि शनकैर्घोरा युगान्तावर्तका ग्रहाः

*samaṃ samabhirohanti durgāṇi gaganecarāḥ*
*śṛṅgāṇi śanakairghorā yugāntāvartakā grahāḥ HV 3.46.13*

Together, they slowly ascend towards the unapproachable horns [of the Moon], wandering in the sky,
the terrifying planets, when they return at the end of the age.

It seems that the Moon is in waning phase here, the last crescent in its morning rising.

चन्द्रमाः सह नक्षत्रैर्ग्रहैः सप्तभिरावृतः

चराचरविनाशार्थं रोहिणी नाभ्यनन्दत

*candramāḥ saha nakṣatrairgrahaiḥ saptabhirāvṛtaḥ*
*carācaravināśārthaṃ rohiṇī nābhyanandata HV 3.46.14*

The Moon together with the stars (of his lunar mansion?) was surrounded by the seven planets,
for the destruction of [all] moving and non-moving [beings]. Rohiṇī did not approve of it.

That Rohiṇī "did not approve" is reminiscent of the astrological term "torment" (*pīḍanam*), which will be discussed later. For, during the super-conjunction that took place at the time of the Mahābhārata War, Rohiṇī was also "tormented". The current verse could thus be alluding to the super-conjunction of the Mahābhārata War.

गृहीतो राहुणा चन्द्र उल्काभिरभिहन्यते

उल्काः प्रज्वलिताश्चन्द्रे प्रचेलुर्घोरदर्शनाः

*gṛhīto rāhuṇā candra ulkābhirabhihanyate |*
*ulkāḥ prajvalitāścandre pracelurghoradarśanāḥ HV 3.46.15*

The Moon is seized by Rāhu and struck by meteors.
The burning meteors crashed into the Moon, their appearance was terrifying.

देवानामपि यो देवः सोऽभ्यवर्षत शोणितम्

अपतन्गगनादुल्का विद्युद्रूपाः सनिःस्वनाः

*devānāmapi yo devaḥ so'bhyavarṣata śoṇitam |*
*apatangaganādulkā vidyudrūpāḥ saniḥsvanāḥ HV 3.46.16*

And the one who is the God of the gods made a rain of blood.
Lightning-shaped comets fell from the sky with a roar.

In principle, however, *ulkāḥ* could also be translated as "heavenly fires" rather than "meteors", and they could allude to the red colour of the dawn that engulfs the old moon like a fire, while it is encircled by the planets. Also, the "rain of blood" could be in reference to the colour of the sky at dawn. This interpretation can be inferred from the following verse, which is taken from the description of celestial omens before the Mahābhārata war:

उभे संध्ये प्रकाशेते दिशां दाहसमन्विते

आसीद्रुधिरवर्षं च अस्थिवर्षं च भारत

*ubhe saṃdhye prakāśete diśāṃ dāhasamanvite*
*āsīdrudhiravarṣaṃ ca asthivarṣaṃ ca bhārata (MBh 6.2.30)*

> Both dawn and dusk were glowing, accompanied by the burning of the [four] directions.
> There was a rain of blood and a rain of bones, O Bhārata.

The battle ends with the destruction of the leader of the demons, Hiraṇyakāśipu, by Nṛsiṃha:

देवारिर्दितिजो दृप्तो नृसिंहं समुपाद्रवत्

*devārirditijo dṛpto nṛsiṃhaṃ samupādravat HV 3.47.13*

> The enemy of the gods, the son of Diti, ran wildly towards the man lion.

समुत्पत्य ततस्तीक्ष्णैर्मृगेन्द्रेण महानखैः

तदोंकारसहायेन विदार्य निहतो युधि

*samutpatya tatastīkṣṇairmṛgendreṇa mahānakhaiḥ*
*tadoṃkārasahāyena vidārya nihato yudhi HV 3.47.14*

> After rising against [him], he was then killed in battle by the lion, who tore him into pieces with his big sharp claws, assisted by the sound of OM.

मही च लोकश्च शशी नभश्च  ग्रहाश्च सूर्यश्च दिशश्च सर्वाः

नद्यश्च शैलाश्च महार्णवाश्च  गताः प्रकाशं दितिपुत्रनाशात्

*mahī ca lokaśca śaśī nabhaśca*
        *grahāśca sūryaśca diśaśca sarvāḥ |*
*nadyaśca śailāśca mahārṇavāśca*
        *gatāḥ prakāśaṃ ditiputranāśāt HV 3.47.15*

> The Earth and mankind, the Moon and the sky,
> the planets and the Sun and all the [four] directions,
> the rivers and the mountains and the oceans
> reappeared again after the destruction of the son of Diti.

Not only the planets, even the whole world had thus entered a state of darkness or non-existence, and after the death of the demon, everything reappeared. For the planets this meant that a synchronous heliacal rising took place after a period of invisibility.

The configuration of the planets at the end of the age is also indicated in other places. In *tretāyuga*, just before Viṣṇu appears as his *avatāra* Vāmana, gods and demons fight with each other. The battles of the different heroes of the gods and the demons are described in detail. As when the sons of the demon Puloman attack the wind god Vāyu:

ते समासाद्य पवनं समावृण्वञ्छरोत्तमैः

पर्वतं वारिधाराभिः प्रावृषीव बलाहकाः

*te samāsādya pavanaṃ samāvṛṇvañcharottamaiḥ HV 3.55.67*
*parvataṃ vāridhārābhiḥ prāvṛṣīva balāhakāḥ*

> They attacked the wind god and encircled him with powerful arrows,
> like thunder clouds in the rainy season [attack and encircle] the mountains with rain showers.

ते पीडयन्तः पवनं क्रुद्धाः सप्त महरथाः

प्रजासंहरणे घोराः सोमं सप्त ग्रहा इव

*te pīḍayantaḥ pavanaṃ kruddhāḥ sapta maharathāḥ (HV 3.55.68)*
*prajāsaṃharaṇe ghorāḥ somaṃ sapta grahā iva*

> The seven angry warriors oppressed the wind god,
> like the seven planets violently [oppress] the moon god when all living beings are reabsorbed.

The "reabsorption" of all living beings refers to the end of a great age. At this time, the Moon is beset by the "seven planets", possibly the five planets in the stricter sense, the Sun, and Rāhu. Or, perhaps the number seven rather stands symbolically for *all* planets. In any case, all planets crowd very tightly around the Moon.

The same configuration is apparently also indicated later, where the war of the Moon god with the demons is described as follows:

एतस्मिन्नन्तरे चैव ब्राह्मणेन्द्रो महाबलः

जघान सोमः शीतास्त्रो दानवानां चमूं रणे

*etasminnantare caiva brāhmaṇendro mahābalaḥ*
*jaghāna somaḥ śītāstro dānavānāṃ camūṃ raṇe HV 3.55.148*

> In that age, the king of the Brahmins of great power,
> the Moon god with cold arrows [of light], destroyed the army of the demons in battle.

कैलासशिखराकारो द्युतिमद्भिर्गणैर्वृतः

अवधीद्दानवान्दृप्तान् (var. दृष्ट्वा) दण्डपाणिरिवान्तकः

*kailāsaśikharākāro dyutimadbhirgaṇairvṛtaḥ*
*avadhīddānavāndṛptān (*var. *dṛṣṭvā) daṇḍapāṇirivāntakaḥ HV 3.55.149*

| |
|---|
| Having the shape of mount Kailāsa's summit, surrounded by shining troops,<br>he slayed the wild demons with the staff in his hand, like the [god] of death. |

पोथयन्रथवृन्दानि वाजिवृन्दानि वै प्रभुः

दैत्येषु व्यचरच्छ्रीमान् युगान्ते कालवद्बली

*pothayanrathavṛndāni vājivṛndāni vai prabhuḥ*
*daityeṣu vyacaracchrīmān yugānte kālavadbalī HV 3.55.150*

| |
|---|
| The lord crushed the host of chariots and the host of horses.<br>He walked among the demons, gloriously and powerfully like the [god of] time at the end of the age. |

When the Moon is compared to a mountain peak, then this probably alludes to the shape of a crescent moon. The shining troops or the demons, amongst which he walks gloriously, might represent the planets.

Intimations of this configuration are also found in other places. Before the Kṛtayuga began, the demon Tāraka took dominion over the world, and the demons defeated the gods. The Sun, the Moon, and the planets were obscured by dark clouds. When Viṣṇu prepared to intervene, the gods and the populace of the entire world were joyful. The Sun, Moon, and planets began to shine again. (HV 1.42) Although this text does not provide a clear description of the super-conjunction, it is still very likely that it refers to the joint heliacal disappearance and reappearance of the planets, as is assumed to occur at the end of every *yuga*. The text quoted further above, where Nṛsiṃha destroys the dominion of the demons, clearly states that the planets are first obscured and later begin to shine again after the victory of the gods (HV 3.47.15; cited above).

In another place in Harivaṃśa, where the world is created at the beginning of an age, it states:

तपसा महता युक्तो ग्रहैः सह निशाकरः (var. पुरःसरः)

चचार नभसो मध्ये प्रभाभिर्भासयञ्जगत्

*tapasā mahatā yukto grahaiḥ saha niśākaraḥ (*var. *puraḥsaraḥ)* |
*cacāra nabhaso madhye prabhābhirbhāsayañjagat HV 3.20.19*

> With tremendous heat, in conjunction with the planets, the Moon ("the night maker")
> walked in the middle of the sky and illuminated the world with his rays.

The Moon in conjunction with the planets, indicates a super-conjunction. The statement that this conjunction takes place in the "middle of the sky" is confusing. A conjunction of all planets can be visible only in the evening or in the morning and only near the horizon because Mercury and Venus always remain close to the Sun. The midheaven, however, is the meridian, the place in the southern direction, where the stars culminate. Is it then to be understood that it is about midday and that the planets are in conjunction with both the Sun and the Moon? However, the verse states that it is the Moon, not the Sun, that illuminates the world, and this is in contradiction with the reference to daytime hours and midday. Astronomically, it seems, the text is not entirely correct. It has to be assumed that here, as in the aforementioned verses, the old moon's crescent sits over the eastern horizon in the morning and is in conjunction with the planets that have made their heliacal rising recently.

## Phases and Types of Super-Conjunctions

Returning to the Mahābhārata War and the celestial configuration that accompanied it. As has been shown some verses refer to a gathering of planets around the Sun, while other verses state that the planets gathered around the Moon. This is not necessarily a contradiction. In reality the two descriptions refer to different phases of a super-conjunction. Super-conjunctions can be schematically divided into the following three phases:

1. During the days and weeks before the planets enter the light of the Sun, they tend to cluster during the evening in the western sky. If the new moon's crescent also joins them, then the Moon can be seen surrounded by the planets.

2. After the planets have entered the light of the Sun, they become imperceptible. For a period no planet can be seen in the sky between sunset and sunrise.
3. When the planets leave the light of the Sun, they tend to accumulate in the eastern morning sky. When the old moon's crescent joins them, then one can witness them rally around the Moon.

Thus when the Mahābhārata states that the planets gather together around the Sun, this means that they enter its light and become undetectable, this being phase 2. On the other hand, when the planets gather together around the Moon, then they are visible either in the evening sky near the new moon's crescent or in the morning sky near the old moon's crescent. Then this is either phase 1 or phase 3.

The phases described above represent a general pattern as to how super-conjunctions evolve. However, in most cases, reality does not strictly adhere to this pattern. First of all, phase 2 is not always preceded by phase 1 and not always followed by phase 3. Before all planets gather around the Sun (phase 2), Mars, Jupiter, and Saturn are observed in the evening sky, but Venus and Mercury could be seen either in the evening sky or in the morning sky. If they were seen in the morning sky, then phase 1, namely all planets positioned around the Moon in the evening sky, *did not take place*. Following the end of phase 2, the three outer planets always appear in the morning sky whereas Venus and Mercury could appear either in the morning or in the evening sky. If the latter, then phase 3 does not take place.

Hence there are two types of super-conjunctions:

A) Super-conjunctions where *all* planets, including Venus and Mercury, are first evening stars and later morning stars. In phase 1, all planets are seen in the evening sky, and in phase 3 all planets are seen in the morning sky.

B) Super-conjunctions where Venus or Mercury (or both) are first morning stars and later become evening stars. Phases 1 and 3 do not exist. Both before and after phase 2, planets are found both in the morning sky and in the evening sky.

However, ancient Indian texts seem to have a preference for super-conjunction type A, because very often it is mentioned that *all five* planets gather around the Moon.

Moreover, it must be noted that even type A super-conjunctions are not very often accompanied by phase 1 or 3 in the strictest sense. It rarely occurs that phase 2 is accompanied by a gathering of *all* planets around the Moon in the evening or the morning sky. Furthermore it is completely impossible for all three phases to occur during a super-conjunction in its purest form. After Mercury has been in conjunction with the Sun, it does not often reappear in the sky before entering another conjunction with the Sun. If it does reappear, then this will only be for a few days, and not necessarily at the same time that the Moon joins the cluster of planets. Also the emergence of Saturn, Jupiter, and Mars may take place so slowly that by the time the last of them has appeared, Mercury has long disappeared again. By the time Mars appears, Jupiter and Saturn may already be so high in the sky, that no alluring planetary cluster can be seen in the morning sky any longer. Thus phase 2 is not always followed by a stunning phase 3, and for similar reasons, it is not always preceded by an engaging phase 1.

Also, it must be noted that when all the planets gather around the Moon in the evening, a phase 2 does not necessarily follow, i. e. not all the planets must disappear in the glare of the Sun. For, Venus could just have left its proximity to the Sun and stand commencing her seven-month-long phase as the evening star. Also, a morning clustering of the planets does not necessarily have to be preceded by a super-conjunction, because Venus could be concluding her phase as the morning star and may have been visible for the previous seven months.

Finally, it must be stated that a clustering in the morning or evening sky can also take place at a greater time distance from a super-conjunction, between one and four years. However, such a greater time distance is not given in the Mahābhārata, because it states that the planets emerge from the Sun exactly in the year of the war, and they all do so at the same time.

## Super-Conjunctions in Astrological Texts

Super-conjunctions are also treated in *Parāśaratantra* in the chapter on "planetary war" (*grahayuddham*). The Sanskrit texts quoted below can be found in R.N. Iyengar's edition (translation D.K.).[76] The statements that are most important for this investigation are given in bold type:

अथाष्टौ ग्रहयोगाः कोपः शृङ्गाटको व्यूहो माला धनुस्तुलाध्वजश्चक्रं चेति

*athāṣṭau grahayogāḥ kopaḥ śṛṅgāṭako vyūho mālā dhanustulādhvajaś-cakraṃ ceti.*

There are 8 planetary conjunctions, the names of which are "anger", "attacking the crescent", "military array", "garland", "bow", "balance", "banner" and "wheel".

तत्रैकर्क्षे पञ्चताराग्रहाः सूर्यानुगताः स्युः स कोपः

***tatraikarkṣe pañcatārāgrahāḥ sūryānugatāḥ syuḥ sa kopaḥ***

Among these: **When the five planets, following the Sun, are in one and the same lunar mansion, then this is an "anger".**

एकर्क्षगास्त्रयश्चन्द्रसंयुक्ताः स शृङ्गाटकः

*ekarkṣagāstrayaścandrasaṃyuktāḥ sa śṛṅgāṭakaḥ*

When three [planets] are in one and the same lunar mansion in conjunction with the Moon, then this is "attacking the crescent".

विना सोमेन दृश्याश्चत्वारः स व्यूहः

*vinā somena dṛśyāścatvāraḥ sa vyūhaḥ*

When four [planets] are seen without the Moon, then this is a "military array".

पञ्चैकर्क्षगा दृश्येरन्स ध्वजः

***pañcaikarkṣagā dṛśyeransa dhvajaḥ***

**When five [planets] are seen in one and the same lunar mansion, then this is a "banner".**

एकैकर्क्षान्तरिताः पञ्च सा माला

***ekaikarkṣāntaritāḥ pañca sā mālā***

**When five [planets] disappear in one and the same lunar mansion, then this is a "garland".**

[76] Parāśaratantra 15.10 (Iyengar p. 201f.)

The last two lines raise the question what exactly is the difference between *ekarkṣagāḥ* and *ekarkṣāntaritāḥ*. In principle, both *gam-* and *antar-i-* with an accusative of direction could have the meaning "to enter into". However, *antar-i-* can also mean "to disappear, to conceal itself". Hence a "banner" could be a visible conjunction of the five planets with the Moon, whereas a "garland" could be an invisible conjunction of the five planets with the Sun. On the other hand, Iyengar translates the last line as follows:

> If they encircle the same star, the formation is Mālā (garland).

This seems to make good sense, too. However, then there is the problem that *ṛkṣam* appears in two different meanings. In the line concerning the "banner" configuration, it means "lunar mansion", in the "garland" configuration it would mean "star".

The text continues:

उदयेऽस्तमये च ग्रहरूपं दृश्यते सा तुला

*udaye'stamaye ca graharūpaṃ dṛśyate sā tulā*

> When one sees a single planet rising and another one setting, then this is a "balance".

स एवाकृतिवशाद्धनुः

*sa evākṛtivaśāddhanuḥ*

> This [same configuration] can, depending on its formation, be a "bow".

An example given further below seems to show that in the latter case the two planets need not necessarily be rising or setting, but in opposite lunar mansions.

उदयास्तमध्यान्तरेभ्योऽन्यर्क्षगाः स चक्रं ...

*udayāstamadhyāntarebhyo'nyarkṣagāḥ sa cakraṃ ...*

> When they enter a new lunar mansion between rising and setting, then this is a "wheel". ...

A little later, interpretations in verse metre are given for the different configurations mentioned above. The following verses are given by Vallālasena, a scholar of the 12th century, however not as a cohering text. The different quotations are separated by a hyphen "–":

मालाभिषिक्तनाशाय मध्यदेशविपत्तये

*mālābhiṣiktanāśāya madhyadeśavipattaye*

| |
|---|
| The "garland" [indicates] destruction of the crowned one, the downfall of Madhyadeśa ("middle land"). |

धनुः कुनृपनाशाय चोरदस्युक्षयाय च

*dhanuḥ kunṛpanāśāya coradasyukṣayāya ca*

| |
|---|
| The "bow" [indicates] destruction of evil rulers and extermination of thieves and robbers. |

शस्याम्बुनाशाय तुला तुलाज्ञश्चोपजीवति

*śasyāmbunāśāya tulā tulājñaścopajīvati*

| |
|---|
| The "balance" [indicates] destruction of the crop by water. He who knows the "balance" can live upon it. |

ध्वजः शस्यविनाशाय चक्रं चक्रं विनाशयेत्

*dhvajaḥ śasyavināśāya cakraṃ cakraṃ vināśayet*

| |
|---|
| The "banner" [indicates] destruction of the crop. The "wheel" destroys the dominion (*cakram*; or: the military array). |

–

उदयास्तमयस्तौ तु यदा शुक्रबृहस्पती

पूर्वसन्ध्यागतौ घोरौ जनयेतां महद्भयम्

*udayāstamayastau tu yadā śukrabṛhaspatī*
*pūrvasandhyāgatau ghorau janayetāṃ mahadbhayam*

| |
|---|
| When Venus and Jupiter stand in the rising or setting,<br>and if they do so in the dawn, then they are terrible and cause great fear/danger. (= "balance"?) |

–

कृत्तिकासु शनैश्चारी विशाखायां बृहस्पतिः

तिष्ठेद्यदा तदा घोरः प्रजानामनयो भवेत्

*kṛttikāsu śanaiścārī viśākhāyāṃ bṛhaspatiḥ*
*tiṣṭhedyadā tadā ghoraḥ prajānāmanayo bhavet*

| |
|---|
| When Saturn stands in Kṛttikā and Jupiter in Viśākhā,<br>then there will be terrible calamity for the living beings. (= "bow"?) |

→

एकनक्षत्रमाश्रित्य दृश्येतां युगपद्यदि

अन्योन्यभेदं जानीयात्तदा पुरनिवासिनाम्

*ekanakṣatramāśritya dṛśyetāṃ yugapadyadi*
*anyonyabhedaṃ jānīyāttadā puranivāsinām*

| |
|---|
| When the two are seen at the same time in one and the same lunar mansion, then one has to know that the inhabitants of cities get into discord with each other. |

–

एकेन यदि वा द्वाभ्यां ग्रहाभ्यां सहितो गुरुः

शनैश्चरो वा दृश्यते कोपवत्फलमादिशेत्

*ekena yadi vā dvābhyāṃ grahābhyāṃ sahito guruḥ*
*śanaiścaro vā dṛśyate kopavatphalamādiśet*

| |
|---|
| When Jupiter or Saturn are seen together with one or two other planets, then this will indicate a result similar to that of [the configuration called] "anger". |

–

The following verses are of particular interest for this investigation:

पुरस्ताद्यत्र दृश्यन्ते पञ्चताराग्रहा दिवि

प्रकाशन्ते ध्वजाग्राणि पार्थिवानां युयुत्सताम्

***purastādyatra dṛśyante pañcatārāgrahā divi***
***prakāśante dhvajāgrāṇi pārthivānāṃ yuyutsatām***

| |
|---|
| **When the five planets are seen in the east in the sky<br>and they appear as the top of a "banner", [then this indicates] pugnaciousness of the earthlings (or: kings).** |

This is exactly the configuration that is described in the Mahābhārata. The planets are all visible in the eastern morning sky. It is phase 3 of a super-conjunction.

यदा सर्वे समागम्य मध्ये तिष्ठन्ति दारुणम्

तत्रापि देशाः पीद्यन्ते मध्यदेशो विशेषतः

***yadā sarve samāgamya madhye tiṣṭhanti dāruṇam***
***tatrāpi deśāḥ pīdyante madhyadeśo viśeṣataḥ***

| |
|---|
| **When they all come together and stand in the middle [of the sky], then [this indicates] horror.<br>Then also the lands will be oppressed, and especially Madhyadeśa.** |

This verse refers to phase 2 of a super-conjunction. All planets are in conjunction with the Sun and concealed in his light. The configuration is assigned to the time of noon (as phase 3 belongs to the morning and phase 1 to the evening). Madhyadeśa is the North Indian "middle land" between the Himālaya und the Vindhya mountain range. *This is the region where the Mahābhārata War took place.*

यदा सर्वे समागम्य मध्ये तिष्ठन्ति दारुणम्

तत्रापि देशाः पीद्यन्ते मध्यदेशो विशेषतः

***pratīcyāṃ yatra dṛśyante pañca te divicāriṇaḥ***
***kṣubhyate pṛthivī sarvā na ca śastraṃ prakupyati***

**When the five celestial wanderers are seen in the west,**
**then the whole earth is shaken, and no weapon is raised in anger.**

This is obviously phase 1 of a super-conjunction. All five planets are seen in the evening sky.

Another passage of similar content quoted by Vallālasena is taken from the Viṣṇudharmottarapurāṇa:

पूर्वस्यां यदि दृश्यन्ते सर्वेताराग्रहा यदि

प्राच्यानां तु तदा राज्ञां भवेत्पीडा च दारुणा

*pūrvasyāṃ yadi dṛśyante sarve tārāgrahā yadi*
*prācyānāṃ tu tadā rājñāṃ bhavetpīḍā ca dāruṇā*

When all planets are seen in the east,
then there will be terrible oppression for eastern kings.

मध्येन यदि दृश्यन्ते मध्यदेशो विनश्यति

वारुण्यां यदि दृश्यन्ते तां दिशं पीडयन्ति ते

*madhyena yadi dṛśyante madhyadeśo vinaśyati*
*vāruṇyāṃ yadi dṛśyante tāṃ diśaṃ pīḍayanti te*

When they are seen in the middle [of the sky], then *Madhyadeśa* is destroyed.
When they are seen in the west, then they oppress this [western] region.

Varāhamihira in *Bṛhatsaṃhitā* 20.1 says:

यस्यां दिशि दृश्यन्ते विशन्ति ताराग्रहा रविं सर्वे

भवति भयं दिशि तस्यामायुधकोपक्षुधातङ्कैः

*yasyāṃ diśi dṛśyante viśanti tārāgrahā raviṃ sarve*
*bhavati bhayaṃ diśi tasyāmāyudhakopakṣudhātaṅkaiḥ (BS 20.1)*

In the direction where all planets are seen [and] enter [the light of] the Sun,
in this direction there is danger/fear of weapons, anger, hunger, and disease.

R. Bhat gives a more liberal, yet quite appropriate, translation:

> The direction in which all the non-luminaries become visible after they emerge from combustion, or are eclipsed by the sun will be afflicted with famine, war and disease.

It could be objected, however, that the verse also includes the *evening* clustering which takes place *before* the planets enter the light of the Sun.

Very interesting are the following verses from Kāśyapa's work, which are taken from R. Bhat's translation of Bṛhatsaṃhitā:

भूमिपुत्रादयः सर्वे यस्यामस्तमिते रवौ

दृश्यन्तेऽस्तमये वापि यत्र यान्ति रवेस्ततः

दुर्भिक्षं शस्त्रकोपं च जनानां मरकं भवेत्

अन्योन्यं भूमिपाः सर्वे विनिघ्नन्ति प्रजास्तथा

*bhūmiputrādayaḥ sarve yasyāmastamite ravau*
*dṛśyante'stamaye vāpi yatra yānti ravestataḥ*
*durbhikṣaṃ śastrakopaṃ ca janānāṃ marakaṃ bhavet*
*anyonyaṃ bhūmipāḥ sarve vinighnanti prajāstathā*

> In the [direction] where Mars and all the other [planets] are seen after sunset or where they go at the time of sunset,
> there will be famine, raging of weapons, and dying of men;
> all kings kill each other, and also all living beings.

There can be hardly a doubt that this description refers to the catastrophic events at the end of a *yuga*, and therefore to the Mahābhārata War.

Another passage in Bṛhatsaṃhitā concerning the different types of super-conjunctions reads as follows:

यस्मिन्खांशे दृश्या ग्रहमाला दिनकरे दिनान्तगते

तत्रान्यो भवति नृपः परचक्रोपद्रवश्च महान्

*yasminkhāṃśe dṛśyā grahamālā dinakare dināntagate*
*tatrānyo bhavati nṛpaḥ paracakropadravaśca mahān (BS 20.3)*

> In which part of the sky a garland of planets is seen after the Sun has reached the end of the day,
> in that direction there is a new king and a great enemy army approaching.

तस्मिन्नृक्षे (var. यस्मिन्नृक्षे) कुर्युः समागमं तज्जनान्ग्रहा हन्युः

अविभेदिनः (var. अविभेदनाः) परस्परममलमयूखाः शिवास्तेषाम् (4)

*tasminn[var. yasminn]ṛkṣe kuryuḥ samāgamaṃ tajjanāngrahā hanyuḥ*
*avibhedinaḥ[var.avibhedanāḥ] parasparamamalamayūkhāḥ śivāsteṣām (4)*

When the planets make a conjunction in a particular lunar mansion, then they will kill the people [ruled] by that [lunar mansion].
When [the planets] are without discord with each other and of immaculate sparkle, then they are auspicious for the same [people].

...

एकर्क्षे चत्वारः सह पौरैर्यायिनोऽथ वा पञ्च

संवर्तो नाम भवेच्छिखिराहुयुतः स सम्मोहः (6)

*ekarkṣe catvāraḥ saha paurairyāyino'tha vā pañca*
*saṃvarto nāma bhavecchikhirāhuyutaḥ sa sammohaḥ (6)*

When four or five defending or marching [planets] are in one and the same lunar mansion,
then this is called an "assembly" (*saṃvartaḥ*). When it is combined with a comet (*śikhī*) or Rāhu, then it is [called] a "folly/battle" (*sammohaḥ*).

...

समौ तु संवर्तसमागमाख्यौ सम्मोहकोशौ भयदौ प्रजानाम्

*samau tu saṃvartasamāgamākhyau sammohakośau bhayadau prajānām (9ab)*

"Assembly" and "conjunction" are moderate. [However] "folly/battle" and "accumulation" give danger/fear to the people.

During the Mahābhārata War, as shall be seen, a case of "folly/ battle" (*sammohaḥ*) is given, because Rāhu and Ketu form part of the conjunction.

In another work by Varāhamihira, titled *Samāsasaṃhitā*, which unfortunately is extant only in fragments, it is stated:

सर्वे यदा दिनकरं विशन्ति कुर्युर्ग्रहास्तद पीडाम्

क्षुच्छस्त्रभयातङ्कैरपरैश्च परस्पराघातैः

*sarve yadā dinakaraṃ viśanti kuryurgrahāstada pīḍām*
*kṣucchastrabhayātaṅkairaparaiśca parasparāghātaiḥ*

When all planets enter the Sun, then they might cause oppression
by hunger, by danger of weapon, by disease and other things that lead to mutual killing.

प्रत्यर्चिषः प्रसन्नाः सम्भृतकिरणाः प्रदक्षिणावर्ताः

सस्निग्धामलतनवः क्षेमसुभिक्षावहास्ते स्युः

*pratyarciṣaḥ prasannāḥ sambhṛtakiraṇāḥ pradakṣiṇāvartāḥ*
*sasnigdhāmalatanavaḥ kṣemasubhikṣāvahāste syuḥ*

| |
|---|
| [However, if they are] luminous, bright, full of rays, in right-handed circumambulation,<br>of kind and impeccable nature, then they will bring security and food. |

Here the criterion for whether a super-conjunction will be auspicious or inauspicious seems to be whether or not the planets are visible. When they surround the Sun and are invisible, then the prediction is apparently inauspicious. However, when they are visible around the Moon, then the prediction seems to be auspicious. Of course, this view is in contradiction with some of the quotations given further above.

In Atharvavedapariśiṣṭa, the following two verses refer to super-conjunctions[77]:

सर्वेषां नभसि समागमे ग्रहाणाम्

उत्कृष्टो भवति तथैव रश्मिवान्यः

स्निग्धत्वं भवति तु यस्य [स ग्रहो ग्रहेण]    (संजयेन ?)

(AS: स्निग्धत्वं भवति च स ग्रहो जयेन)

संयुक्तो भवति [तु यः] पराजयेत शेषः

(AS: संयुक्तो भवति तु यः पराजयेन)

*sarveṣāṃ nabhasi samāgame grahāṇām*
*utkṛṣṭo bhavati tathaiva raśmivānyaḥ*
*snigdhatvaṃ bhavati tu yasya [sa graho graheṇa][78]   (saṃjayena ?)*
*(AS: snigdhatvaṃ bhavati ca sa graho jayena)*
*saṃyukto bhavati [tu yaḥ] parājayeta śeṣaḥ (AVP 51.2.5)*
*(AS: saṃyukto bhavati tu yaḥ parājayena)*

→

[77] The text is taken from the edition of Bolling and Negelein, p. 351. The variant AS is found in Vallālasena's *Adbhutasāgara* (*grahayuddhādyadbhutāvarttaḥ*), on p. 209 in the edition of Murali Dhara Jha.

[78] Bolling/Negelein comment: "those words have come from the close of the next verse, supplanting: saṃjayena", p. 353.

When during a conjunction of all planets in the sky
one of them stands out in brightness,
then this planet is auspicious for him [to whom it is astrologically assigned].
(var.: then this planet is auspicious by virtue of victory.)
But the rest [of the planets] that is in conjunction will be defeated.
(var.: But [a planet] that is in conjunction [is auspicious] by virtue of defeat.)

बुधश्च भौमः शनिभार्गवाङ्गिराः

प्रदक्षिणं याति यदा निशाकरम् । (var. यान्ति !, var. तदा)

अनामयत्वं त्रिषु सौख्यमुत्तमं (तेषु ?)

विपर्यये चापि महाञ्जनक्षयः

*budhaśca bhaumaḥ śanibhārgavāṅgirāḥ*
*pradakṣiṇaṃ yāti yadā niśākaram |* *(var. yānti !, var. tadā)*
*anāmayatvaṃ triṣu saukhyamuttamaṃ* *(teṣu ?)*
*viparyaye cāpi mahāñjanakṣayaḥ (AVP 51.3.2)*

When Mercury, Mars, Saturn, Venus, and Jupiter
make a right-handed circumambulation around the Moon,
then there is absence of suffering and greatest happiness.
In the opposite case, however, there is a great destruction of people.

Judging from visual perception, a right-handed circumambulation would probably be given when the Moon passes the planets to the south. However, Vṛddhagarga and Ṛṣiputra define it the other way around.[79] However that may be, the text clearly shows the association of the super-conjunction with the disastrous end of the yuga.

*To conclude it can be stated that ancient astrologers, other than many modern authors, believed that the Mahābhārata War took place at the time of a super-conjunction.*

## The Super-Conjunction of 1198 BCE

Returning to the astronomical descriptions given in the Mahābhārata, it states that the planets fly together to the Sun and later re-emerge from it. In addition, there is mention of a day on which all planets were seen in conjunction with the Moon before sunrise in the eastern morning sky. If these observations are taken seriously, then the great war took place near a super-conjunction of type A

[79] vide Bhat, *Varāhamihira's Bṛhatsaṃhitā*, p. 206.

with pronounced phases 2 and 3. There is no support in the text for phase 1. It seems there was no evening conjunction of all planets before they entered the light of the Sun.

Can a date for the grand war be deduced on the basis of these facts alone? The possibility exists, as type A super-conjunctions are extremely rare. Two lists of super-conjunctions can be noted in the appendix: the first one contains conjunctions, where a new moon took place while the planets were imperceptible, the second one lists conjunctions that did not take place during a new moon phase. Overall, there were about 39 super-conjunctions during the period from 4000 BCE to the year 0, of which 21 occurred during a new moon. An atmospheric extinction coefficient k=0.3 was used for calculation, thus extremely clear skies were not assumed. With very good visibility, the number of super-conjunctions would be reduced even further. Among the conjunctions found, 33 were type B, and only six of them were type A, of which only four occurred during a new moon.

If it is necessary that phase 2 of the super-conjunction be followed by a startling phase 3 (where all planets were visible with the Moon in the morning sky), then only two candidates remain:

1. During the new moon of 8th September, 2966 BCE, the planets were not visible for approximately 11 days. On the morning of 4th November, nearly two months after the super-conjunction had ended, all the planets could be seen with the crescent of the old moon before sunrise in the eastern sky, scattered over an area of approximately 32°.

2. During the new moon of 21st October, 1198 BCE, the planets were also imperceptible for 11 days. On the morning of 18th November, just before sunrise, all the planets were also visible with the crescent of the old moon in the eastern sky, scattered over a range of only 19°.

To decide which of these is most suitable, further information is required, which will be elaborated later. Since the Mahābhārata mentions a lunar eclipse in the month Kārttika and a solar eclipse which occurred during a new moon in Jyeṣṭhā, it must be examined whether these events could have taken place around the same time as one of the two super-conjunctions.

The super-conjunction of 2966 BCE does not meet this criterion, as the new moon of 8th September occurred in Citrā, and the full moon before and after it, took place in Revatī and Bharaṇī. Also neither a solar or lunar eclipse took place at either of these times. The lunar eclipses in October and November were penumbral and therefore not perceivable to the human eye. If a massive error is assumed in current estimates of ΔT for that period, there is a small possibility that a partial solar eclipse took place on 6th November, however in the lunar mansion Mūla, which does not conform to the required criteria.

In contrast, the super-conjunction of 1198 BCE meets the required conditions amazingly well. The new moon on 21st October occurred in Anurādhā, not far from the star Jyeṣṭhā (Antares). The full moon before and after it occurred in Bharaṇī and Rohiṇī. A solar eclipse did occur during the new moon at a magnitude of 87%. The full moon in Rohiṇī – thus assigned to the month Kārttika – was a lunar eclipse with a magnitude of 71%. The super-conjunction of 1198 BCE thus accords incredibly well with the information given in the Mahābhārata. One must keep in mind how extremely small the probability was that one of the two possible super-conjunctions was accompanied by eclipses in the exact areas in the sky mentioned. This is quite unexpected.

## Moon in Maghā?

A problem arises from the position of the Moon mentioned in the following verse, which appears in the description of the astronomical occurrences shortly before the great battle:

> मघाविषयगः सोमस्तद्दिनं प्रत्यपद्यत (var. प्रत्यदृश्यत)
>
> दीप्यमानाश्च संपेतुर्दिवि सप्त महाग्रहाः
>
> *maghāviṣayagaḥ somastaddinaṃ pratyapadyata* (var. *pratyadṛśyata*)
> *dīpyamānāśca saṃpeturdivi sapta mahāgrahāḥ (MBh 6.17.2)*

| |
|---|
| On that day, the Moon god (Soma) entered the region of Maghā.<br>The seven great planets burned in the sky and flew together. |

Here, the Moon seems to be in the lunar mansion Maghā. The verse suggests that the planets gather around the Moon in the *nakṣatra*

Maghā. However, this interpretation is not consistent with any of the two super-conjunctions mentioned above, which occurred near Citrā and Anurādhā, quite far from Maghā. It is also incompatible with the stated eclipses in Jyeṣṭhā and during the month of Kārttika that should have occurred at the time of the super-conjunction.

Now the verb *pratyapadyata*, "he entered", could also refer to a *pratipad*, i.e. to the first day after the astronomical new moon or full moon. However, a convergence of all the planets around the Moon can only occur with the *pratipad* of a *new moon*, because the convergence includes Mercury and Venus, both of which are always close to the Sun. Thus a clustering about the Moon on *pratipad* can only occur in the western evening sky, after the first appearance of the new crescent moon. In contrast, a convergence on the day after a full moon, thus in opposition to the Sun, is impossible because Mercury and Venus must remain in close proximity to the Sun. Thus, assuming a clustering on a new moon evening, the verse would translate as follows:

> On this day, the [new crescent of the] Moon emerged in the region of Maghā.
> The seven great planets burned in the sky and flew together.

Not that this interpretation is compulsory. Nīlakaṇṭha and Ganguli do not take it into consideration.[80] Still, it seems a reasonable deduction. The verse could then describe one of the following two configurations:

1. It could have been phase 2 of a super-conjunction, where all planets disappeared in the glare of the Sun near the day a new crescent moon appeared in Maghā. There are two dates satisfying the condition: 14th June 1973 BCE and 29th June 1296 BCE. The super-conjunction of 1973 BCE was also rare type A. Unfortunately, however, it is not followed by a pronounced phase 3. Nor was it accompanied by eclipses as described in the text.

2. It could have been phase 1 of a super-conjunction, where the planets gathered around the Moon in the western evening sky.

[80] Ganguli translates the verse as follows: "On that day on which the battle commenced Soma approached (*pratyapadyata*, D. K.) the region of Pitris. The seven large planets, as they appeared in the firmament, all looked blazing like fire." (p. 38; http://www.sacred-texts.com/hin/m06/m06017.htm)

> However, a conspicuous phase 3 would also be required to adhere to the necessary criteria. Unfortunately, as stated earlier, a pronounced phase 1 is never accompanied by both phases 2 and 3. Two super-conjunctions were found that were type A and had pronounced phases 2 and 3, but in both cases, phase 1 was not so "conspicuous" that it could be referred to as a "gathering" of the planets around the Moon. Although on 28th June, 1198 BCE the new crescent moon was in Magha, Mercury was invisible, and the other planets and Moon were dispersed over a fairly wide range of 74°. It was not really a "clustering of planets". Also on the other date considered, 12th/13th June, 2966 BCE the situation was no better.

The occurrence of the first crescent or *pratipad* in Maghā thus does not lead to a sensible solution.

Is there another possible solution? The appendix to this verse in the critical edition shows that there are a number of very different variants for the first two syllables (*maghā-*), whereas the subsequent wording is common to almost all manuscripts. It seems that the beginning of the verse is corrupt and that the text originally did not mention the word *maghā*. A very interesting solution is provided by the variant *tathāviṣayagaḥ*, which would lead to the following translation:

> तथाविषयगः सोमस्तद्दिनं प्रत्यपद्यत (var. प्रत्यदृश्यत)
>
> *tathāviṣayagaḥ somastaddinaṃ pratyapadyata* (var. *pratyadṛśyata*)
>
> And the Moon, who had entered invisibility, emerged [again] on that day.

Thus the war would have begun on the first day after the astronomical new moon, but not necessarily in Maghā. Hence it may be wrong to attach too much importance to the statement concerning the Moon in Maghā.

The following fact is interesting to note, though. On 13th October 1198 BCE, Venus was the final planet to disappear in the glare of the Sun, thereby perfecting the super-conjunction. On the same day, the Moon happened to be in the lunar mansion Maghā. Could this be the intended meaning of the verse? If so, the seventh planet could not have been the Moon but Rāhu.

## Another Super-Conjunction at the Death of Kṛṣṇa?

As has been illustrated, The Mahābhārata epic contains clear evidence that a super-conjunction of all planets took place at the time of the great war. However, the traditional belief amongst Hindu astrologers is that a super-conjunction did not occur in the year of the war, but 36 years later, in the year when Kṛṣṇa died and the *kaliyuga* began. The date given for this event is 17th/18th February 3102 BCE. The astronomical configuration for this traditionally accepted *kaliyuga* date will be examined shortly. However, it should first be considered whether a super-conjunction 36 years after the war could be derived from textual evidence within the Mahābhārata itself.

To begin with, the Mahābhārata itself states that the super-conjunction and the transition from *dvāparayuga* to *kaliyuga* took place during the year of the war. This is evident from the following verse:

अन्तरे चैव संप्राप्ते कलिद्वापरयोरभूत्

समन्तपञ्चके युद्धं कुरुपाण्डवसेनयोः

*antare caiva samprāpte kalidvāparayorabhūt*
*samantapañcake yuddhaṃ kurupāṇḍavasenayoḥ (MBh 1.2.91)*

When the transition of Kali and Dvāpara arrived,
the battle between the two armies of the Kurus and Pāṇḍavas took place in Kurukṣetra (Samantapañcaka).

Another passage reads as follows:

यदा द्रक्ष्यसि संग्रामे श्वेताश्वं कृष्णसारथिम्

ऐन्द्रमस्त्रं विकुर्वाणमुभे चैवाग्निमारुते

*yadā drakṣyasi saṃgrāme śvetāśvaṃ kṛṣṇasārathim*
*aindramastraṃ vikurvāṇamubhe caivāgnimārute (MBh 5.140(142).6)*

When you see [Arjuna] in battle with white horses, with Kṛṣṇa as his charioteer,
wielding the weapons of Indra, Agni, and the Maruts,

गाण्डीवस्य च निर्घोषं विस्फूर्जितमिवाशनेः

न तदा भविता त्रेता न कृतं द्वापरं न च

*gāṇḍīvasya ca nirghoṣaṃ visphūrjitamivāśaneḥ*
*na tadā bhavitā tretā na kṛtaṃ dvāparaṃ na ca (7)*

and the thunder-like roaring sound of [his bow] Gaṇḍīva,
then *tretā-*, *kṛta-*, and *dvāparayuga* will be over.

यदा द्रक्ष्यसि संग्रामे कुन्तीपुत्रं युधिष्ठिरम्

जपहोमसमायुक्तं स्वां रक्षन्तं महाचमूम्

*yadā drakṣyasi saṃgrāme kuntīputraṃ yudhiṣṭhiram*
*japahomasamāyuktaṃ svāṃ rakṣantaṃ mahācamūm (8)*

When you see Kuntī's son Yudhiṣṭhira in battle,
devoted to Japa and Homa and supervising his own large army,

आदित्यमिव दुर्धर्षं तपन्तं शत्रुवाहिनीम्

न तदा भविता त्रेता न कृतं द्वापरं न च

*ādityamiva durdharṣaṃ tapantaṃ śatruvāhinīm*
*na tadā bhavitā tretā na kṛtaṃ dvāparaṃ na ca (9)*

who, like the Sun, is invincible [and] burns the army of the enemies,
then *tretā-*, *kṛta-*, and *dvāparayuga* will be over.

यदा द्रक्ष्यसि संग्रामे भीमसेनं महाबलम्

*yadā drakṣyasi saṃgrāme bhīmasenaṃ mahābalam ...*

When you see Bhīmasena empowered in battle ... (10)

And another verse:

उन्मत्तमकरावर्तौ महाग्राहसमाकुलौ

युगान्ते समुपेतौ द्वौ दृश्येते सागराविव

*unmattamakarāvartau mahāgrāhasamākulau*
*yugānte samupetau dvau dṛśyete sāgarāviva (MBh 6.16.45)*

The two armies resemble two oceans that flow together at the end of the age,
that are churned up by wild sea monsters, and abound with huge crocodiles.

And on the 18th day of the battle, Kṛṣṇa says to Balarāma:

प्राप्तं कलियुगं विद्धि

*prāptaṃ kaliyugaṃ viddhi (MBh 9.59(60).21a)*

... know that the Kali age has arrived.

The "contradiction" between the astronomical tradition and the Mahābhārata can perhaps be explained by the fact that the transition between the *yugas* is considered to extend over a longer period of time, the so-called "dawn" (*saṃdhiḥ*) of the ages. However, it is impossible that a gathering of planets lasts over a period of 36 years. Nor do celestial mechanics permit another such super-conjunction to occur 36 years after a super-conjunction, where all planets disappear in the light of the Sun. An interval of at least 38 years is necessary. This is because Jupiter-Saturn conjunctions, which are always included in a super-conjunction, happen only once every 20 years, and also because Mars and the other planets must accidentally accompany them.

The question arises whether the Mahābhārata narrative also provides evidence of a *second* super-conjunction that would have occurred almost four decades after the war around the day of Kṛṣṇas demise.

It is interesting that in the 16th book of the Mahābhārata, shortly before the death of Kṛṣṇa, similar omens occurred as have been described for the year leading up to the great war:

षट्त्रिंशे त्वथ संप्राप्ते वर्षे कौरवनन्दन

ददर्श विपरीतानि निमित्तानि युधिष्ठिरः

*ṣaṭtriṃśe tvatha saṃprāpte varṣe kauravanandana*
*dadarśa viparītāni nimittāni yudhiṣṭhiraḥ MBh 16.1.1*

When the 36th year arrived, O joy of the Kurus,
Yudhiṣṭhira saw inauspicious omens.

ववुर्वाताः सनिर्घाता रूक्षाः शर्करवर्षिणः

अपसव्यानि शकुना मण्डलानि प्रचक्रिरे

*vavurvātāḥ sanirghātā rūkṣāḥ śarkaravarṣiṇaḥ*
*apasavyāni śakunā maṇḍalāni pracakrire MBh 16.1.2*

The winds blew in tempests, dry and raining gravel.
The birds circumambulated to the right.

प्रत्यगूहुर्महानद्यो दिशो नीहारसंवृताः

उल्काश्चाङ्गारवर्षिण्यः प्रपेतुर्गगनाद्भुवि

*pratyagūhurmahānadyo diśo nīhārasaṃvṛtāḥ*
*ulkāścāṅgāravarṣiṇyaḥ prapeturgaganādbhuvi MBh 16.1.3*

The great rivers flowed backwards. The [four] directions were shrouded in mist.
Meteors descended bringing rain of coal from the sky onto the earth.

आदित्यो रजसा राजन्समवच्छन्नमण्डलः

विरश्मिरुदये नित्यं कबन्धैः समदृश्यत

*ādityo rajasā rājansamavacchannamaṇḍalaḥ*
*viraśmirudaye nityaṃ kabandhaiḥ samadṛśyata MBh 16.1.4*

The Sun disk was shrouded in haze, O king.
He was constantly without rays at sunrise and was seen vesseled in clouds.

परिवेषाश्च दृश्यन्ते दारुणाश्चन्द्रसूर्ययोः

त्रिवर्णाः श्यामरूक्षान्तास्तथा भस्मारुणप्रभाः

*pariveṣāśca dṛśyante dāruṇāścandrasūryayoḥ*
*trivarṇāḥ śyāmarūkṣāntāstathā bhasmāruṇaprabhāḥ MBh 16.1.5*

Terrifying halos were seen around both the Moon and Sun,
in three colours with black and harsh edges, with devouring reddish light.

एते चान्ये च बहव उत्पाता भयशंसिनः

दृश्यन्तेऽहरहो राजन्हृदयोद्वेगकारकाः

*ete cānye ca bahava utpātā bhayaśaṃsinaḥ*
*dṛśyante 'haraho rājanhṛdayodvegakārakāḥ MBh 16.1.6*

These and many other incidences that indicated danger/fear,
are seen day after day, O king, that cause agitation to the heart.

There is no mention of planets in this passage. It is interesting, however, that the omens described are very similar to those that occur shortly before the great battle. The only thing that is missing is the mention of the super-conjunction. However, it can be found in a related text. In Bhāgavatapurāṇa 1.14.17 it says:

सूर्यं हतप्रभं पश्य ग्रहमर्दं मिथो दिवि

ससङ्कुलैर्भूतगणैर्ज्वलिते इव रोदसी

*sūryaṃ hataprabhaṃ paśya grahamardaṃ mitho divi*
*sasaṅkulairbhūtagaṇairjvalite iva rodasī* (BhP 1.14.17)

See, the glare of the Sun is destroyed, the planets gather together in the sky. Sky and earth are set on fire, as it were, by the host of living beings that are [entangled] in battle.

The burning of the sky and the earth might allude to the reddish evening or morning sky, above which the gathering of planets could be seen. However, it seems that in reality this text is referring to the super-conjunction which occurred during the war. It is likely that the super-conjunctions during the war and the one at the time of Kṛṣṇa's death were one and the same.

In MBh 16.5(4), the death of Kṛṣṇa in the forest is described as follows:

स संनिरुद्धेन्द्रियवाङ्मनास्तु शिश्ये महायोगमुपेत्य कृष्णः

जराथ तं देशं उपाजगाम लुब्धस्तदानीं मृगलिप्सुरुग्रः

*sa saṃniruddhendriyavāṅmanāstu*
*śiśye mahāyogamupetya kṛṣṇaḥ*
*jarātha taṃ deśaṃ upājagāma*
*lubdhastadānīṃ mṛgalipsurugraḥ (MBh 16.5(4).19)*

After he had withdrawn his senses, speech, and mind,
had laid himself down and gone into *mahāyoga*,
Jara came to this place
at the same time, greedy, desirous of a deer, impetuous. (19)

स केशवं योगयुक्तं शयानं मृगाशङ्की लुब्धकः सायकेन

जराविध्यत्पादतले त्वरावांस्तं चाभितस्तज्जिघृक्षुर्जगाम

*sa keśavaṃ yogayuktaṃ śayānaṃ*
*mṛgāśaṅkī lubdhakaḥ sāyakena*
*jarāvidhyatpādatale tvarāvāṃs*
*taṃ cābhitastajjighṛkṣurjagāma (20)*

Lying there in *yoga*, Kṛṣṇa
was taken as a deer by the greedy Jara.
He pierced the sole of his foot with an arrow
and swiftly went to him, wanting to catch the [deer]. (20)

मत्वात्मानमपराद्धं स तस्य जग्राह पादौ शिरसा चार्तरूपः

आश्वासयत्तं महात्मा तदानीं गच्छन्नूर्ध्वं रोदसी व्याप्य लक्ष्म्या

*matvātmānamaparāddhaṃ sa tasya*
*jagrāha pādau śirasā cārtarūpaḥ*
*āśvāsayattaṃ mahātmā tadānīṃ*
*gacchannūrdhvaṃ rodasī vyāpya lakṣmyā (21)*

Thinking he had sinned,
he touched (Kṛṣṇa's) feet with his head, his appearance full of pain.
Then the Great Self consoled him,
rising up and pervading heaven and earth with beauty.

दिवं प्राप्तं वासवोऽथाश्विनौ च रुद्रादित्या वसवश्चाथ विश्वे

प्रत्युद्ययुर्मुनयश्चापि सिद्धा गन्धर्वमुख्याश्च सहाप्सरोभिः

*divaṃ prāptaṃ vāsavo 'thāśvinau ca*
*rudrādityā vasavaścātha viśve*
*pratyudyayurmunayaścāpi siddhā*
*gandharvamukhyāśca sahāpsarobhiḥ (22)*

When he reached the sky, the Vasus, the Aśvins,
the Rudras, Ādityas, Vasus and Viśvedevas,
rose towards him, and the sages and siddhas
and the foremost of the Gandharvas with the Apsaras.

ततो राजन्भगवानुग्रतेजा नारायणः प्रभवश्चाव्ययश्च

योगाचार्यो रोदसी व्याप्य लक्ष्म्या स्थानं प्राप स्वं महात्माप्रमेयम्

*tato rājanbhagavānugratejā*
*nārāyaṇaḥ prabhavaścāvyayaśca*
*yogācāryo rodasī vyāpya lakṣmyā*
*sthānaṃ prāpa svaṃ mahātmāprameyam (23)*

Then O king, the holy one, with terrible glare,
Nārāyaṇa (Kṛṣṇa), the origin and the imperishable one,
the teacher of *yoga*, pervaded heaven and earth with beauty;
the Great Self arrived at his own immeasurable abode.

ततो देवैर्ऋषिभिश्चापि कृष्णः समागतश्चारणैश्चैव राजन्

गन्धर्वाग्र्यैरप्सरोभिर्वराभिः सिद्धैः साध्यैश्चानतैः पूज्यमानः

*tato devairṛṣibhiścāpi kṛṣṇaḥ*
*samāgataścāraṇaiścaiva rājan*
*gandharvāgryairapsarobhirvarābhiḥ*
*siddhaiḥ sādhyaiścānataiḥ pūjyamānaḥ (24)*

Then Kṛṣṇa joined the gods and the Ṛṣis
and the Cāraṇas, O king,
worshipped by the foremost of the Gandharvas, the best Apsarās,
the Siddhas, Sādhyas and Cānatas.

ते वै देवाः प्रत्यनन्दन्त राजन्मुनिश्रेष्ठा वाग्भिरानर्चुरीशम्

(ins. B6 शिवब्रह्माद्यैर्लोकपालैः समेत्य संस्तूयमानः सुरसिद्धसंघैः)

गन्धर्वाश्चाप्युपतस्थुः स्तुवन्तः प्रीत्या चैनं पुरुहूतोऽभ्यनन्दत्

*te vai devāḥ pratyanandanta rājan*
*muniśreṣṭhā vāgbhirānarcurīśam*
(ins. B6 *śivabrahmādyairlokapālaiḥ sametya*
*saṃstūyamānaḥ surasiddhasaṃghaiḥ*)
*gandharvāścāpyupatasthuḥ stuvantaḥ*
*prītyā cainaṃ puruhūto 'bhyanandat (25)*

These gods welcomed him, O king.
The best of the sages praised him as the lord with their words.
(B6: after he had united with the kings of the world, Śiva, Brahmā etc.,
praised by the hosts of the gods and siddhas.)
The Gandharvas awaited him with praises,
and Indra welcomed him lovingly.

Although a conjunction of the planets is not mentioned, the text gives the impression that there are some astronomical occurrences. Kṛṣṇa *rose to the sky* and filled heaven and earth with beauty. After that a considerable number of superhuman beings are mentioned that *"rose towards him*" (*pratyudyayur*). Could this have a deeper meaning? Could it be a mythological representation of a super-conjunction and a synchronous heliacal rising of all planets?

If so, what then would Kṛṣṇa represent? The Moon? The verses from Harivaṃśa quoted further above describe how the planets gathered around the Moon. Perhaps Kṛṣṇa represents the last crescent of the Moon that rose in the morning, and the planets made their heliacal rising "towards him". When holy or powerful beings gather about their leader, then this is often compared to a clustering of the planets around the Moon. The same theme can be found in the following verse from the Bhāgavatapurāṇa. Śuka, the son of Vyāsa, gives a lesson to King Parīkṣit while being surrounded by many Ṛṣis:

स संवृतस्तत्र महान्महीयसां ब्रह्मर्षिराजर्षिदेवर्षिसङ्घैः

व्यरोचतालं भगवान्यथेन्दुर्ग्रहर्क्षतारानिकरैः परीतः

*sa saṃvṛtastatra mahānmahīyasāṃ brahmarṣirājarṣidevarṣisaṅghaiḥ vyarocatālaṃ bhagavānyathendurgraharkṣatārānikaraiḥ parītaḥ (BhP 1.19.30)*

| |
|---|
| Surrounded by the hosts of the Brahmarṣis, Rājarṣis and Devarṣis, himself being the greatest amongst the greatest,<br>the Holy One (Śuka) shone like the Moon, when multitudes of planets and the stars of the lunar mansions engulf him. |

This verse might indeed allude to the configuration that took place at the beginning of *kaliyuga*. Parīkṣit is the first king after Yudhi-ṣṭhira, thus the first king of the *kaliyuga*.

A similar description is given at the return of Rāma to Kosala. All people gather about him, and then it can be read that:

पुष्पकस्थो नुतः स्त्रीभिः स्तूयमानश्च वन्दिभिः

विरेजे भगवान्राजन्ग्रहैश्चन्द्र इवोदितः

*puṣpakastho nutaḥ strībhiḥ stūyamānaśca vandibhiḥ*
*vireje bhagavānrājangrahaiścandra ivoditaḥ (BhP 9.10.045)*

| |
|---|
| Sitting in his celestial chariot, praised by women and lauded by bards,<br>the Holy One shone, O king, like the rising Moon [is praised] by the planets. |

And the Bhāgavatapurāṇa says:

सान्त्वयित्वा तु तान्रामः सन्नद्धान्वृष्णिपुङ्गवान्

नैच्छत्कुरूणां वृष्णीनां कलिं कलिमलापहः

*sāntvayitvā tu tānrāmaḥ sannaddhānvṛṣṇipuṅgavān*
*naicchatkurūṇāṃ vṛṣṇīnāṃ kaliṃ kalimalāpahaḥ (BhP 10.68.14)*

Balarāma appeased those Vṛṣṇi men, who were prepared [for battle]; He, who destroys the impurity of the [*yuga* of] quarrel (*kaliḥ*), did not want the quarrel (*kaliḥ*) between the Kurus and the Vṛṣṇis.

जगाम हास्तिनपुरं रथेनादित्यवर्चसा

ब्राह्मणैः कुलवृद्धैश्च वृतश्चन्द्र इव ग्रहैः

*jagāma hāstinapuraṃ rathenādityavarcasā*
*brāhmaṇaiḥ kulavṛddhaiśca vṛtaścandra iva grahaiḥ (BhP 10.68.15)*

He went to Hastināpura with a chariot that shone like the Sun, surrounded by Brahmins and elders of the family, like the Moon [is surrounded] by the planets.

And:

तत्र तत्र तमायान्तं पौरा जानपदा नृप

उपतस्थुः सार्घ्यहस्ता ग्रहैः सूर्यमिवोदितम्

*tatra tatra tamāyāntaṃ paurā jānapadā nṛpa*
*upatasthuḥ sārghyahastā grahaiḥ sūryamivoditam (BhP 10.86.19)*

Wherever he went, O king, the inhabitants of the cities and the country gathered around him with gifts in their hands, like the Sun risen together with the planets.

Also interesting is the following verse from Brahmapurāṇa:

अचन्द्रार्कग्रहा भूमिर्भवेदियमसंशयम्

अपौरवा मही नैव भविष्यति कदाचन

*acandrārkagrahā bhūmirbhavediyamasaṃśayam*
*apauravā mahī naiva bhaviṣyati kadācana (BrP 13.140)*

No doubt this earth might be without moon, sun and planets [at the end of the *yuga*],
however the earth will never be without the sons of Puru.

When all the planets and the Moon are in conjunction with the Sun, it is impossible that the Moon and planets could be visible in the sky. But, why is the Sun surrounded by the planets in both these verses, whereas in the verse before that the Moon is surrounded by them? Astronomically, it does not necessarily make a big difference. It is only shortly before sunrise or shortly after sunset that the planets and the Moon can all be visible clustered together. The Sun is always very close to them. Besides, this kind of conjunction often follows or precedes a conjunction of all planets with the Sun, where they actually disappear in the light of the Sun and become invisible. This is in reference to earlier explanations of the various stages and types of super-conjunctions. Thus when in some places the planets gather around the Sun and in others around the Moon, then this is in relation to the different phases of one and the same super-conjunction.

Reverting to the demise of Kṛṣṇa, another description of his ascension is found in Bhāgavatapurāṇa 11.30 and 31. After Kṛṣṇa was hit by the hunter Jara's arrow, his charioteer Dāruka finds him below a fig tree:

दारुकः कृष्णपदवीमन्विच्छन्नधिगम्य ताम्

वायुं तुलसिकामोदमाघ्रायाभिमुखं ययौ

*dārukaḥ kṛṣṇapadavīmanvicchannadhigamya tām*
*vāyuṃ tulasikāmodamāghrāyābhimukhaṃ yayau (BhP 11.30.41)*

Dāruka looked for the way to Kṛṣṇa and found it:
he could smell the fragrance of Tulasī in the wind and followed it,

तं तत्र तिग्मद्युभिरायुधैर्वृतं ह्यश्वत्थमूले कृतकेतनं पतिम्

स्नेहप्लुतात्मा निपपात पादयो रथादवप्लुत्य सबाष्पलोचनः

*taṃ tatra tigmadyubhirāyudhairvṛtaṃ hyaśvatthamūle kṛtaketanaṃ patim*
*snehaplutātmā nipapāta pādayo rathādavaplutya sabāṣpalocanaḥ (BhP 11.30.42)*

to his lord, who, surrounded by sharp shiny weapons, had set down there at the root of the Aśvattha tree.
Overwhelmed by a flood of love, he fell down to his feet, after he had jumped down from the chariot, his eyes filled with tears.

अपश्यतस्त्वच्चरणाम्बुजं प्रभो दृष्टिः प्रणष्टा तमसि प्रविष्टा

दिशो न जाने न लभे च शान्तिं यथा निशायामुडुपे प्रणष्टे

*apaśyatastvaccaraṇāmbujaṃ prabho dṛṣṭiḥ praṇaṣṭā tamasi praviṣṭā*
*diśo na jāne na labhe ca śāntiṃ yathā niśāyāmuḍupe praṇaṣṭe (BhP 11.30.43)*

"O Lord, when I do not see your lotus feet, then my sight disappears and enters into darkness.
I cannot see the [four] directions and can find no peace, like a night when the Moon has disappeared."

इति ब्रुवति सूते वै रथो गरुडलाञ्छनः

खमुत्पपात राजेन्द्र साश्वध्वज उदीक्षतः

*iti bruvati sūte vai ratho garuḍalāñchanaḥ*
*khamutpapāta rājendra sāśvadhvaja udīkṣataḥ (BhP 11.30.44)*

| |
|---|
| Whilst the charioteer was speaking these words, the chariot with the Garuḍa sign<br>flew up to the sky, O king of kings, in front of Dāruka who was looking upwards. |

तमन्वगच्छन्दिव्यानि विष्णुप्रहरणानि च

तेनातिविस्मितात्मानं सूत आह जनार्दनः

*tamanvagacchandivyāni viṣṇupraharaṇāni ca*
*tenātivismitātmānaṃ sūta āha janārdanaḥ (BhP 11.30.45)*

| |
|---|
| Behind the [chariot] followed the celestial weapons of Viṣṇu.<br>To the charioteer, who was in a state of great astonishment at this [occurrence], spoke Kṛṣṇa: |

Again, this passage seems to talk of astronomical events. After all our considerations, their interpretation is obvious. The Moon has not been visible in the sky the whole night long. When Dāruka complained to his lord about the darkness, the chariot of Kṛṣṇa rises up to the sky. Could the chariot represent the last crescent of the Moon that rose in the eastern morning sky? And could the "sharp shiny weapons" that ascended to the sky behind him be the planets? Before rising, these weapons surrounded Kṛṣṇa. Does this picture symbolise the conjunction of all planets with the Moon and the Sun?

Immediately thereafter, there is talk of an assembly of gods and all kinds of supernatural beings, among which were Brahmā, Śiva and his wife Parvatī:

अथ तत्रागमद्ब्रह्मा भवान्या च समं भवः

महेन्द्रप्रमुखा देवा मुनयः सप्रजेश्वराः

*atha tatrāgamadbrahmā bhavānyā ca samaṃ bhavaḥ*
*mahendrapramukhā devā munayaḥ saprajeśvarāḥ (BhP 11.31.1)*

| |
|---|
| Then Brahmā and Śiva arrived with Parvatī,<br>the gods, lead by the great Indra, the sages together with the lord of the creatures, |

→

पितरः सिद्धगन्धर्वा विद्याधरमहोरगाः

चारणा यक्षरक्षांसि किन्नराप्सरसो द्विजाः

*pitaraḥ siddhagandharvā vidyādharamahoragāḥ*
*cāraṇā yakṣarakṣāṃsi kinnarāpsaraso dvijāḥ (BhP 11.31.2)*

the ancestors, Siddhas and Gandharvas, the Vidyādharas and great Nāgas,
Cāraṇas, Yakṣas and Rakṣās, Kinnaras, Apsaras and twice-born ones,

द्रष्टुकामा भगवतो निर्याणं परमोत्सुकाः

गायन्तश्च गृणन्तश्च शौरेः कर्माणि जन्म च

*draṣṭukāmā bhagavato niryāṇaṃ paramotsukāḥ*
*gāyantaśca gṛṇantaśca śaureḥ karmāṇi janma ca (BhP 11.31.3)*

in their desire to see the ascent of the holy one, and in their longing for the Supreme [Lord],
praising and lauding the deeds and the birth of Kṛṣṇa.

ववृषुः पुष्पवर्षाणि विमानावलिभिर्नभः

कुर्वन्तः सङ्कुलं राजन्भक्त्या परमया युताः

*vavṛṣuḥ puṣpavarṣāṇi vimānāvalibhirnabhaḥ*
*kurvantaḥ saṅkulaṃ rājanbhaktyā paramayā yutāḥ (BhP 11.31.4)*

They released a rain of flowers, while densely filling the sky with the rows of their celestial chariots, O king, filled with the highest devotion.

All sorts of celestial beings gathered around Kṛṣṇa and formed a kind of "conjunction" in the sky. It may also be mentioned, in an analogy to the verses quoted above: "... like the planets and stars gather around the Moon". The host is headed by Brahmā and Śiva. This awakens memories of RV X.141.3 (*brahmāṇaṃ ca bṛhaspatim*), and Brahmā can perhaps be identified with Jupiter (*Bṛhaspati*) and Śiva with Venus (Śukra).

भगवान्पितामहं वीक्ष्य विभूतीरात्मनो विभुः

संयोज्यात्मनि चात्मानं पद्मनेत्रे न्यमीलयत्

*bhagavānpitāmahaṃ vīkṣya vibhūtīrātmano vibhuḥ*
*saṃyojyātmani cātmānaṃ padmanetre nyamīlayat (BhP 11.31.5)*

The holy one looked at the grandfather [Brahmā]; the all-pervading one united the all-pervading powers of his Self,
[uniting] his Self within his Self, and closed his lotus eyes.

→

लोकाभिरामां स्वतनुं धारणाध्यानमङ्गलम्

योगधारणयाग्नेय्या दग्ध्वा धामाविशत्स्वकम्

*lokābhirāmāṃ svatanuṃ dhāraṇādhyānamaṅgalam*
*yogadhāraṇayāgneyyā dagdhvā dhāmāviśatsvakam (BhP 11.31.6)*

| |
|---|
| His own person, that had given pleasure to the world and had been [full of] happiness [based on] concentration and meditation:<br>he burnt it with fire-like yoga concentration and entered his own [true] abode. |

Kṛṣṇa causes his own cremation through the "fire" of his spiritual concentration. Could this mean – on an astronomical level – that the old Moon enters the glare of the Sun and thereby the invisible world? The text continues:

दिवि दुन्दुभयो नेदुः पेतुः सुमनसश्च खात्

सत्यं धर्मो धृतिर्भूमेः कीर्तिः श्रीश्चानु तं ययुः

*divi dundubhayo neduḥ petuḥ sumanasaśca khāt*
*satyaṃ dharmo dhṛtirbhūmeḥ kīrtiḥ śrīścānu taṃ yayuḥ (BhP 11.31.7)*

| |
|---|
| Drums resounded in the sky, and flowers (or: good thoughts) rained from the heights.<br>Truth, duty, firmness, fame, and glory followed him and left the earth. |

देवादयो ब्रह्ममुख्या न विशन्तं स्वधामनि

अविज्ञातगतिं कृष्णं ददृशुश्चातिविस्मिताः

*devādayo brahmamukhyā na viśantaṃ svadhāmani*
*avijñātagatiṃ kṛṣṇaṃ dadṛśuścātivismitāḥ (BhP 11.31.8)*

| |
|---|
| The gods and the other [beings], lead by Brahmā, could not see how Kṛṣṇa, whose path was unknown, entered his own abode, and they were very astonished. |

सौदामन्या यथाकाशे यान्त्या हित्वाभ्रमण्डलम्

गतिर्न लक्ष्यते मर्त्यैस्तथा कृष्णस्य दैवतैः

*saudāmanyā yathākāśe yāntyā hitvābhramaṇḍalam*
*gatirna lakṣyate martyaistathā kṛṣṇasya daivataiḥ (BhP 11.31.9)*

| |
|---|
| As a lightning bolt runs through the sky, leaving behind a circle of clouds,<br>Kṛṣṇa's departure could not be witnessed by mortal deities. |

ब्रह्मरुद्रादयस्ते तु दृष्ट्वा योगगतिं हरेः

विस्मितास्तां प्रशंसन्तः स्वं स्वं लोकं ययुस्तदा

*brahmarudrādayaste tu dṛṣṭvā yogagatiṃ hareḥ*
*vismitāstāṃ praśaṃsantaḥ svaṃ svaṃ lokaṃ yayustadā (BhP 11.31.10)*

| |
|---|
| When Brahmā, Śiva, and the other [gods], saw Kṛṣṇa's yogic departure,<br>they were amazed and praised it, and each of them went into his own world. |

The gods broke up their assembly, separated, and each of them went his own way, like the planets use to do after a super-conjunction. The disappearance of Kṛṣṇa could allude to the disappearance of the old moon's crescent in the light of day.

Other Purāṇas give a different description of the cremation of Kṛṣṇa, but even there some evidence of an astronomical configuration can be seen, e. g. in Viṣṇupurāṇa 5.38 and Brahmapurāṇa 212.8:

अर्जुनोऽपि तदान्विष्य रामकृष्णकलेवरे

संस्कारं लंभयामास तथान्येषामनुक्रमात्

*arjuno'pi tadānviṣya rāmakṛṣṇakalevare*
*saṃskāraṃ laṃbhayāmāsa tathānyeṣāmanukramāt (VP 5.38.1)*

| |
|---|
| And Arjuna searched for the dead bodies of Rāma and Kṛṣṇa<br>and performed their funeral rites, also for the other [heroes] one by one. |

अष्टौ महिष्यः कथिता रुक्मिणीप्रमुखास्तु याः

उपगुह्य (var. उपगृह्य) हरेर्देहं विविशुस्ता हुताशनम्

*aṣṭau mahiṣyaḥ kathitā rukmiṇīpramukhāstu yāḥ*
*upaguhya* (var. *upagṛhya) harerdehaṃ viviśustā hutāśanam (VP 5.38.2)*

| |
|---|
| The eight that are said to be his queens, headed by Rukmiṇī,<br>embraced the body of Kṛṣṇa and entered into the fire. |

रेवती चापि रामस्य देहमाश्लिष्य सत्तमा

विवेश ज्वलितं वाह्निं तत्सङ्गाह्लादशीतलम्

*revatī cāpi rāmasya dehamāśliṣya sattamā*
*viveśa jvalitaṃ vāhniṃ tatsaṅgāhlādaśītalam (VP 5.38.3)*

| |
|---|
| And the best Revatī also embraced the body of Rāma<br>and entered into the blazing fire, refreshed and cooled by the contact with him (or: it?). |

उग्रसेनस्तु तच्छ्रुत्वा तथैवानकदुन्दुभिः

देवकी रोहिणी चैव विविशुर्जातवेदसम्

*ugrasenastu tacchrutvā tathaivānakadundubhiḥ*
*devakī rohiṇī caiva viviśurjātavedasam (VP 5.38.4)*

| |
|---|
| And when Ugrasena and Vasudeva heard it<br>and Devakī and Rohiṇī, they also entered into the fire. |

ततोऽर्जुनः प्रेतकार्यं कृत्वा तेषां यथाविधि

निश्चक्राम जनं सर्वं गृहीत्वा वज्रमेव च

*tato'rjunaḥ pretakāryaṃ kṛtvā teṣāṃ yathāvidhi*
*niścakrāma janaṃ sarvaṃ gṛhītvā vajrameva ca (VP 5.38.5)*

| |
|---|
| After Arjuna had done the funeral rites for them according to rule,<br>he departed and took everyone including Vajra with him. |

वारवत्या विनिष्क्रान्ताः कृष्णपत्न्यः सहस्रशः

वज्रं जनं च कौतेयः पालयञ्छनकैर्ययौ

*dvāravatyā viniṣkrāntāḥ kṛṣṇapatnyaḥ sahasraśaḥ*
*vajraṃ janaṃ ca kauteyaḥ pālayañchanakairyayau (VP 5.38.6)*

| |
|---|
| The thousands of wives of Kṛṣṇa that departed from Dvārakā,<br>and Vajra and the people – Arjuna took them under his protection and went quietly away. |

सभा सुधर्मा कृष्णेन मर्त्यलोके समुज्झिते (var. समाहृता)

स्वर्गं जगाम मैत्रेय (var. भो विप्राः) पारिजातश्च पादपः

*sabhā sudharmā kṛṣṇena martyaloke samujjhite (*var. *samāhṛtā)*
*svargaṃ jagāma maitreya (*var. *bho viprāḥ) pārijātaśca pādapaḥ (VP 5.38.7)*

| |
|---|
| After Kṛṣṇa had abandoned the world of the mortals, the splendid assembly and the assembly hall<br>and the Pārijāta tree went up to the sky, O Maitreya. |

यस्मिन्दिने हरिर्यातो दिवं संत्यज्य मेदिनीम्

तस्मिन्नेवावतीर्णोऽयं कालकायो बली कलिः

*yasmindine hariryāto divaṃ saṃtyajya medinīm*
*tasminnevāvatīrṇo 'yaṃ kālakāyo balī kaliḥ (VP 5.38.8)*

| |
|---|
| On the day Kṛṣṇa (Hari) went to the sky and departed from earth,<br>on that very day the powerful era of Kali commenced. |

प्लावयामास तां शून्यां द्वारकां च महोदधिः

वासुदेवगृहं त्वेकं न प्लावयति (var. नाप्लावयत) सागरः

*plāvayāmāsa tāṃ śūnyāṃ dvārakāṃ ca mahodadhiḥ*
*vāsudevagṛhaṃ tvekaṃ na plāvayati (var. nāplāvayata) sāgaraḥ (VP 5.38.9)*

| |
|---|
| And the ocean flooded the empty [city] of Dvārakā;<br>only the house of Kṛṣṇa was not flooded by the sea. |

Together with Kṛṣṇa, the "bright assembly" (*sabhā*)[81] and the "assembly hall of the gods" (*sudharmā*) rose to the sky. From our above considerations it is very likely that, again, this description alludes to the super-conjunction of all planets with the Sun and their synchronous heliacal rising. The super-conjunction could also be represented by the fact that some of his close relatives entered into the funeral pyre of the "Kṛṣṇa sun". Thus perhaps that barbaric custom that requires widows to burn themselves together with their deceased husbands has an astronomical-astrological motif.

Thus it can be deduced, as the sources seem to indicate, that there were two super-conjunctions: one during the great battle, and another one almost four decades later when Kṛṣṇa died. However, the evidence supporting the second super-conjunction is rather cryptic, whereas the first one is described very clearly.

In fact, it is more likely that there was only one super-conjunction that was associated with *both* events, with the war and the death of Kṛṣṇa. It must be remembered that the super-conjunction occurs at the end of an age and constitutes part of the general *pralayaḥ*, or the "dissolution" of all things back to their origin. It is followed by a new emanation (*sṛṣṭiḥ*) of the cosmic order and a new age, which is accompanied by a synchronous re-emergence of the planets from the Sun. *The transition from one age to the other is indicated by only one super-conjunction, not by two.*

[81] The author assumes this word to be etymologically derived from *bhā*, meaning "light" or "rays", although its original derivation could have been different.

# *The Traditional Kaliyuga Era*

## The Clustering of Planets in 3102 BCE

The Indian astronomical tradition believes that the *kaliyuga* began on 18th February, 3102 BCE with a super-conjunction of all the planets exactly at the initial point of the sidereal zodiac. Moreover, it is assumed that the Mahābhārata battle had taken place already 36 years prior, in August/September 3139 or 3138 BCE.[82] Now the Mahābhārata states that a super-conjunction took place precisely at the time of the war, not 36 years later. And as a matter of fact, there was no super-conjunction in 3139/3138 BCE. Hence it can be stated from the beginning that the astronomical tradition is in contradiction with the information given in the Mahābhārata. However, it is also obvious that Siddhāntic astronomy still maintains the idea of a super-conjunction at the beginning of our current age.

Ancient Indian astronomical works, such as the Sūryasiddhānta, assume that on 17th February 3102 BCE, all planets were located exactly at the initial point of the sidereal zodiac (0°00' Aries), and they use this date as a reference point in their ephemeris calculations. In reality, however, the planets were in a very wide "conjunction", dispersed over a range of more than 41°.[83] At no point in time

[82] See e. g. Venkatachelam, *The Plot in Indian Chronology*, p. 1. However, a bit later he mentions the preceding year, p. 182.

[83] If we use the orbital parameters that are given in the Sūryasiddhānta, then the mean positions of all planets on the Kaliyuga date fall exactly on 0° in the sidereal zodiac. The table below shows the mean and true positions of the planets based on Sūryasiddhāntic and modern algorithms for the same date, including their deviations from the zero point of the Sūryasiddhāntic zodiac, which is assumed at the fixed star *Revatī* (*ζ Piscium*).

The true positions were calculated using the JPL Ephemeris DE431, the mean positions using the orbital elements by Simon & alii in Astron. Astrophys. 282, 663-683 (1994). The zero point chosen is the ecliptic longitude of the star *Revatī*. However, we do not know exactly where the zero point was assumed. Besides, strictly speaking, the Sūryasiddhānta does not use rectangular but polar projection of stars on the ecliptic. The true positions according to Sūryasiddhānta were calculated using the programme *Jagannatha Hora* by Narasimha PVR Rao. The Sūryasiddhāntic algorithms contained in it were programmed by Vinay Jha.

during that year did all planets disappear in the glare of the Sun, and at no point did they all gather around the crescent of the Moon in the evening or morning sky, as is indicated by the Mahābhārata. Additionally, "conjunctions" that are comparably closer are not rare at all, but recur every few decades.[84] While this particular conjunction may have been special in that it took place near the beginning of the sidereal zodiac, other conjunctions of similar or even better accuracy did take place in the same area of the sky.[85]

K.D. Abhyankar and G.M. Ballabh believe that the Kaliyuga conjunction actually took place two years earlier, around 7th February

```
18 Feb. 3102 BCE (-3101) jul., 0:00 LMT in Ujjain,75°46'06" E
UT: 588465.289537   delta t: 77051.335797 sec
ET: 588466.181335   ayanāṃśa =  309°12'46.3" = -50°47'13.4"
```

| | SS mean | modern mean | deviation | modern true | deviation | SS true | deviation |
|---|---|---|---|---|---|---|---|
| Sun | 0° | 353°16 | -6°44 | 355°17 | -4°43 | 2°06 | 2°06 |
| Moon | 0° | 359°45 | -0°15 | 4°29 | 4°29 | 4°44 | 4°44 |
| Mercury | 0° | 322°47 | -37°13 | 340°22 | -19°38 | 359°20 | -0°40 |
| Venus | 0° | 26°54 | 26°54 | 8°00 | 8°00 | 359°02 | -0°58 |
| Mars | 0° | 341°15 | -18°45 | 351°48 | -8°12 | 7°00 | 7°00 |
| Jupiter | 0° | 8°58 | 8°58 | 8°23 | 8°23 | 357°58 | -2°02 |
| Saturn | 0° | 332°56 | -27°04 | 327°23 | -32°37 | 358°12 | -1°48 |
| distrib. | 0° | | 63°57 | | 41°00 | | 9°02 |

Thus if we consider *mean* planetary positions (ignoring the lunar node), then the planets are distributed over a range of about 64°. And if *true* positions are considered, then the planets are distributed over a range of more than 41°.

[84] E.g., a lot more impressing was the conjunction of 16th April 3243 BCE, where all planets met within 17° near the vernal point. The super conjunction of 18th November 959 BCE had an orb of even only 14°, however not at the beginning sidereal Aries, nor at the vernal point, but in sidereal Sagittarius in the lunar mansions of Mūla ("root"!) and Pūrvāṣāḍhā. There were no narrower conjunctions between 4000 BCE and the year 0. However, we must keep in mind that ancient star gazers, as long as they did not have a planetary theory and could not calculate planetary positions, were not able to detect narrow clusters. For, when all planets gather about the Sun, then they cannot be observed. The only thing that can be observed is the fact that planets disappear one after another in the glare of the Sun and cannot be seen anymore in the sky between sunset and sunrise. Not even this was the case in 3102 BCE. With good visibility, Venus and Saturn re-appeared *before* the disappearance of Jupiter. With a visibility of 50 km, Venus made her evening first round about 11th February, Saturn his Morning first on 30th January and Jupiter his evening last on 17th February. Venus and Saturn should have been observable around 17th/18th February.

[85] E.g. on 22th February 3542 BCE, 23th February 2568 BCE, 25th/26th February 1536 BCE, 14th/15th March 920 BCE, and 12th March 860 BCE. Also interesting is the clustering of 13th/14th March 1951 BCE, because in the subsequent days Mars and Saturn made their heliacal rising in Revatī.

3104 BCE.[86] On this date, there was a gathering of the planets around the Moon, like the one so often mentioned in the Mahābhārata and in the Purāṇic texts. However, with careful calculation it turns out that not all planets were visible near the Moon on that date. Mercury and Mars were combust by the Sun and therefore *invisible*.[87] Furthermore this configuration was not preceded by a super-conjunction, wherein all the planets get lost in the glare of the Sun. Hence, there was not really a "super-conjunction" during that year.

Besides, there were comparable configurations in several other years, as is stated by the authors themselves.[88] Abhyankar notes, however, that this conjunction was special in that it took place in the month of Phālguna, the first month of the year, which began on 11th January, when the Sun was positioned near the winter solstice.

Hindus firmly believe that the Kaliyuga began on 18th February, 3102 BCE and that this date, or actually rather the counting of days and years that starts on that date, has been passed down to us through an unbroken tradition. However this must be questioned. The date of the start of the *kaliyuga* is not attested in any older sources, neither the Purāṇas, the Mahābhārata, or in any other Vedic text. In fact, as will be shown, it is even incompatible with these sources, although traditionalists will assume all kinds of mental handstands and somersaults in order to make those incompatibilities seemingly disappear. There are no archaeological or historical data providing any such clues that the date 3102 BCE has any significance whatsoever.

The *kaliyuga* era was first attested to by the ancient astronomer Āryabhaṭa, who assumed the beginning of *kaliyuga* to be 3600 years before the 23rd year of his life, which corresponds to the year 499 CE. Traditionalists love referring to the inscription of King Pulakeśin II in Aihole, Karṇāṭaka, which allegedly supports this dating.

---

[86] Abhyankar and Ballabh, "Astronomical and Historical Epoch of Kaliyuga".

[87] With a visibility of 70 km (or atmospheric extinction 0.3) the morning first of Mercury took place about 13th February, that of Mars only in the middle of April. With very good visibility of 100 km (extinction 0.25) the morning first of Mercury was about 11th February, that of Mars in the end of March.

[88] op. cit., p. 92.

However, this inscription dates from the year 634 CE and is therefore even younger than Āryabhaṭa. Moreover, some authors refer to a number of title deeds written on copper plates that allegedly go back to King Janamejaya, who is said to have lived near 3000 BCE.[89] However, these "copper grants" are obvious forgeries that served the purpose to support claims of ownership.[90] Hence the

[89] K. Venkatachelam, *The Age of the Mahabharata War*, p. 47ff.; J. F. Fleet, "Sanskrit and Old Canarese Inscriptions", in: *Indian Antiquary* IV(1875), p. 333f.; R. Cole und V. N. Narasimmiyengar, "Three Maisur Copper Grants", in: *Indian Antiquary* I(1872), p. 375-379; L. Rice, "Two New Chalukya Grants. With Comparison of the Professed Grants by Janamejaya of the Sarpa Yâga", in: *Indian Antiquary* VIII(1879), p. 89-99; A. Upadhyay, "Janamejaya inscriptions of 3014 BC". On the phenomenon on forged title deeds, vide also: J. F. Fleet, "Spurious Indian Records", in: *Indian Antiquary* XXX(1901), p. 201-223, in particular p. 219ff.

[90] Since these "documents" are of potentially great importance for Hindus, I mention some points that may suggest a forgery, without pretension of completeness:

1. All Janamejaya grants are written in a younger form of Devanagari script (Balabodha, Balabandha), hence not older than a few centuries. One must keep in mind that the oldest extant inscriptions in India, with the only exception of the Indus script, stem from the 3rd century BCE and are written either in Brahmi or in Kharoshthi script. Devanagari script is attested even only since the 7th century CE. Even Vinay Jha and Arun Upadhyay, who believe in the authenticity of these grants, conceded in a public debate that they might be copies from earlier plates.

2. All Janamejaya grants this author has seen mention the weekday (*vāsara*) on which they were made. However, weekdays do not exist in pre-Hellenistic Indian literature. While the word *vāsara* does occur, it means either "matutinal" or "day". In the Mahābhārata, e. g., a great number of calendar dates are mentioned, but a weekday is never given. Hence, the mention of weekdays in the copper grants is an obvious anachronism.

3. Two of the inscriptions contain exactly the same date in the 89th year of "Yudhiṣṭhira Era". However, in one of them, Janamejaya sits on the throne in Kiṣkindhā in southern India (*śrījanamejayabhūpaḥ kiṣkindhyānagaryāṃ siṃhāsanasthaḥ*), and in the other inscription he sits on the throne in Indraprastha (Delhi; *śrījanamejayabhūpaḥ indraprasthanagarīsiṃhāsanasthaḥ*). It is of course impossible that Janamejaya sat on both thrones on the same day. It rather seems that the one grant was forged on the basis of the other.

4. Astronomically, the inscriptions are not plausible either. Two of the grants were allegedly made in the 89th year of "Yudhiṣṭhira Era" (*yudhiṣṭhiraśake*), on a Wednesday or Monday (*saumyavāsare*) in the month of Pauṣa (*sahasyamāsi*) and on a new moon (*amāvāsyāyām*) and on the day of a solar eclipse (*uparāgasamaye*). (*Indian Antiquary* IV, p. 333f.; Venkatachelam, op. cit.) Reckoned from the Kaliyuga Era, this information provides 27th November 3014 BCE. However,

statement found in Āryabhaṭa's work is in fact the oldest testimony for the *kaliyuga* era, and over a whole period of 3600 years, the alleged tradition did not leave any trace in literary or archaeological

---

this day was a Friday, and the visibility zone of the eclipse was so far in the south that it could not have been observed from India, not even in partial phase. Even the popular trick of manipulating ΔT will not help in such a case, because it allows an offset only in geographic longitude, not latitude. Vinay Jha chooses a different solution, though. He reckons the date from Yudhiṣṭhira's inauguration immediately after the Mahābhārata war, thus 36 years before the Kaliyuga Era. The date he finds is 5th November 3050 BCE. This day was a Monday, indeed, however the solar eclipse of that day, which belonged to the same Saros cycle, was again too far in the south and could not have been observed from India. Thus it must be concluded that the date was back-calculated using the Sūryasiddhānta, which is known to provide eclipse calculations but cannot predict local observability. While Jha believes that *uparāga* here means "twilight" rather than "solar eclipse", it can hardly be considered a coincidence that in fact this *was* an eclipse date. It rather points to a forgery.

5. The other grants are not convincing either from an astronomical viewpoint. Their date is given as follows:

"... in the dark half of the month of Chaitra of the year 111, on Monday combined with Bharani Nakshatra, Sankranti and Vyatipata Nimitta, on the occasion of Sarpa Yaga ..." (translation by Narasimmiyengar)

The Sanskrit original is quoted as follows by Arun Upadhyay:

कटकं उत्कलित चैत्रमासे कृष्णपक्ष सोमदिने भरणी महानक्षत्रे संक्रान्ति व्यतीपात निर्मित समये सर्पयागं करोमि)

Another grant is dated as follows:

"... in the dark fortnight of the month of Chaitra in the year 111, on new-moon day, which was a Monday, coupled with 'Bharani nakshatra, and Kimstugna karana,' ... in Vuttarayana and in Sankranti, governed by Vyatipatam, on the occasion of a solar eclipse, when the Sun was half obscured, when the snake sacrifice was performed ..." (in: Indian Antiquary I (1872), p. 375f.; the Sanskrit wording is unfortunately not given).

Reckoned from 3102 BCE, this date corresponds to 2nd March 2992 BCE, which is a Monday indeed. However, a solar eclipse occurred only a month later. The lunar mansion is wrong, namely Aśvinī, not Bharaṇī. Interestingly, the correct lunar mansion is found if Sūryasiddhāntic calculus is used. This indicates a forgery, although Jha objects that *tithi* was traditionally *always calculated and never observed*. I made the calculations using the programme *Jagannatha Hora*. Its algorithms for Sūryasiddhāntic calculations were programmed by Vinay Jha.

On the other hand, if reckoning from the great war, one arrives at 10th March 3028 BCE. Here again, the *nakṣatra* Bharaṇī is only found with Sūryasiddhāntic calculus. A solar eclipse did take place on that day, however it was most probably not observable in India. Besides, the day was not a Monday, but a Saturday.

sources. It must therefore be considered speculation. While the Mahābhārata and the Purāṇas do provide evidence that planetary clusterings were observed and considered important in ancient times, there is no available evidence that could support the *kaliyuga* era commencing in either 3102 or 3104 BCE.

Serious scholars therefore, do not accept the idea that the *kaliyuga* beginning on 18th February 3102 BCE is based on a true, unbroken tradition. Rather they assume that this date was *back-calculated* by Indian astronomers of late antiquity. It served as a mooring point for a theory of planetary cycles, as given in the Sūryasiddhānta, the most important work on ancient Indian astronomy.

As has been stated, the planetary theory of the Sūryasiddhānta starts with the assumption that on a particular date in the remote past all planets, the Sun, and the Moon were in precise conjunction at the initial point of the sidereal zodiac near the star *Revatī* (*ζ Piscium*). The same super-conjunction is assumed to occur again at the same place at the end of each *yuga*, after all celestial bodies have completed a well-defined number of cycles. The start date of this planetary theory, on which all planets were located precisely at the zero point of the zodiac, is believed to be 18th February 3102 BCE.

Now, if the positions of the Sun and the planets are calculated using this start date with the planetary cycles provided in the older Sūryasiddhānta, then the results will tally well with modern calculations of 500 CE, but the margin of error increases more and more the more time progresses from that epoch.[91] For 18th February, 3102 BCE, the calculation will naturally result in a precise conjunction of all planets at 0° in sidereal Aries. However, as has been said, the error is considerable, and there was not really a super-conjunction in that year. From these facts it has to be concluded that the planetary constants of the old Sūryasiddhānta were developed approximately 500 CE.

[91] The planetary constants of the older Sūryasiddhanta are found in Varāhamihira's *Pañcasiddhāntikā*. The same constants are also found in Brahmagupta's *Khaṇḍakhādyaka* and in Āryabhaṭa's *Āryabhaṭīya*. The current Sūryasiddhanta is a result of several reviews, hence the same effect does not appear as striking as with the other works mentioned.

This date can also be confirmed by the fact that the Sūryasiddhānta assumes the initial point of the zodiac near the star *Revatī* at the vernal equinoctial point. In 500 CE, the vernal point was located exactly at this position. Thus it follows that 18th February, 3102 BCE, must also have been defined at the same time, being approximately 500 CE.[92] This must have been arrived at in the following way: Ancient astronomers searched for a date in the remote past on which all planets were near 0° Aries. On that date they set the longitudes of all planets to 0 and corrected the planetary cycles in such a way that they provided good ephemerides for their own epoch, again being approximately 500 CE.

The evidence against the authenticity of the traditional *kaliyuga* date is indeed overwhelming. However, for Hindu traditionalists this is extremely difficult to accept. It is for this reason that this issue be examined in greater depth. If the reader is not interested in exploring this point, he or she may skip to the next chapter.

In an article published in 1996, Abhyankar and Ballabh raise the following objection against the above conclusions:

> On account of such glaring discrepances it has been concluded by most investigators that Āryabhaṭa derived the moment of the commencement of *Kaliyuga* by making back calculations from his planetary constants. However, it would be almost impossible to get an exact conjunction of all the seven bodies from a given set of planetary data on account of the incommensurability of their periods. It is much more likely that Āryabhata made the assumption that there was a conjunction of all the seven bodies at *Meśādi* (the beginning of sidereal Aries, D.K.) on the date chosen by him, and then combining this with the observations available to him in his epoch, he derived the best fitting constants of the planetary motions. [93]

And:

> ... Then the question arises as to why did Āryabhata choose that particular year for the beginning of *Kaliyuga*? The answer would be that there must have been a tradition based on some past memory of an event when the seven luminaries were actually seen together near the beginning of the

[92] S. Sengupta, *Ancient Indian Chronology*, p. 34ff.; see also commentary of Burgess on Sūryasiddhānta I.27-34, in: Burgess, *The Sûrya Siddhânta*, p. 14-28; see also PC Sengupta's introduction in Burgess, p. xi ff.; last but not least: Chandra Hari, "On the Origin of 'Kaliyugādi' Synodic Super-Conjunction".

[93] Abhyankar und Ballabh, "Kaliyuga, Saptarṣi, Yudhiṣṭhira and Laukika Eras", p. 22f.

> year. However, at no time in the Vedic antiquity did the year start at the middle of *Śiśir ṛtu* (one of the six seasons of the year; D.K.) as one would infer from the tropical longitude of the sun equal to 304° as was the case on February 18, 3102 BC.

The authors believe it impossible for Āryabhaṭa to arrive at the *kaliyuga* date by back-calculation and state that he must have learned about it through some 3600-year-old tradition. This argument is not convincing, as in reality, it is actually *very easy* to find dates on which the planets were close to a conjunction, if the mean positions and velocities of the planets are provided. An exact conjunction is not required. After an approximate conjunction has been found, it can be *assumed as accurate* and the orbital parameter can be *adjusted* so that they still provide good ephemerides for the present time.

Additionally, as has been stated earlier, the configuration on 7th February 3104 BCE was not of the kind that Abhyankar and Ballabh assert:

> ...some past memory of an event when the seven luminaries were actually seen together near the beginning of the year.

The planets were *not* all visible. Mercury and Mars were outshone by the glare of the Sun and were therefore invisible. No gathering of all planets about the Moon could be observed.

Another argument that is time and again raised in favour of the *kaliyuga* date being 3102 BCE is the following. Koenraad Elst puts it as follows:

> Bailly and Playfair had already shown that the position of the moon (the fastest-moving "planet", hence the hardest to back-calculate with precision) at the putative beginning of Kali-Yuga, 18 February 3102, as given by Hindu tradition, was accurate to 37'. (Playfair 1790/1971:88-89) Either the Brahmins had made an incredibly lucky guess, or they had recorded an actual observation on Kali Yuga day itself.[94]

To begin with, it must be asked what Elst and Playfair mean by "actual observation". Mean positions could not be observed directly. Moreover, the *true* position of the Moon was not observable at

---

[94] Elst, "Astronomical Chronology of Vedic Literature : Some New Arguments". Playfair's consideration on the accuracy of the lunar position are found in: *The Works of John Playfair*, vol. 3, p. 121f. They are part of an article titled "Remarks on the Astronomy of the Brahmins". Bailly's explanations can be found in: Bailly, *Traité de l'astronomie indienne et orientale*, p. 111ff.

midnight being a new moon. On the next evening when the new crescent appeared, the Moon was at 15° in the sidereal zodiac, if the zero point is assumed near the star *Revatī*. However, in the twilight most stars were not visible, especially not those that were close to the Moon and near the horizon. Thus how could the position of the Moon be determined accurately? What Playfair and Elst call an *actual observation*, could, at best have been a calculation based on long-term observations and a scientific lunar theory.

Moreover, the question arises where exactly the zero point of the sidereal zodiac must be assumed according to the Sūryasiddhānta. In Playfair's opinion, it was 54° west of the vernal point on the *kaliyuga* date.[95] Playfair's information that the error in the lunar position was only 37' (with the Moon at 359°23') is based on this assumption and on a special method to calculate the mean lunar position stemming from the 18th century. However, when the same calculation is done with a modern formula[96] and the above-mentioned *ayanāṃśa* of –54° is used, then a mean Moon is arrived at 2°58' in the sidereal zodiac. This would also be the resulting error for the Sūryasiddhāntic Moon, being +2°58' rather than the –37' as asserted by Playfair.

However, the assumption that the zero point of the zodiac on the commencing date of the *kaliyuga* was 54° west of the vernal point, is also questionable. Playfair's sources probably derive this figure from the Sūryasiddhāntic precession theory (or trepidation theory) and calculate 54" times 3600 years (= 54°), relative to Āryabhaṭa's year 499 CE. But this calculation would be based on a misunderstanding of the trepidation theory. The Sūryasiddhānta assumes that the spring equinox deviates never more than 27° (half of 54°) from the sidereal zero point and that the direction of its motion reverses every 3600 years when it reaches such a maximum. The Sūryasiddhānta believes that on the Kaliyuga date the sidereal zero point of the zodiac coincided with the vernal point.

---

[95] Playfair, op. cit., p. 117: "The Brahmins place the beginning of their moveable zodiac, at the time of their epoch, 54° before the vernal equinox, or in the longitude of $10^s$, 6°, according to our method of reckoning."

[96] J. L. Simon & alii in: *Astronomy and Astrophysics* 282, 663-683 (1994).

But where exactly *was* the zero point. Unfortunately, it is not known. According to the Sūryasiddhānta, the star Revatī (*ζ Piscium*) is at 359°50’ in polar ecliptic projection. The zero point would thus be 10’ west of this star. Unfortunately, however, the position given for *Revatī* contradicts other star positions that are also given in the same list, e.g. Citrā (*Spica*) is placed at 180°.[97] The two positions result in an uncertainty as to the zero point of approximately 4°, and it follows that the potential error in the mean position of the Moon for the Kaliyuga date is of the same amount.

Another clue to the zero point of the zodiac is given in Sūryasiddhānta 1.27, where it states that at the end of each yuga the Sun, the Moon, and the planets unite in a precise conjunction “at the end of Revatī” (*pauṣṇānte*).[98] However, what does “at the end of Revatī” mean? Is the star located exactly at the end of its lunar mansion? Then the error in the mean lunar position on the *kaliyuga* commencement date would be only -15’, as can be seen in the table that is given on p. 158. However, the wording “the end of Revatī” probably does not refer to the star, but to the lunar mansion of the same name that contains the star and has a size of 13°20’. So it must be asked, where exactly the end of the lunar mansion is.

Another possible solution is the following: The Sūryasiddhānta and all other works of ancient Indian astronomy assume the initial point of sidereal Aries at the spring equinox. Now, it can be determined which epoch the planetary positions resulting from the algorithms of the Sūryasiddhānta are in best agreement with modern calculations. If the orbital parameters of the older Sūryasiddhānta are used, then it can be seen that the year in best agreement is about 510 CE.[99] If the sidereal zodiac is fixed at the spring equinox of that year, the error for the mean position of the Moon at the beginning of the Kaliyuga is about -1°18’.

---

[97] Sūryasiddhānta 8; Burgess’ translation on p. 202ff.; star list p. 205.

[98] Burgess p. 14.

[99] R. Billard did this calculation using the orbital parameters given by Āryabhaṭa, which are identical with those of the older Sūryasiddhānta, except for Jupiter and Mercury. (Billard, “Āryabhaṭa and Indian Astronomy”, in: *Indian Journal of History of Science* 12, p. 207-224).

There is also another problem. As the Earth's rotation angle for that remote epoch is uncertain, the exact position of the Moon at midnight on 18th February, 3102 BCE is unknown. The estimated standard error in ΔT for that epoch is about 2 h 40 min, which corresponds to an uncertainty of the lunar position of +–2.6°. Since this is a standard error, a considerably greater error of +–5° or even more cannot be ruled out.

Thus from all these considerations it obviously cannot be determined exactly how accurate is the mean lunar position resulting from the Sūryasiddhānta for the commencement of the *kaliyuga*. There is an uncertainty of several degrees. It has to be noted, that this is not an uncertainty inherent in the ephemeris of the Moon, but an uncertainty that results (1) from the fact that it is unknown, exactly where the sidereal zodiac has its zero point and (2) from the fact that it is also unknown exactly what the Earth's rotation angle (ΔT) for 3102 BCE was.

The next question to be asked would be how difficult it was for astronomers who lived in 500 CE to calculate the mean position of the Moon for the beginning of the *kaliyuga* with an accuracy of a couple of degrees. In reality this was not very difficult, if the mean sidereal period of the Moon around the year 500 CE was known with sufficient accuracy, such as the accuracy of Ptolemy's value. Ptolemy's value of the sidereal period of the Moon was 0.38 seconds shorter than the value given by Sūryasiddhānta.[100] Over a time span of 3600 years this difference accumulates to 5.1 hours, corresponding to a longitudinal offset of 2°49'. This therefore is the difference between the mean lunar ephemerides according to Sūryasiddhānta and Ptolemy after 3600 years, if one has them start at the same initial position. This value is within the frame of the discrepancies given further above.

[100] According to Ptolemy, the length of the tropical month is 27d 7h 43m 7.261s. Using Ptolemy's rate of precession of 1° in 100 years, the resulting sidereal month length is 27d 7h 43m 12.166s. The sidereal month length given by the Sūryasiddhānta is 27d 7h 43m 12.548s. According to modern algorithms the correct value for the year 499 CE is 27d 7h 43m 11.29s. It becomes apparent how incredibly accurate were the calculations of ancient astronomers. It also becomes apparent that the sidereal month length of Ptolemy is even better than that of Sūryasiddhānta.

It is unknown how ancient Indians arrived at their value for the length of the sidereal month. Only the result of their efforts is known. Ptolemy, on the other hand, explains in the 4th book of the *Almagest*, how the mean motion of the Moon was determined with high accuracy from observations of lunar eclipses over a time period of several centuries. He refers to observations by older Greek, Egyptian, and Babylonian astronomers. As he does not mention Indian sources or observations, it can be ruled out any Indian influence. On the other hand it is possible that Indian astronomers benefitted from Mesopotamian and Greek-Egyptian observations. However, influence in this direction is not attested to either.

Playfair also uses Ptolemy in his argument, but in a different way:

> To confirm this conclusion, Bailly computes the place of the moon for the same epoch, by all the tables to which the Indian astronomers can be supposed to have ever had access. He begins with the tables of Ptolemy ; and if, by help of them, we go back from the era of Nabonassar, to the epoch of the Calyougham, taking into account the comparative length of the Egyptian and Indian years, together with the difference of the meridians between Alexandria and Tirvalore, we shall find the longitude of the sun 10°, 21', 15'' greater, and that of the moon 11°, 52', 7'' greater that has just been found from the Indian tables. At the same time that this shows, how difficult it is to go back, even for a less period than that of 3000 years, in an astronomical computation, it affords a proof, altogether demonstrative, that the Indian astronomy is not derived from that of Ptolemy.[101]

However, Bailly is comparing apples with oranges. Ptolemy's positions are *tropical, based on Ptolemy's tropical year length*. The Indian positions to which Bailly compares them are also given relative to the tropical zodiac, however they are *based on a modern precession theory*, which is incomparable. The correct procedure has been demonstrated above: One has to do the calculation *sidereally* using the *sidereal* lunar speed that can be derived from Ptolemy's theory. It need not be discussed whether or not the planetary or lunar theory of the Sūryasiddhānta was influenced by Ptolemy. What is important for this investigation is that on the basis of the astronomical skills that were available in late antiquity *was* it possible to calculate the mean position of the Moon for the *kaliyuga* date with a precision of only a few degrees.

[101] Playfair, op. cit., p. 122, referring to Bailly, op. cit., p. 114f.

Yet another consideration is brought up by Playfair. The mean orbital speed of the Moon slows down over the centuries and millennia. The Sūryasiddhānta is not aware of this decrease in speed. However, the mean speed it gives for the Moon provides better ephemerides for the period 3102 BCE to 500 CE than could be expected using the mean lunar speed at the epoch 500 CE or 0 CE. Now this is generally to be expected in ancient lunar theories because they were developed based on centuries of observations. Playfair, however, interprets this phenomenon as a proof that the lunar theory of Sūryasiddhānta is based on observations that go back to the 4th millennium BCE.[102]

In order to test this assertion, the following experiment was done: First the mean position of the Moon for the vernal equinox 499 CE was calculated using modern formulas. Then, starting from this start date and this initial moon position, the position of the Moon for the *kaliyuga* date was calculated in two ways: 1. using the mean sidereal speed of the Moon as given by the Sūryasiddhanta, 2. using the mean sidereal speed as resulting from Ptolemy's Almagest. In addition, the correct position of the Moon was calculated using the polynomial by Simon in his 1994 article. In this way, the accuracy of the different methods could be compared directly. It turned out that the Ptolemaic lunar speed results in an error of –1°55’ for the *kaliyuga* commencement date. On the other hand, with the ancient Indian lunar speed, the error is only +54’. The ancient Indian solution is therefore better, at least in the long run; in the shorter term the Ptolemaic solution is better.

However, it would be wrong to draw conclusions about the observation period that ancient Indian astronomers needed to develop their theory. It cannot be concluded that the Indians observed a longer period than Ptolemy and his predecessors. First of all, it is unknown what methods of observation were used. Also, the special nature of the Sūryasiddhāntic planetary theory must be taken into account. The Sūryasiddhānta defines the mean velocities by stating how many complete revolutions a celestial body completes within 4,320,000 years. However, only whole numbers, no fractions, are given. *Thus the Indian sidereal lunar cycle is not purely empirical.*

---

[102] Playfair, op. cit., p. 125f.

*Rather, an original empirical value was stretched or compressed so that an integer number of cycles fit into one yuga.* The Moon was supposed to complete 14,438,334 sidereal revolutions within a period of 1,080,000 years, but it is unknown in what way they rounded it. As they preferred numbers that were either even or divisible by five, it must be assumed that up to an entire cycle was added or taken away. Over a period of 3600 years (499 CE to 3102 BCE), this manipulation makes a difference of up to +–1°12'. Therefore, it cannot even be determined whether the underlying empirical value of the Indian theory was better than that based on Ptolemy. Playfair is apparently not aware of this problem.

In conclusion: *It is unnecessary to postulate a* kaliyuga *tradition that goes back to the year 3102 BCE, as is assuming an "incredibly lucky guess" in order to explain why the position of the Moon on the* kaliyuga *date is "so accurate". The astronomical knowledge available around 500 AD, at least, in the West, was capable, in principle, to calculate the* kaliyuga *commencement date as a purely theoretical construct. It is to be expected that the position of the Moon on that date should be fairly accurate.*

Referring back to Elst, he also mentions the following argument:

> Indeed, if the Hindu astronomers were able to calculate this position after a lapse of many centuries (when the Jyotisa-Shâstras were written), it is unclear what reason they would have had for picking out that particular conjunction.

This question has already been examined: *The "conjunction" occurred near the zodiacal zero point of the Sūryasiddhānta, or near the point where the vernal equinox was in 500 CE. Therefore it was an ideal starting point for the planetary theory of ancient Indian astronomy.*

## Revatī as Ecliptic Zero Point in Vedic Times?

A lot more interesting, as an argument in favour of an older tradition that assumed the zodiacal zero point at Revatī, is the text Taittirīyabrāhmaṇa 1.5.4.2, which apparently has never been considered in this context:

प्रजापतिः पशूनसृजत। ते नक्षत्रं नक्षत्रमुपातिष्ठन्त। ते समावन्त एवाभवन्। ते रेवतीमुपातिष्ठन्त। ते रेवत्यां प्राभवन्। तस्माद्रेवत्यां पशूनां कुर्वन्ति। यत्किं चार्वाचीनं सोमात्। प्रैव भवन्ति। सलिलं वा इदमन्तरासीत्। यदतरन्। तत्तारकाणां तारकत्वम्।

*prajāpatiḥ paśūnasṛjata. te nakṣatraṃ nakṣatramupātiṣṭhanta. te samāvanta evābhavan. te revatīmupātiṣṭhanta. te revatyāṃ prābhavan. tasmādrevatyāṃ paśūnāṃ kurvanti. yatkiṃ cārvācīnaṃ somāt. praiva bhavanti. salilaṃ vā idamantarāsīt. yadataran. tattārakāṇāṃ tārakatvam.* (TaiBr 1.5.2.4)

> Prajāpati created the animals (or cattle). These approached one *nakṣatra* after the other. They became owners of the year (or "of a year" or "of years")[103]. They approached Revatī. They appeared (or: became visible) in Revatī. In Revatī therefore they give to the animals everything that is on this side of the Moon. They appeared. Water was that in between (i.e. in the sky between the junction stars). [The fact] that they crossed it (*a-tar-an*), that [explains] why the stars are called "stars" (*tār-aka-*).

There is talk of cattle that wander through the lunar mansions. It is likely that they stand for the planets. Through their wandering, they become "owners of years" (*samāvantaḥ*). This may indicate that each of them has its own cycle and its own orbital period. The fact that they "arise, appear, become visible" (*prabhavanti*) in Revatī could mean that the starting point of these cycles was assumed at Revatī. If this interpretation is correct, the question arises whether this text could be a testimony of a precursor of Siddhāntic planetary theories.

However, it should be noted that the two commentators of the above-quoted text, Bhaṭṭabhāskaramiśra and Sāyana, *do not see any connection* of the text with an astronomical planetary theory. They do not even suspect that it could refer to the planets.[104] Thus,

---

[103] The commentators Bhaṭṭabhāskaramiśra and Sāyana interpret *te samāvanta evābhavan* in the sense of: "they became equal-sized". However, the proposal in this work seems to make better sense, and it also explains the long *ā* in *samāvantaḥ*.

[104] Sāyana's commentary is as follows (according to R. Mitra, *The Taittirīya Brāhmaṇa of the Black Yajur Veda with the Commentary of Sayanacharya*, vol. I, p. 212):

प्रजापतिना सृष्टाः पशवः रेवतीव्यतिरिक्ते तस्मिन्नक्षत्रे स्वकीयस्वामिगृहे समागताः ते च समा एवाभवन्। समशब्दादुत्पन्न (!) आवन्तुप्रत्ययः स्वार्थिकः। यावन्तः समागतास्तावन्त एव न तु वृद्धिं गताः। रेवत्यान्तु स्वामिगृहं प्राप्ताः प्रभूता अभवन्। तस्मात्सोमयागादर्वाचीनं पशूनां सम्बन्धि यत्कर्म वायव्यं

श्वेतमालभेतेत्यादि तद्रेवत्यां कुर्वीत तेन पशवः प्रभूता एव भवन्ति। ... द्यावापृथिव्योरन्तर्मध्ये यदिदं स्थावरजङ्गमात्मकं जगद्दृश्यते तत्सर्व्वं पुरा प्रलयकाले सलिलमेवासीत्। तदानीं कृत्तिकाद्याः सलिलं तीर्त्वा लोकान्तरेषु गताः। तस्मात्तरन्तीति व्युत्पत्त्या तारकत्वं सम्पन्नम्।

*prajāpatinā sṛṣṭāḥ paśavaḥ revatīvyatirikte tasminnakṣatre svakīyasvāmigṛhe samāgatāḥ te ca samā evābhavan. samaśabdādutpanna (!) āvantupratyayaḥ svārthikaḥ. yāvantaḥ samāgatāstāvanta eva na tu vṛddhiṃ gatāḥ. revatyāntu svāmigṛhaṃ prāptāḥ prabhūtā abhavan. tasmātsomayāgādarvācīnaṃ paśūnāṃ sambandhi yatkarma vāyavyaṃ śvetamālabhetetyādi tadrevatyāṃ kurvīta tena paśavaḥ prabhūtā eva bhavanti. ... dyāvāpṛthivyorantarmadhye yadidaṃ sthāvarajaṅgamātmakaṃ jagaddṛśyate tatsarvvaṃ purā pralayakāle salilamevāsīt. tadānīṃ kṛttikādyāḥ salilaṃ tīrtvā lokāntareṣu gatāḥ. tasmāttarantīti vyutpattyā tārakatvaṃ sampannam.*

“Prajāpati created the animals (or cattle). In the lunar mansion, that ends (?) with Revatī, they gathered as the house that is ruled by them, and they became equal-sized. The meaning of the [suffix] *āvant* that is attached to the word *sama* ('equal') is indication of property. In what size they gathered, of that size they did not continue to grow. By attaining Revatī, the lunar mansion that is ruled by them, they 'became', i. e. they arose. For this reason, the ritual pertaining to the cattle during the Soma sacrifice ought to be done in Revatī, accompanied by the words 'one should take the white sacrificial vessel' etc. Thereby the cattle become and arise. ... What is seen in the middle between the sky and the earth as this world, which by nature is immovable and movable, all that was water at the time of the dissolution [of the world]. In that time, [the lunar mansions] Kṛttikā etc. crossed the water and went into other worlds. Therefore, because they 'cross' (*tarantīti*), this is why they were given by etymology the name 'stars' (*tāraka*).”

Bhaṭṭabhāskaramiśra’s commentary is as follows (according to A. M. Sastry, *The Taittiriya Brahmana with the Commentary of Bhattabhaskaramisra*, vol. 1, p. 257):

प्रजापतिः पशूनित्यादि। पशवस्सर्वं नक्षत्रं उपातिष्ठन्त उपासर्पन्। ते समावन्त एवाभवन्। समा अनुपचिता एवातिष्ठन्त न वृद्धिं गताः। समादावतुष् स्वार्थिकः। ते रेवत्युपस्थानेन प्रभूता अभवन् तस्माद्रेवत्यां पशूनां संबन्धि कर्म इष्टिपश्वादिकं प्राक् सोमात् कुर्वन्ति। प्रभवन्त्येव। सलिलं वा इत्यादि। इदं द्यावापृथिव्योरन्तरं सलिलं सलिलकल्पं अप्रतिष्ठत्वात् अव्यक्तावस्थां गतं आसीत् तत्र पृथिव्युद्धरणक्षोभे बुद्बुदकल्पा यस्मात् अतरन् उत्तीर्यान्तस्स्थिताः तत् आसां तारकत्वम्।

***prajāpatiḥ paśūnityādi***. *paśavassarvaṃ nakṣatraṃ* ***upātiṣṭhanta*** *upāsarpan*. ***te samāvanta evābhavan***. *samā anupacitā evātiṣṭhanta na vṛddhiṃ gatāḥ. samād-āvatuṣ svārthikaḥ. te* ***revatyupasthānena pra****bhūtā* ***abhavan tasmādrevatyāṃ paśūnāṃ*** *saṃbandhi karma iṣṭipaśvādikaṃ prāk* ***somāt kurvanti***. ***prabhavantyeva***. **salilaṃ vā** ityādi. ***idaṃ*** *dyāvāpṛthivyorantaraṃ* ***salilaṃ*** *salilakalpaṃ apratiṣṭhatvāt avyaktāvasthāṃ gataṃ* ***āsīt*** *tatra pṛthivyuddharaṇakṣobhe budbudakalpā yasmāt* ***ataran*** *uttīryāntassthitāḥ* ***tat*** *āsāṃ* ***tārakatvam***.

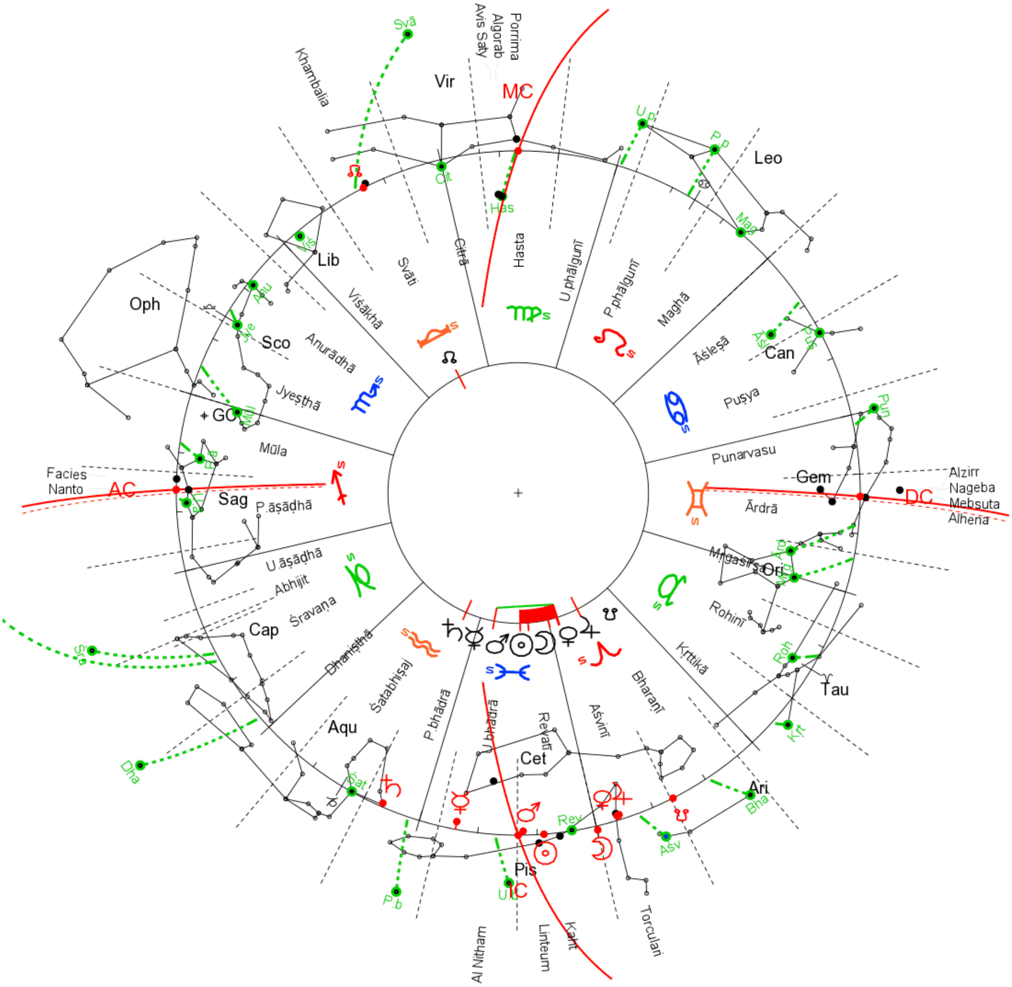
*if* the text really alludes to an ancient planetary theory, it is nevertheless true that at the time of those commentators this was not understood anymore. So, even if the text had been written in the 4th millennium BCE, how could there be talk of an unbroken tradition of the *kaliyuga* era?

Additionally, the evidence presented further above remains valid in any case. The orbital elements of the planets as given by the older Sūryasiddhānta clearly originate from the epoch 500 CE, and the *kaliyuga* era is not attested to before that date. In other words, if the above-cited text, which should be a lot older, refers to an astronomical theory, then both its cycles as well as the start date should have been very different from those of the Sūryasiddhānta. It should also be understood that older works of ancient Indian astrology and astronomy, namely the Yavanajātaka and the Vedāṅgajyotiṣa, use more primitive orbital elements than the Sūryasiddhānta, and they do not know the *kaliyuga* era.

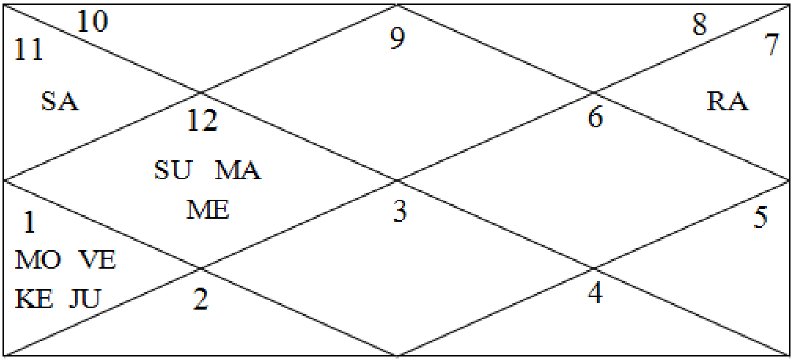
From all this it must be concluded that 18th February, 3102 BCE does not have any historical relevance whatsoever.

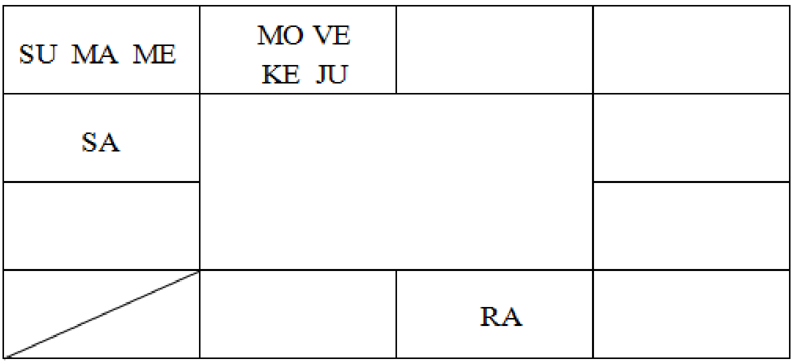
---

“'Prajāpati [created] the cattle' etc.: The cattle betook themselves, i. e. moved to each lunar mansion. They became equal-sized. They moved in equal size, without increasing, i.e. they did not grow. The [suffix] *āvat* after *sama* ('equal') indicates property. They became, i. e. they arose, by betaking themselves to Revatī. Therefore the ritual that pertains to the cattle, the object of which is sacrifice and cattle, is done in Revatī before [the ritual, the object of which is] Soma. [That is how the cattle] arose. 'Water was' etc.: That interspace between the sky and the earth was water, i. e.: because, like water, it has no ground, it is in the state of the primordial unmanifested. Because in their motion to beyond the earth they 'crossed' (*ataran*) over like embryos, i.e. because after crossing they were in between, this is why they are called 'stars' (*tāraka-*).”



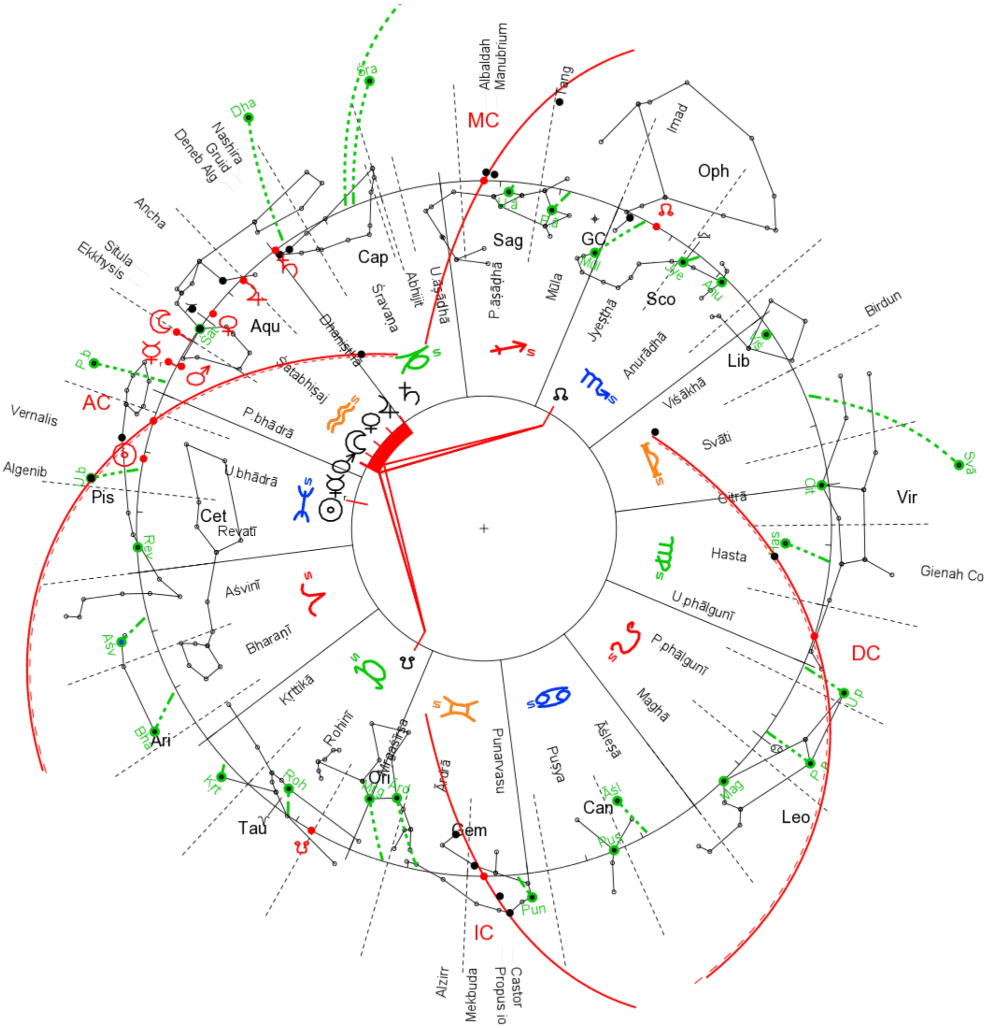

Configuration at midnight on 17th/18th February, 3102 BCE, where the Indian astronomical tradition assumes the beginning of the *kaliyuga*. The tradition asserts that in this moment all planets met in a precise conjunction exactly at the beginning of the sidereal zodiac. In reality, however, the planets were scattered over a range of about 41°. At no time during that year did all planets disappear in the glare of the Sun and become invisible. And at no time were all of them visible in conjunction with the old moon. In the above configuration, Venus is even about to become the evening star. It is therefore not a real super-conjunction.



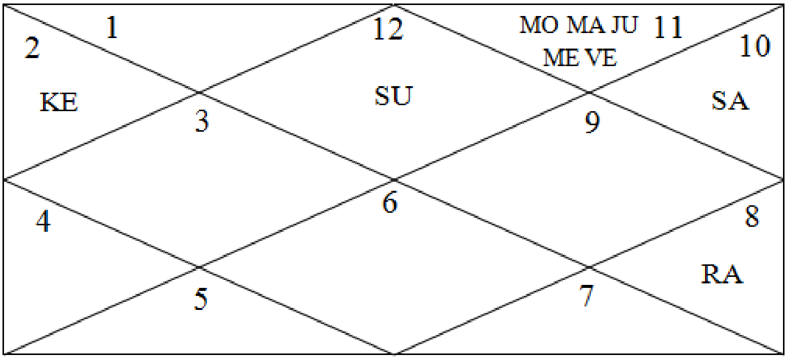



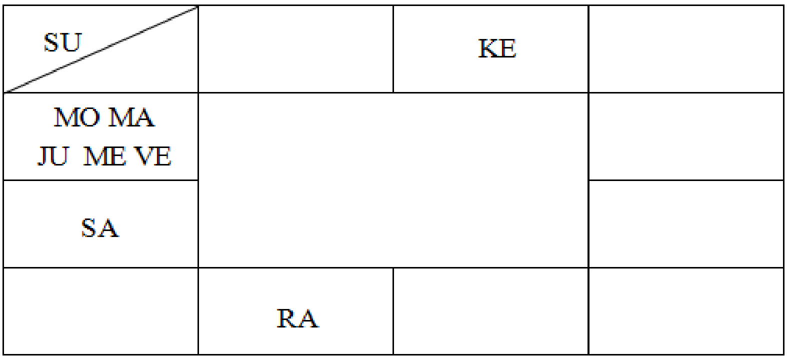

Kaliyuga (traditional date)
18 Feb 3102 BCE (-3101) jul., 0:00 LMT, Ujjain 75e46,23n11
JD (UT)=588465.2895370, JD (ET)=588466.1807964, delta_t=77004.8 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 313°24'24" (True Citra)
Sidereal time: 8:09:55 (122°28'46")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 256°12'16" | Dha/Sag 16°12'16" | PAs | | |
| Sun | 351°05'40" | Min/Pis 21°05'40" | Rev | 4 | 0°00'05" |
| Moon | 0°03'20" | Mes/Ari 0°03'20" | Asv | 5 | 1°03'04" |
| Mercury | 336°10'43" | Min/Pis 6°10'43" | UBh | 4 | -2°06'52" |
| Venus | 3°48'02" | Mes/Ari 3°48'02" | Asv | 5 | -1°12'30" |
| Mars | 347°36'12" | Min/Pis 17°36'12" | Rev | 4 | -1°03'58" |
| Jupiter | 4°11'05" | Mes/Ari 4°11'05" | Asv | 5 | -1°20'00" |
| Saturn | 323°10'54" | Kum/Aqu 23°10'54" | PBh | 3 | -1°00'50" |
| Rahu | 193°40'44" | Tul/Lib 13°40'44" | Sva | 11 | |
| Ketu | 13°40'44" | Mes/Ari 13°40'44" | Bha | 5 | |




Configuration of 7th February, 3104 BCE, 6:45 a. m., beginning of the *kaliyuga* in the opinion of Abhyankar and Ballabh, close in time to the traditional *kaliyuga* date. The authors give preference to this configuration because allegedly all planets were visible with the Moon in the eastern morning sky. In reality, however, Mercury and Mars only became visible a couple of weeks later. Furthermore, no super-conjunction preceded this morning conjunction, as there was no disappearance of all planets in the glare of the Sun.




Kaliyuga (Abhyankar)
7 Feb 3104 BCE (-3103) jul., 6:45 LMT, Kurukshetra 76e51,29n59
JD (UT)=587724.5677778, JD (ET)=587725.4597723, delta_t=77068.3 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 313°22'43" (True Citra)
Sidereal time: 14:14:35 (213°38'38")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 334°39'31" | Min/Pis 4°39'31" | UBh | | |
| Sun | 341°07'21" | Min/Pis 11°07'21" | UBh | 1 | 0°00'00" |
| Moon | 320°07'20" | Kum/Aqu 20°07'20" | PBh | 12 | 4°26'40" |
| Mercury | 324°51'59" | Kum/Aqu 24°51'59" | PBh | 12 | 2°24'59" |
| Venus | 314°19'30" | Kum/Aqu 14°19'30" | Sat | 12 | -0°30'22" |
| Mars | 324°32'11" | Kum/Aqu 24°32'11" | PBh | 12 | -1°06'48" |
| Jupiter | 306°49'45" | Kum/Aqu 6°49'45" | Sat | 12 | -0°34'07" |
| Saturn | 299°34'13" | Mak/Cap 29°34'13" | Dha | 11 | -0°00'32" |
| Rahu | 232°56'04" | Vrk/Sco 22°56'04" | Jye | 9 | |
| Ketu | 52°56'04" | Vrb/Tau 22°56'04" | Roh | 3 | |

## The Clustering of Planets in 3143 BCE

The planetary clustering of 3102 is linked to the beginning of *kali-yuga* and the death of Kṛṣṇa. According to the Mahābhārata, the great battle took place 36 years before the death of Kṛṣṇa. And, as has been shown, the epic mentions a super-conjunction during that year in which the battle took place. It is impossible, however, that two planetary clusters ever take place within 36 years. For astronomical reasons, the shortest possible interval is 38 or 39 years. This can be explained by the fact that Jupiter-Saturn conjunctions, which are part of every planetary clustering, take place only, approximately every 20 years. Hence, if a super-conjunction took place during the battle, this rules out another planetary clustering 36 years later. It can thus be said that the *kaliyuga* era commencing in 3102 BCE is in contradiction with the information given by the Mahābhārata. This means that, if one wanted to adhere to the *kaliyuga* era at any rate, then the war could not have taken place 36 earlier, in the year 3139/3138 BCE. Sky maps for that year are shown on p. 182ff. As can be seen, there was no actual "planetary clustering" in that year. As will be shown, some sort of a clustering can be found only, if the "36 years" are corrected to 38 to 41 years.

Now, the Mahābhārata demands that at the time of the war, and thus at the time of the super-conjunction, a new moon occurred in the lunar mansion *Jyeṣṭhā* (near Antares) and a full moon took place that was assigned to the month of Kārttika and therefore must have been located in one of the two lunar mansions Kṛttikā or Rohiṇī.[105] From this it must be concluded that the super-conjunction took place somewhere near the *nakṣatra* Jyeṣṭhā. The tradition of the *kaliyuga* era 3102 BC, on the other hand, wants a super-conjunction at the beginning of the sidereal zodiac near the fixed star *Revatī (ζ Piscium)*. Although there is no evidence for this view in the Mahābhārata or the Purāṇas, let it be assumed correct for the sake of argument. If a similarly wide distribution of the planets is accepted for the month of the war as was given on the *kaliyuga* commencement date, then a reasonably fitting configuration is found in the autumn

[105] P. V. Holay, "The Year of Kaurava-Pāṇḍava War".

of the year 3143 BCE, 41 years before the *kaliyuga* era began or 39 years before Abhyankar's and Ballabh's *kaliyuga* conjunction. This year of war has been proposed by P.V. Holay. The question is therefore how well the clustering of 3143 BCE accords with the information given in the Mahābhārata. The temporal evolution of this clustering must be examined more closely:

1. On 14th September 3143 BCE there was a new moon in the lunar mansion Svāti. The planets were scattered over an area of 45°. Venus and Mars were visible as morning stars, Jupiter as an evening star. Saturn and Mercury were too close to the Sun to be seen.

2. On 13th October a new moon took place shortly before the star Jyeṣṭhā (Antares). The planets were distributed over an area of 36°. One day earlier, all planets except Jupiter were gathered about the Moon in the morning sky. Jupiter was too close to the Sun to be visible.

3. On 13th November, a new moon occurred between the stars Pūrvāṣāḍhā and Uttarāṣāḍhā. The planets were scattered within a range of 51°. There was a partial solar eclipse. Two days earlier, all planets except Mercury were visible in the morning sky together with the Moon. Mercury was too close to the Sun to be seen.

It turns out that at no time in that year did all the planets disappear in the glare of the Sun. Also to note, at no time in the same year were all planets seen in the morning sky together with the Moon.

P.V. Holay assumes the beginning of the battle with the solar eclipse on the new moon of 13th November, 3143 BCE (hence on the third date in the above list).[106] Incidentally, this new moon took place between the junction stars Pūrvāṣāḍhā and Uttarāṣāḍhā and therefore does not match the Jyeṣṭhā new moon mentioned in the narrative. The new moon near Jyeṣṭhā took place a month earlier, on 14th October. However, there was no solar eclipse then.

One of the verses mentioning the super-conjunction reads:

[106] op. cit., p. 84.

मघाविषयगः सोमस्तद्दिनं प्रत्यपद्यत (var. प्रत्यदृश्यत)

दीप्यमानाश्च संपेतुर्दिवि सप्त महाग्रहाः

*maghāviṣayagaḥ somastaddinaṃ pratyapadyata* (var. *pratyadṛśyata*)
*dīpyamānāśca saṃpeturdivi sapta mahāgrahāḥ (MBh 6.17.2)*

On that day, the Moon god (Soma) entered the region of Maghā.
The seven great planets burned in the sky and flew together.

Holay believes that this verse refers to 3rd November 3143 BCE[107]. The Moon stood in Maghā, 116° before the Sun, which was in Mūla. However, on this day, Mars, Saturn, Jupiter, and Venus were visible in the morning sky. Thus the former three had already made their heliacal rising, whereas Venus was to have her *final* morning only one month later and was therefore near the *end* of her seven-month-long phase as morning star. Hence there cannot be talk of a "flying together" of the planets. In reality, the planets were already about to separate. On 3rd November, the planets were scattered over 43°. The gathering was closest on 13th October (36°); or, if the Moon is overlooked, on 7th October (34°).

The other important verse for the dating of the super-conjunction states:

निश्चरन्तो व्यदृश्यन्त सूर्यात्सप्त महाग्रहाः

*niścaranto vyadṛśyanta sūryātsapta mahāgrahāḥ* (MBh 8.26(37)34)

The seven planets were seen coming out of the Sun,

This verse refers to the day on which Karṇa died, which in Holay's opinion, was 11th December during the same year.[108] The statement that the planets "came out of the sun" presupposes that they were hidden in the glare of the Sun prior. However, as has been said previously, this was not the case, and therefore the planets could not have "come out" of the Sun. In reality, Venus had just made her final morning in the days before 11th December and had just *entered the light of the Sun*. The Moon, too, who on this day was visible for the last time, was about to enter the glare of the Sun. Saturn was already 77° away from the Sun; he had made his heliacal rising already two months earlier. Mars and Jupiter had also been visible in the morning sky for several weeks. Mercury was just about to appear in the

[107] op. cit., p. 83.

[108] op. cit., p. 85.

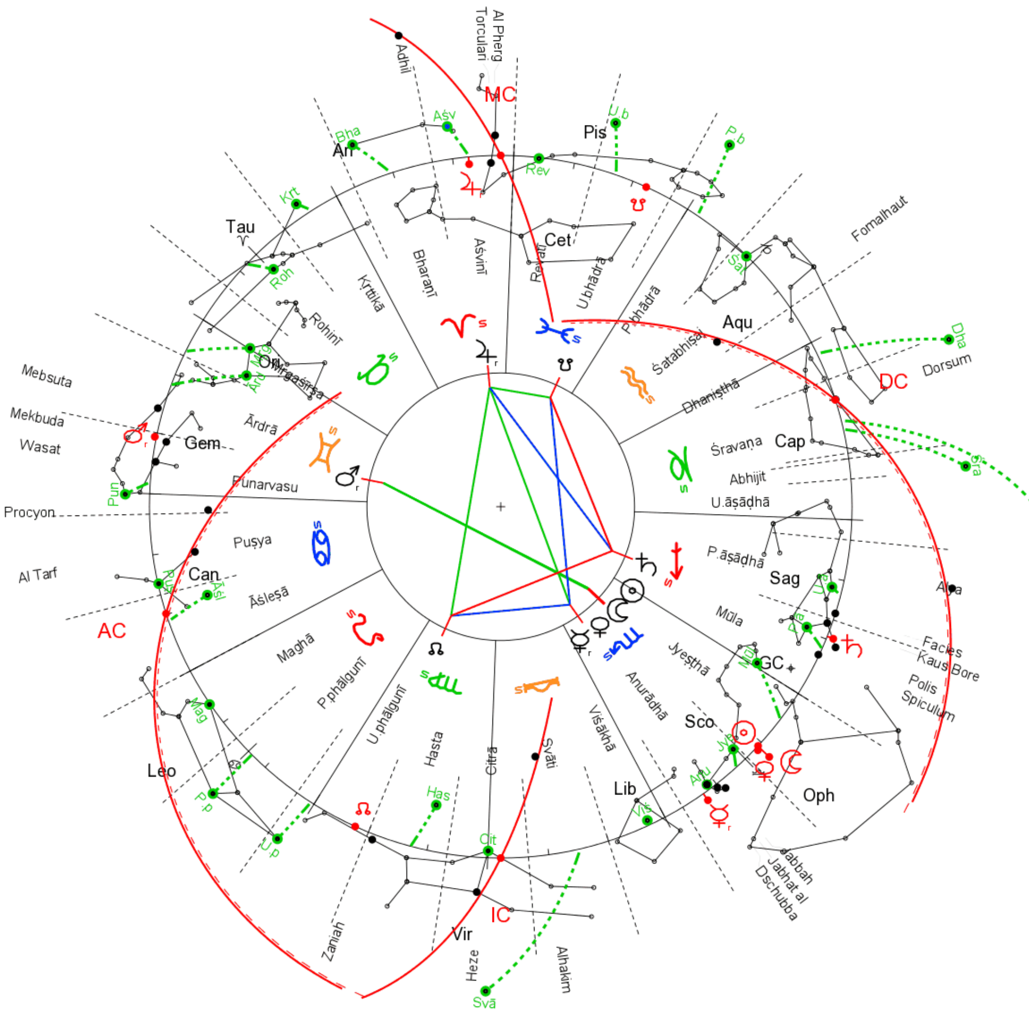
evening sky. Hence, this configuration does not accord at all with the statement that the planets "came out" of the Sun.

It turns out that these configurations are really a far cry from the dynamics of the "flying together" and "emerging from the Sun". Holay's super-conjunction does not accord with the astronomical information given by the epic about the year of the war.

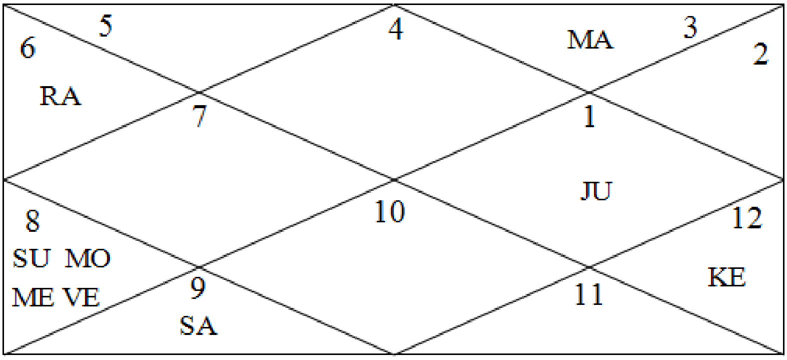
It thus turns out that neither of the two clusters occurring in 3143 or 3102 BCE was close enough to be a real super-conjunction. At no time in these two years did all the planets disappear in the light of the Sun, and, at no time were all the planets seen gathered around the Moon in the morning or evening. Thus the *kaliyuga* era is completely irrelevant to our investigations in the super-conjunction that took place during the great battle. At best, it is interesting that not only the Mahābhārata, but also the tradition itself links the great battle and the *kaliyuga* transition with a conjunction of all the planets.

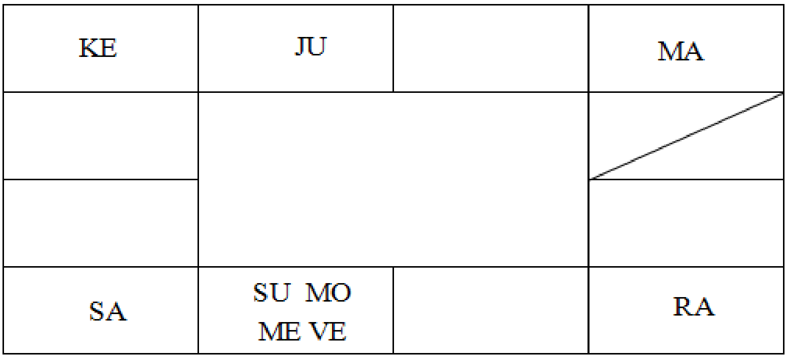
Are there other pairs of clusterings at intervals of 38-39 years that are compatible with the Mahabharata? If one demands super-conjunctions in the strictest sense (type A), where all the planets first disappear in the Sun's light (phase 2) and after that all re-emerge and are visible in conjunction with the Moon in the morning sky (phase 3), then the phenomenon is extremely rare. There are only two years in which this kind of super-conjunctions occurred, 2966 and 1198 BCE. None of these two super-conjunctions are followed by another one taking place four decades later, not even if type B is accepted or only one of the two phases is given.

Of course, one could lessen the requirements and search for pairs of conjunctions where all planets disappear in the glare of the Sun (phase 2) *without* a subsequent gathering of all planets around the old moon (phase 3). As well it could be accepted that such gatherings around the Moon are not preceded by an invisibility of all the planets. In the latter case, in particular, many solutions can be found, because one can define quite arbitrarily how narrow the conjunction should be. It seems unworthy of pursuit, especially since it seems that the double super-conjunction is merely a phantom. The texts seem to indicate only a single super-conjunction at the end of the age, but it seems they are not completely sure about whether it took place during the war or at the time of Kṛṣṇa's death.



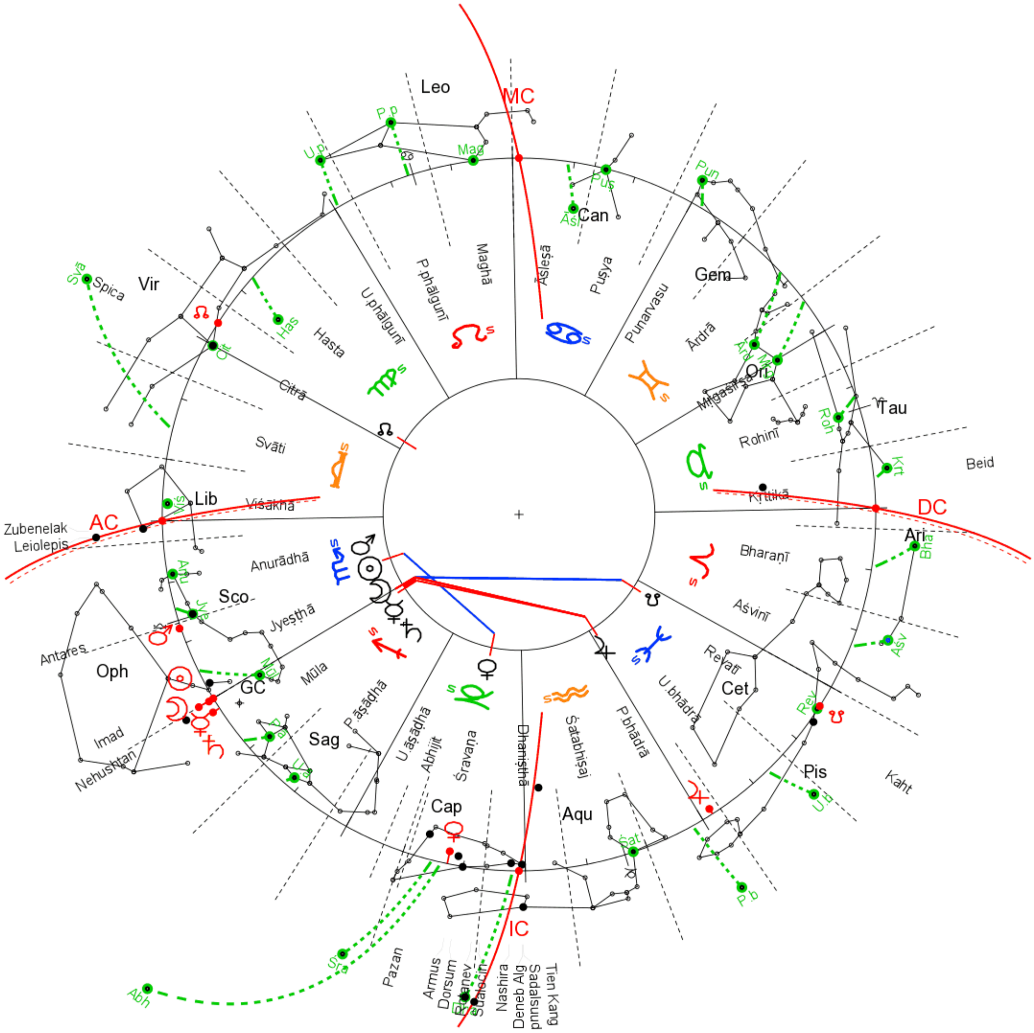

New moon near Jyeṣṭhā (Antares) on 19th October 3138 BCE (9:00 pm), 35½ years before the beginning of Kaliyuga, hence the war configuration as derived from the Kaliyuga date. There was no super-conjunction in this year. Jupiter and Mars were located far off. The position of the lunar nodes also illustrates that eclipses could not have occurred near the Jyeṣṭhā new moon.



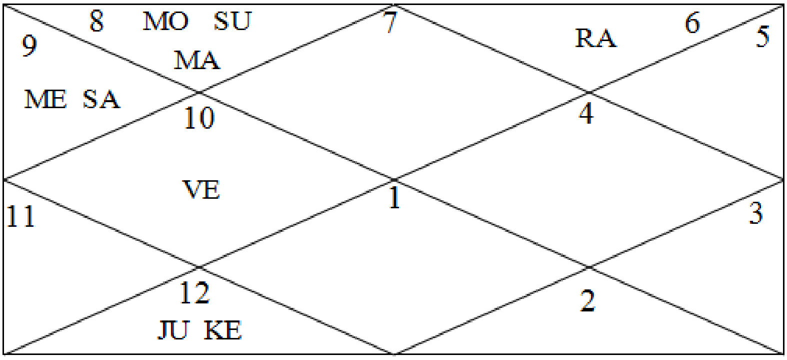



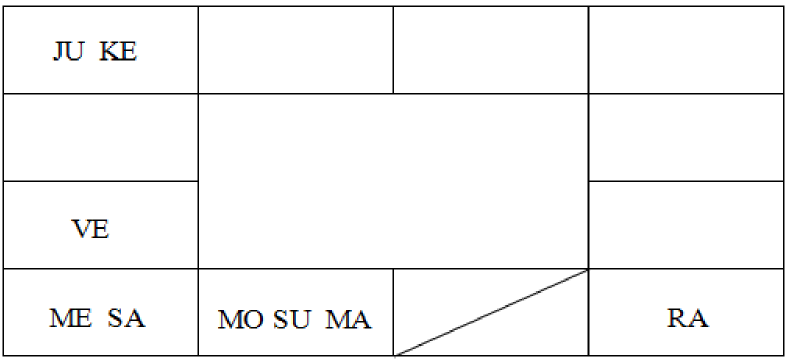

New Moon Near Jyestha 3138 BCE
19 Oct 3138 BCE (-3137) jul., 21:00 LMT, Kurukshetra 76e51,29n59
JD (UT)=575560.1615278, JD (ET)=575561.0656373, delta_t=78115.1 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 312°54'50" (True Citra)
Sidereal time: 21:10:22 (317°35'36")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 109°47'42" | Kar/Can 19°47'42" | Asl | | |
| Sun | 229°11'18" | Vrk/Sco 19°11'18" | Jye | 5 | -0°00'05" |
| Moon | 229°06'21" | Vrk/Sco 19°06'21" | Jye | 5 | 4°00'40" |
| Mercury | 217°18'40" | Vrk/Sco 7°18'40" | Anu | 5 | 2°01'44" |
| Venus | 228°39'49" | Vrk/Sco 18°39'49" | Jye | 5 | 0°43'22" |
| Mars | 80°38'45" | Mit/Gem 20°38'45" | Pun | 12 | 0°25'04" |
| Jupiter | 7°20'50" | Mes/Ari 7°20'50" | Asv | 10 | -1°51'53" |
| Saturn | 250°26'44" | Dha/Sag 10°26'44" | Mul | 6 | 1°39'14" |
| Rahu | 157°36'43" | Kan/Vir 7°36'43" | UPh | 3 | |
| Ketu | 337°36'43" | Min/Pis 7°36'43" | UBh | 9 | |



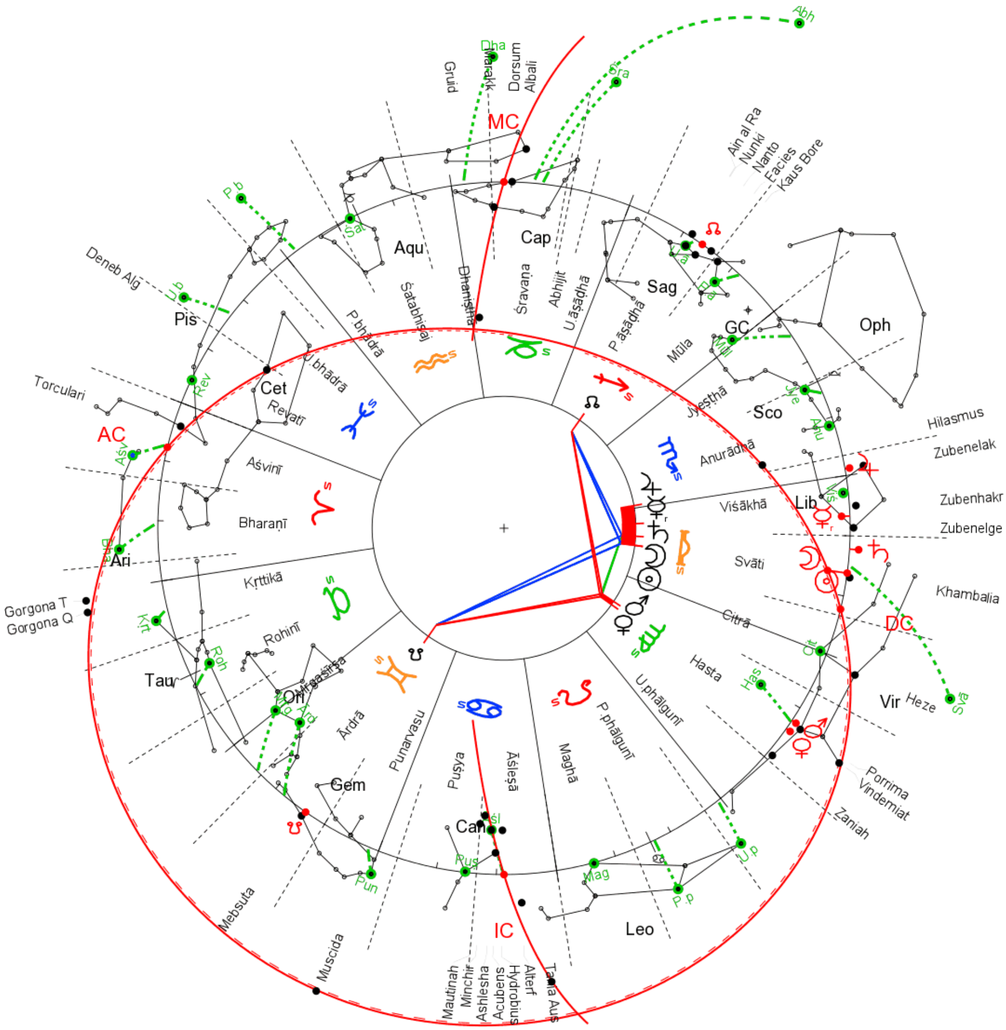

New moon near Jyeṣṭhā (Antares) on 30th October, 3139 BCE (3:49 a.m.), 36½ years before the beginning of Kaliyuga. There was no super-conjunction in this year. Jupiter and Venus were far away from the other planets. The position of the lunar nodes illustrates that eclipses could not have taken place near this date.



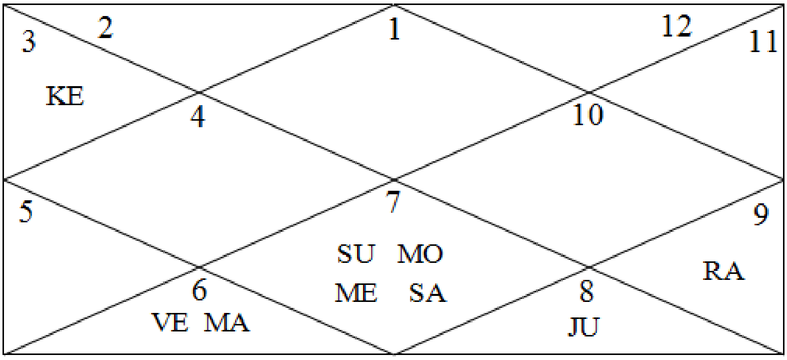



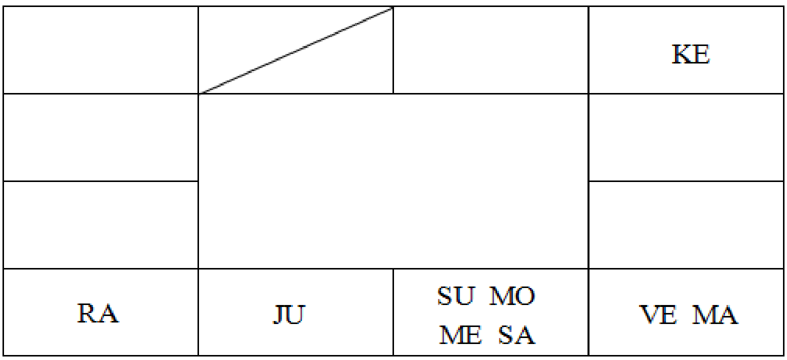

New Moon Near Jyestha 3139 BCE
30 Oct 3139 BCE (-3138) jul., 3:49 LMT, Kurukshetra 76e51,29n59
JD (UT)=575205.4455556, JD (ET)=575206.3500196, delta_t=78145.7 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 312°54'06" (True Citra)
Sidereal time: 4:40:53 (70°13'13")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 209°54'57" | Tul/Lib 29°54'57" | Vis | | |
| Sun | 239°57'59" | Vrk/Sco 29°57'59" | Jye | 2 | 0°00'00" |
| Moon | 239°57'38" | Vrk/Sco 29°57'38" | Jye | 2 | 4°16'45" |
| Mercury | 240°02'06" | Dha/Sag 0°02'06" | Mul | 3 | 1°20'08" |
| Venus | 287°19'00" | Mak/Cap 17°19'00" | Sra | 4 | -3°11'23" |
| Mars | 227°29'37" | Vrk/Sco 17°29'37" | Jye | 2 | 0°20'59" |
| Jupiter | 331°46'44" | Min/Pis 1°46'44" | PBh | 6 | -1°30'27" |
| Saturn | 241°50'00" | Dha/Sag 1°50'00" | Mul | 3 | 1°56'03" |
| Rahu | 176°24'35" | Kan/Vir 26°24'35" | Cit | 12 | |
| Ketu | 356°24'35" | Min/Pis 26°24'35" | Rev | 6 | |



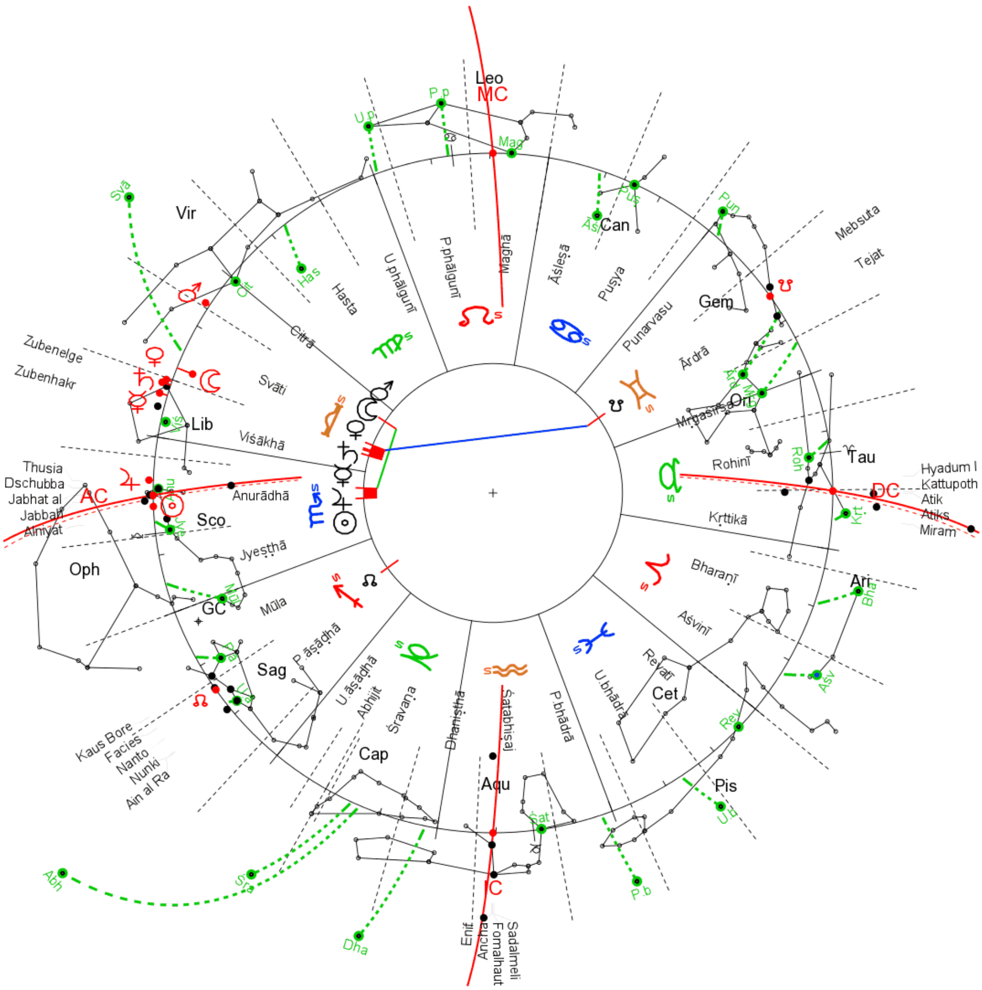
Clustering of planets on the new moon of 14th September, 3143 BCE (6:15 p.m.), 40½ years before the traditional beginning of Kaliyuga or 38½ years before Abhyankar’s and Ballabh’s Kaliyuga date. This is not a super-conjunction in the strict sense. At no time during this year did all planets disappear in the glare of the Sun. The new moon occurred in the lunar mansion Svāti. Jupiter and Venus stood about 45° apart.



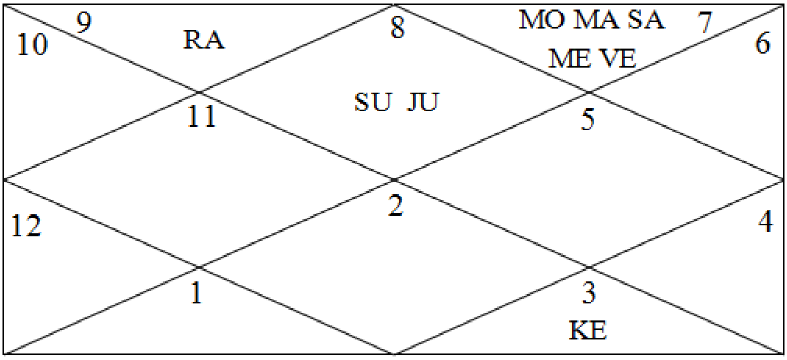



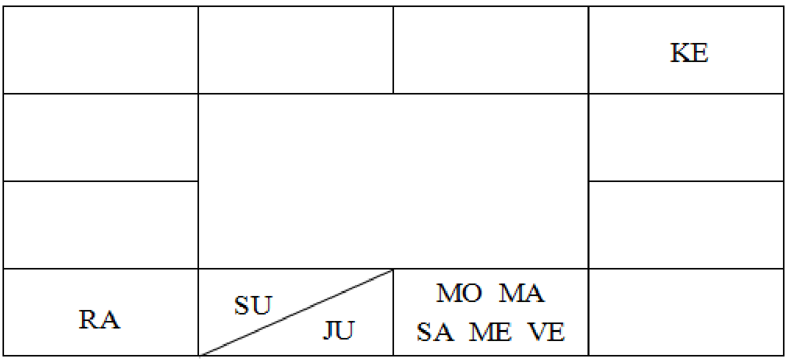

Cluster on New Moon in September 3143 BCE
14 Sep 3143 BCE (-3142) jul., 18:15 LMT, Kurukshetra 76e51,29n59
JD (UT)=573699.0469444, JD (ET)=573699.9529147, delta_t=78275.8 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 312°50'33" (True Citra)
Sidereal time: 16:07:48 (241°56'59")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 7°41'18" | Mes/Ari 7°41'18" | Asv | | |
| Sun | 193°46'01" | Tul/Lib 13°46'01" | Sva | 7 | -0°00'11" |
| Moon | 193°45'53" | Tul/Lib 13°45'53" | Sva | 7 | -5°07'32" |
| Mercury | 203°14'17" | Tul/Lib 23°14'17" | Vis | 7 | -2°10'14" |
| Venus | 165°50'17" | Kan/Vir 15°50'17" | Has | 6 | 1°13'59" |
| Mars | 167°29'29" | Kan/Vir 17°29'29" | Has | 6 | 1°15'30" |
| Jupiter | 211°05'23" | Vrk/Sco 1°05'23" | Vis | 8 | 1°11'49" |
| Saturn | 197°45'01" | Tul/Lib 17°45'01" | Sva | 7 | 2°22'46" |
| Rahu | 256°14'46" | Dha/Sag 16°14'46" | PAs | 9 | |
| Ketu | 76°14'46" | Mit/Gem 16°14'46" | Ard | 3 | |



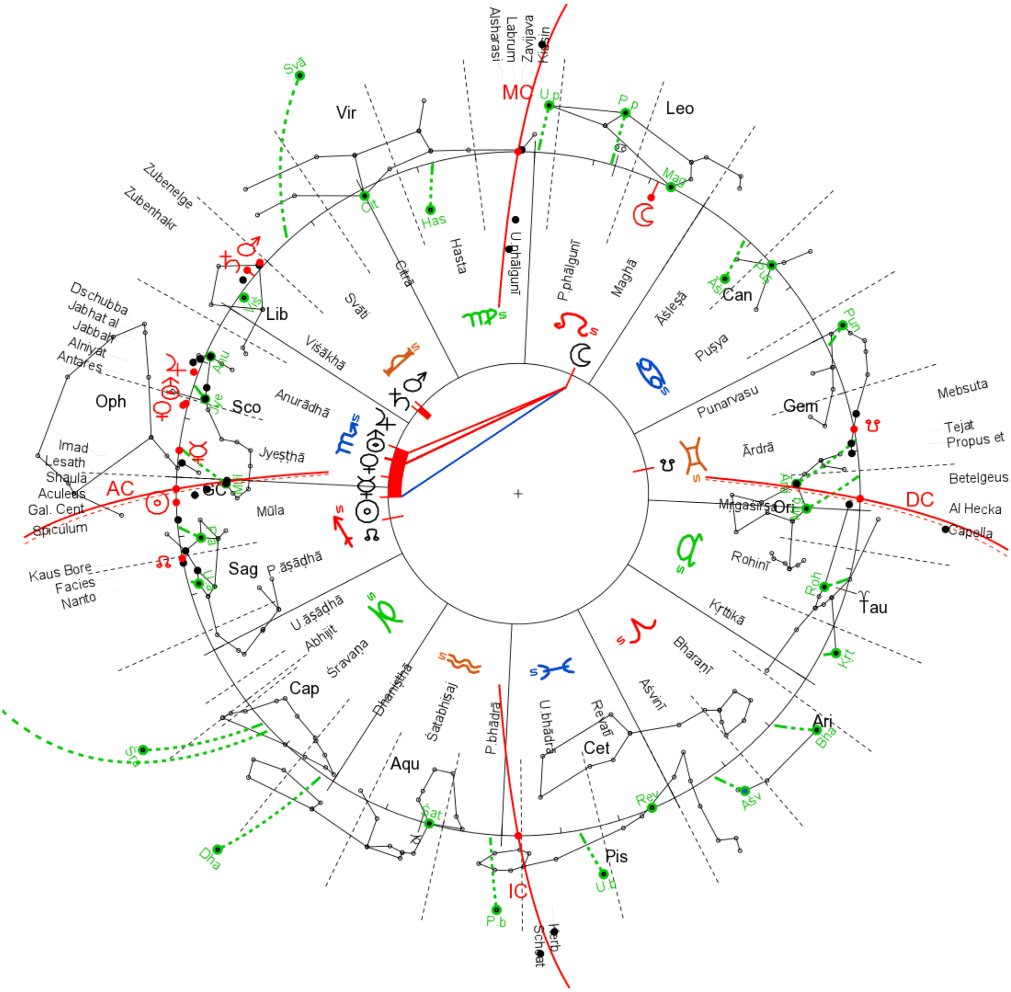
Clustering of the planets around the old moon in the morning of 12th October, 3143 BCE. Jupiter remained invisible, though, and the conjunction remained incomplete. On the next day there was a new moon near Jyeṣṭhā (Antares). Mars and the Sun stood 36° from each other. This is the closest clustering of the year. If the Moon is overlooked, then the clustering of 7th October was slightly closer (34°). There was no solar eclipse on this new moon. There was an eclipse only one month later on 13th November, in the area of the lunar mansions Pūrvāṣāḍhā and Uttarāṣāḍhā.



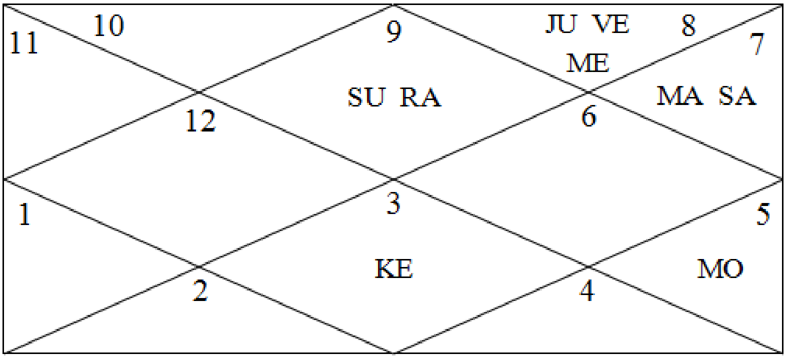



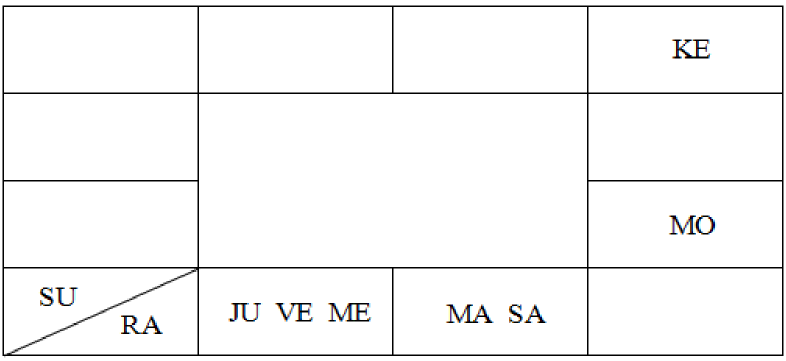

Cluster Around Old Moon in October 3143 BCE
12 Oct 3143 BCE (-3142) jul., 5:45 LMT, Kurukshetra 76e51,29n59
JD (UT)=573726.5261111, JD (ET)=573727.4320539, delta_t=78273.5 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 312°50'41" (True Citra)
Sidereal time: 5:26:08 (81°32'03")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 219°47'10" | Vrk/Sco 9°47'10" | Anu | | |
| Sun | 221°41'12" | Vrk/Sco 11°41'12" | Anu | 1 | -0°00'02" |
| Moon | 197°48'06" | Tul/Lib 17°48'06" | Sva | 12 | -4°28'03" |
| Mercury | 202°42'57" | Tul/Lib 22°42'57" | Vis | 12 | 2°09'10" |
| Venus | 200°14'39" | Tul/Lib 20°14'39" | Vis | 12 | 1°33'46" |
| Mars | 185°55'05" | Tul/Lib 5°55'05" | Cit | 12 | 1°16'00" |
| Jupiter | 217°15'46" | Vrk/Sco 7°15'46" | Anu | 1 | 1°09'49" |
| Saturn | 200°54'21" | Tul/Lib 20°54'21" | Vis | 12 | 2°23'58" |
| Rahu | 254°47'18" | Dha/Sag 14°47'18" | PAs | 2 | |
| Ketu | 74°47'18" | Mit/Gem 14°47'18" | Ard | 8 | |



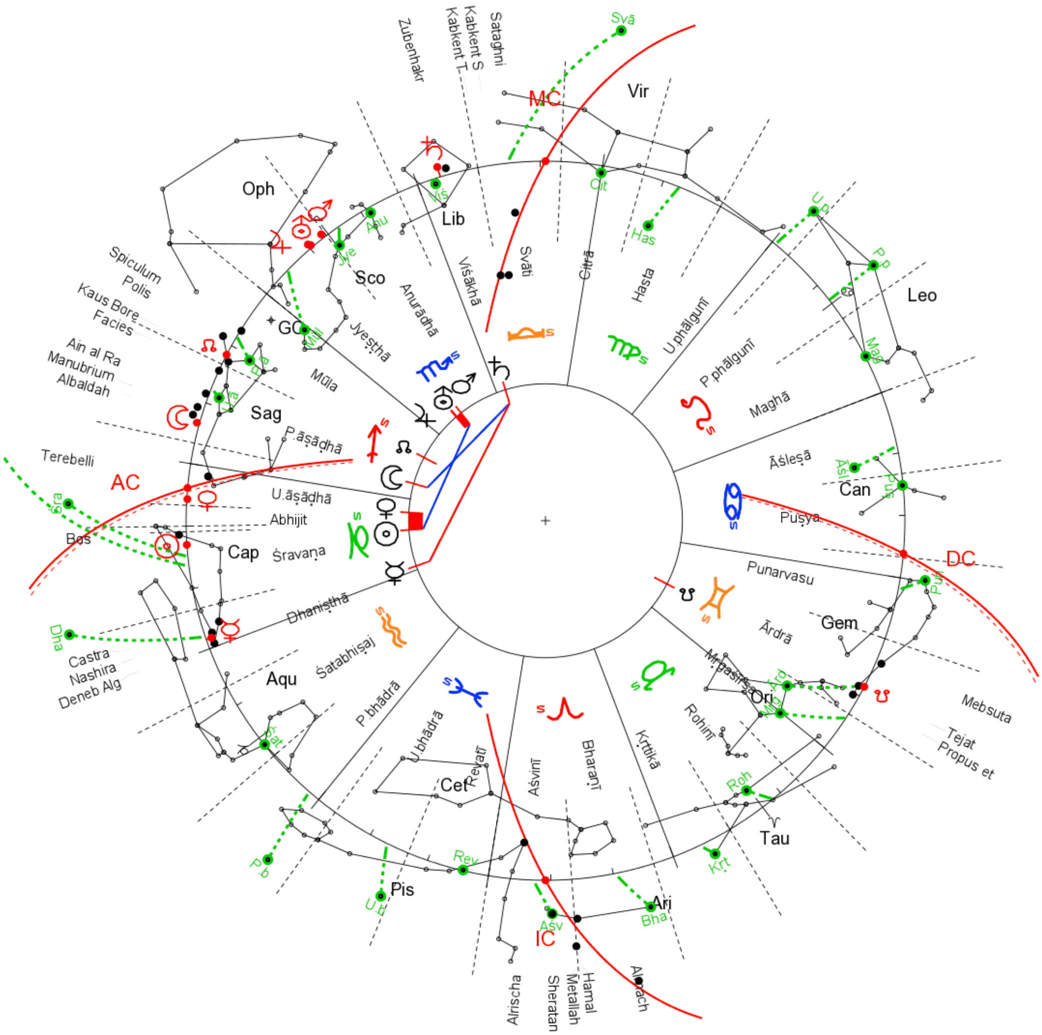

Configuration on 3rd November, 3143 BCE at sunrise. The Moon stood in Maghā and "the seven planets flew together" (MBh. 6.17.2), according to P. V. Holay. However, the planets did *not* disappear in the glare of the Sun. Mars, Jupiter, and Saturn had made their heliacal rising recently. Moreover, it is not the case that all planets were visible before sunrise. Mercury remained invisible, even on 11th November, when the Moon joined the planets. Uranus, which is included in the conjunction by Holay, was also invisible to the naked eye. On 3rd November, the Sun and the planets (without the Moon) were scattered over an area of 43°, on 11th November over an area of 48°. The clustering was narrower on 12th October (36°; see p. 188f.).



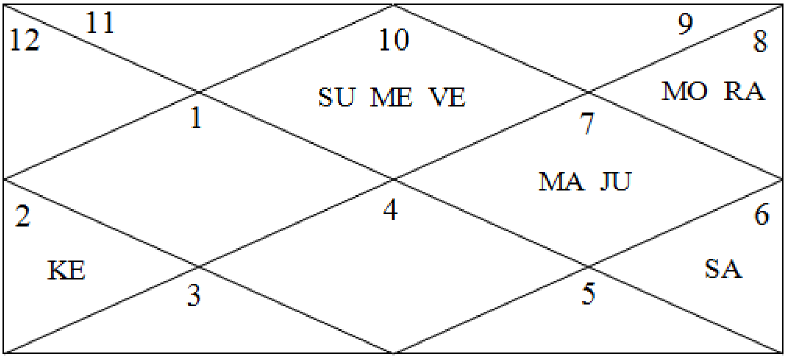



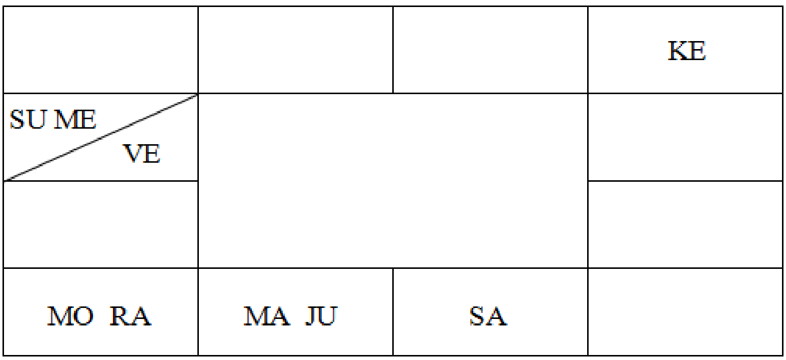

Planets Flew Together (Holay)
3 Nov 3143 BCE (-3142) jul., 6:00 LMT, Kurukshetra 76e51,29n59
JD (UT)=573748.5365278, JD (ET)=573749.4424485, delta_t=78271.6 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 312°50'51" (True Citra)
Sidereal time: 7:07:55 (106°58'46")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 241°54'43" | Dha/Sag 1°54'43" | Mul | | |
| Sun | 244°11'01" | Dha/Sag 4°11'01" | Mul | 1 | 0°00'01" |
| Moon | 128°32'51" | Sim/Leo 8°32'51" | Mag | 9 | -4°34'29" |
| Mercury | 235°26'41" | Vrk/Sco 25°26'41" | Jye | 12 | -0°04'24" |
| Venus | 227°56'44" | Vrk/Sco 17°56'44" | Jye | 12 | 1°11'50" |
| Mars | 200°53'31" | Tul/Lib 20°53'31" | Vis | 11 | 1°13'58" |
| Jupiter | 222°10'27" | Vrk/Sco 12°10'27" | Anu | 12 | 1°09'26" |
| Saturn | 203°12'44" | Tul/Lib 23°12'44" | Vis | 11 | 2°26'41" |
| Rahu | 253°37'13" | Dha/Sag 13°37'13" | PAs | 1 | |
| Ketu | 73°37'13" | Mit/Gem 13°37'13" | Ard | 7 | |




Configuration on 11th December, 3143 BCE. In P. V. Holay’s opinion, this was the day when Karṇa died and when, according to Mahābhārata, the planets “emerged from the Sun” (MBh 8.26(37)34). In reality, Venus had just entered the Sun a couple of days earlier. The Moon was visible for the last time this morning and was also about to enter the Sun. Mars, Jupiter, and Saturn had made their heliacal rising already several weeks earlier.




Planets Emerged from the Sun / Karna Died (Holay)
11 Dec 3143 BCE (-3142) jul., 6:00 LMT, Kurukshetra 76e51,29n59
JD (UT)=573786.5365278, JD (ET)=573787.4424105, delta_t=78268.3 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 312°51'09" (True Citra)
Sidereal time: 9:37:45 (144°26'10")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 273°51'47" | Mak/Cap 3°51'47" | UAs | | |
| Sun | 282°56'15" | Mak/Cap 12°56'15" | Sra | 1 | 0°00'03" |
| Moon | 263°23'06" | Dha/Sag 23°23'06" | PAs | 12 | 0°38'54" |
| Mercury | 298°22'14" | Mak/Cap 28°22'14" | Dha | 1 | -1°22'18" |
| Venus | 275°38'29" | Mak/Cap 5°38'29" | UAs | 1 | -0°10'48" |
| Mars | 227°09'39" | Vrk/Sco 17°09'39" | Jye | 11 | 1°03'26" |
| Jupiter | 229°47'58" | Vrk/Sco 19°47'58" | Jye | 11 | 1°11'13" |
| Saturn | 206°06'31" | Tul/Lib 26°06'31" | Vis | 10 | 2°34'38" |
| Rahu | 251°36'09" | Dha/Sag 11°36'09" | Mul | 12 | |
| Ketu | 71°36'09" | Mit/Gem 11°36'09" | Ard | 6 | |

# *The Seven Ṛṣis and Varāhamihira's* Kaliyuga *Era*

## Conjunction of the Seven Ṛṣis at the Beginning of *Kaliyuga*

There is a text found in several of the Purāṇas that links the beginning of the Kaliyuga with the death of Kṛṣṇa. However, instead of a conjunction of all planets, it mentions a conjunction of the Seven Ṛṣis in the lunar mansion Maghā. This text can be found in several different variations in VP 4.24.102ff., BhP 12.2.24ff., BrAP 2.74.225ff., MatsyaP 271.38ff. The text begins as follows:[109]

> यावत्परीक्षितो जन्म यावन्नन्दाभिषेचनम्
>
> एतद्वर्षसहस्रं तु ज्ञेयं पञ्चदशोत्तरम् (VP 4.24.24)
>
> (एतद्वर्षसहस्रं तु ज्ञेयं पञ्चाशदुत्तरम् (BndP 2.74.227))
>
> (एतद्वर्षसहस्रं तु शतं पञ्चदशोत्तरम् (BhP 12.2.26))
>
> (एकमेव सहस्रं तु ज्ञेयं पञ्चशतोत्तरम् (MatsyaP 271.38))
>
> *yāvatparīkṣito janma yāvannandābhiṣecanam*
> *etadvarṣasahasraṃ tu jñeyaṃ pañcadaśottaram (VP 4.24.24)*
> (*etadvarṣasahasraṃ tu jñeyaṃ pañcāśaduttaram (BndP 2.74.227)*)
> (*etadvarṣasahasraṃ tu śataṃ pañcadaśottaram (BhP 12.2.26)*)
> (*ekameva sahasraṃ tu jñeyaṃ pañcaśatottaram (MatsyaP 271.38)*)

> From the birth of Parīkṣit until the inauguration of Nanda,
> one must know, there are 1015 (var. 1050, 1115, 1500) years.

Parīkṣit is the first king of Hastināpura after Yudhiṣṭhira. His inauguration took place after Kṛṣṇa's funeral, when Yudhiṣṭhira and his brothers renounced the kingdom and abdicated. Nanda is also called Mahāpadma in some versions of the text. He was the first king of the Nanda dynasty of Magadha. According to the Viṣṇupurāṇa, the Nandas ruled for about 100 years and were followed by Chandragupta Maurya, who seized power over Maghada in 321

---

[109] http://gretil.sub.uni-goettingen.de/#Pur ; cf. Pargiter, *The Purāṇa Text of the Dynasties of the Kali Age*, p. 57ff.

BCE. The great number of variations of this text, e.g. the numbers of years mentioned, illustrates the text's poor transmission. It is difficult to have confidence in any data given in it. Since the time between Parīkṣit's seizure of power and Mahāpadma is between 1000 and 1500 years, Parīkṣit's lifetime and the Mahābhārata battle would have fallen between the 20th and the 15th century BCE. This is in stark contrast to the traditional *kaliyuga* era, said to begin in 3102 BC.[110]

The text continues:

> सप्तर्षीणां तु यौ पूर्वौ दृश्येते ह्युदितौ दिवि
>
> तयोस्तु मध्ये नक्षत्रं दृश्यते यत्समं निशि
>
> *saptarṣīṇāṃ tu yau pūrvau dṛśyete hyuditau divi*
> *tayostu madhye nakṣatraṃ dṛśyate yatsamaṃ niśi (VP 4.24.105)*

| |
|---|
| Of the first two of the Seven Ṛṣis who are seen rising in the sky, exactly in their middle is seen the junction star at night. |

> तेन सप्तर्षयो युक्तास्तिष्ठन्त्यब्दशतं नृणाम्
>
> ते तु पारीक्षिते काले मघास्वासन्द्विजोत्तम
>
> *tena saptarṣayo yuktāstiṣṭhantyabdaśataṃ nṛṇām*
> *te tu pārīkṣite kāle maghāsvāsandvijottama (VP 4.24.106)*

| |
|---|
| The Seven Ṛṣis stand in conjunction with this [junction star] for 100 years according to human [calculation].<br>And in the time of Parīkṣit they were in the [lunar mansion] Maghā, O best one of the twice-born. |

The Seven Ṛṣis – whoever they might be – gather and form a conjunction in the lunar mansion Maghā. At first only two leading ones gather about the junction star Maghā (Regulus), later all the seven join them. The conjunction lasts for 100 years, during the reign of King Parīkṣit.

---

[110] However, traditionalists shun no effort in order to defend the Kaliyuga Era 3102 BCE. For that purpose, they are even ready to rewrite not only the whole history of India, but even the whole world history. The flowers of these absurd efforts: Buddha was allegedly born in 1887 BCE, Candragupta Maurya crowned in 1534 BCE, Aśoka in 1472 BCE, Śaṅkara was born in 509 BCE, etc. etc. (see K. Venkatachelam, *The Plot in Indian Chronology*, Appendix III). I shall not dwell on this, but refer to T. S. Kuppanna Sastry, *Collected Papers on Jyotisha*, p. 255-317, where the thinking errors in such approaches are exposed.

तदा प्रवृत्तश्च कलिर्द्वादशाब्दशतात्मकः

*tadā pravṛttaśca kalirdvādaśābdaśatātmakaḥ (VP 4.24.107)*

| |
|---|
| Then the Kali [age] began, which by nature lasts for 1200 years [of gods]. |

यदैव भगवान्विष्णोरंशो यातो दिवं द्विज

वसुदेवकुलोद्भूतस्तदैवात्रागतः कलिः

*yadaiva bhagavānviṣṇoraṃśo yāto divaṃ dvija*
*vasudevakulodbhūtastadaivātrāgataḥ kaliḥ (VP 4.24.108)*

| |
|---|
| When the holy one, the part of Viṣṇu (i. e. Kṛṣṇa), went to the sky, O twice-born one,<br>who was born from the family of Vasudeva, then the Kali [age] had arrived. |

यावत्सपादपद्माभ्यां पस्पर्शेमां वसुंधराम्

तावत्पृथ्वीपरिष्वङ्गे समर्थो नाभवत्कलिः

*yāvatsapādapadmābhyāṃ pasparśemāṃ vasuṃdharām*
*tāvatpṛthvīpariṣvaṅge samartho nābhavatkaliḥ (VP 4.24.109)*

| |
|---|
| As long as he touched this earth with his lotus feet,<br>so long the Kali [age] was not able, to twine around the earth. |

गते सनातनस्यांशे विष्णोस्तत्र भुवो दिवम्

तत्याज सानुजो राज्यं धर्मपुत्रो युधिष्ठिरः

*gate sanātanasyāṃśe viṣṇostatra bhuvo divam*
*tatyāja sānujo rājyaṃ dharmaputro yudhiṣṭhiraḥ (VP 4.24.110)*

| |
|---|
| However, when that part of the everlasting Viṣṇu had ascended from the earth to the sky,<br>Yudhiṣṭhira, the son of *dharma*, together with his brothers gave up the kingdom. |

विपरीतानि दृष्ट्वा च निमित्तानि हि पाण्डवः

याते कृष्णे चकाराथ सोऽभिषेकं परीक्षितः

*viparītāni dṛṣṭvā ca nimittāni hi pāṇḍavaḥ*
*yāte kṛṣṇe cakārātha so 'bhiṣekaṃ parīkṣitaḥ (VP 4.24.111)*

| |
|---|
| For, when Yudhiṣṭhira (Pāṇḍava) saw inauspicious omens,<br>after Kṛṣṇa had passed away, he arranged the inauguration of Parīkṣit. |

→

प्रयास्यन्ति यदा चैते पूर्वाषाढां महर्षयः

(BhP: यदा मघाभ्यो यास्यन्ति पूर्वाषाढां महर्षयः

तदा नन्दात्प्रभृत्येष गतिवृद्धिं गमिष्यति

*prayāsyanti yadā caite pūrvāṣāḍhāṃ maharṣayaḥ*
(BhP: *yadā maghābhyo yāsyanti pūrvāṣāḍhāṃ maharṣayaḥ (32)*)
*tadā nandātprabhṛtyeṣa gativṛddhiṃ gamiṣyati (VP 4.24.112)*

When these [seven] great Ṛṣis enter the [lunar mansion] Pūrvāṣāḍhā,
(var. When the [seven] great Ṛṣis go from the Maghās to Pūrvāṣāḍhā,)
then, starting from Nanda, that [Kali age] will increasingly take its course.

यस्मिन्कृष्णो दिवं यातस्तस्मिन्नेव तदाहनि

प्रतिपन्नं कलियुगं तस्य संख्यां निबोध मे

*yasminkṛṣṇo divaṃ yātastasminneva tadāhani*
*pratipannaṃ kaliyugaṃ tasya saṃkhyāṃ nibodha me (VP 4.24.113)*

On the day that Kṛṣṇa went to the sky, precisely on that [day]
began the Kali age. Hear its calculation from me:

Verse 112 mentions another conjunction of the Seven Ṛṣis that took place in the lunar mansion Pūrvāṣāḍhā, about 1000 years later at the inauguration of King Nanda. Hence, taking into account the verse further above concerning the years elapsed between Parīkṣit and Nanda, it follows that the correct number of years must be either 1015 or 1050 years. Hence, Parīkṣit's life time would fall into the 15th century BCE.

The longer text version of Brahmāṇḍapurāṇa (BrAP 2.74.228-233b) includes some additional verses that say that it takes the Seven Ṛṣis 2700 years to complete the whole circle of the *nakṣatras* and that they spend 100 years in each *nakṣatra*. This information is in agreement with the above-mentioned statements that the Seven Ṛṣis once formed a conjunction in the lunar mansion Maghā and 1000 years later another conjunction in Pūrvāṣāḍhā.

But who are the Seven Ṛṣis, and what kind of astronomical phenomenon is hidden behind this "theory"? Tradition identifies them with the constellation Ursa Major, and the astrologer Varāhamihira in his *Bṛhatsaṃhitā* (chap. 13) is in agreement:

सैकावलीव राजति ससितोत्पलमालिनी सहासेव

नाथवतीव च दिग्यैः कौबेरी सप्तभिर्मुनिभिः

*saikāvalīva rājati sasitotpalamālinī sahāseva*
*nāthavatīva ca digyaiḥ kauberī saptabhirmunibhiḥ (BṛS 13.1)*

The Seven Sages, who cause the north to shine with a bead necklace, as it were, [through whom the north] laughs with a crown of white lotus flowers, as it were, whom [the north] has as its lords, as it were,

ध्रुवनायकोपदेशान्नरिनर्त्तीवोत्तरा भ्रमद्भिश्च

यैश्चारमहं तेषां कथयिष्ये वृद्धगर्गमतात्

*dhruvanāyakopadeśānnarinarttīvottarā bhramadbhiśca*
*yaiścāramahaṃ teṣāṃ kathayiṣye vṛddhagargamatāt (BṛS 13.2)*

who, commanded by the leadership of the pole star (*dhruva*) revolve and cause [the north] to dance [in circles], – I shall explain the motion of these [Seven Sages] according to the teaching of Vṛddhagarga.

In any case, there can be no doubt that in Varāhamihira's opinion, the Seven Ṛṣis are a constellation near the celestial north pole.

The subsequent verses talk of exactly the same theory that also appears in the Purāṇas:

आसन्मघासु मुनयः शासति पृथ्वीं युधिष्ठिरे नृपतौ

षड्द्विकपञ्चद्वियुतः शककालस्तस्य राज्ञश्च

*āsanmaghāsu munayaḥ śāsati pṛthvīṃ yudhiṣṭhire nṛpatau*
*ṣaḍdvikapañcadviyutaḥ śakakālastasya rājñaśca (BṛS 13.3)*

The Seven Sages were in Maghā when King Yudhiṣṭhira ruled the earth, and the Śaka Era and [the era] of this king are 2526 [years] apart.

एकैकस्मिन्नृक्षे शतं शतं ते चरन्ति वर्षाणां

प्रागुदयतोऽप्यविवराद्दजून्नयति तत्र संयुक्ताः

*ekaikasminnṛkṣe śataṃ śataṃ te caranti varṣāṇāṃ*
*prāgudayato'pyavivarādṛjūnnayati tatra saṃyuktāḥ (BṛS 13.4)*

One lunar mansion by one they move 100 years in each.
[The lunar mansion] that from the rising in the east leads them in direct line, – that is where they are in conjunction.

King Yudhiṣṭira was inaugurated after the end of the Mahābhārata battle. According to the above verses, this happened 2526 years before the Śaka Era, which is counted from the year 78 CE. From this, it can be calculated that the year of the battle was 2449 BCE. (-2448). I shall not dwell on the absurd mental gymnastics by which traditionalists try to reconcile Varāhamihira's statement with the *kaliyuga* commencement being the year 3102 BCE.[111] More interesting are the astronomical clues given by the text.

The last sentence of Varāhamihira seems to refer to a heliacal rising of a lunar mansion that is somehow connected with the Seven Sages or Ursa Major by a straight line. Astronomically, however, all this does not make any sense.

The position of the stars in Ursa Major relative to other constellations is very stable over many millennia. It is impossible that they wander into the lunar mansion Maghā, let alone through the whole circle of *nakṣatras*. Do they change their position in some other way that makes it possible to correlate them to some *nakṣatra*, and does this correlation change every 100 years? Some believe that the wandering of the Seven Ṛṣis could be explained by their position relative to the celestial north pole, which changes due to the precession of the equinoxes. Ratnagarbha Bhaṭṭācārya gives the following explanation in his commentary on Viṣṇupurāṇa:[112]

> तत्र यौ पूर्वौ प्रथमोदितौ पुलहक्रतुसंज्ञौ तयोस्तत्पूर्वयोश्च मध्ये समं दक्षिणोत्तररेखायां समदेशावस्थितं यदश्विन्यादिनक्षत्रेष्वन्यतमनक्षत्रं दृश्यते तेन तथैव युक्ता नृणामब्दशतं तिष्ठन्ति
>
> *tatra yau pūrvau prathamoditau pulahakratusaṃjñau tayostatpūrvayoś-ca madhye samaṃ dakṣiṇottararekhāyāṃ samadeśāvasthitaṃ yadaśviny-ādinakṣatreṣvanyatamanakṣatraṃ dṛśyate tena tathaiva yuktā nṛṇām-abdaśataṃ tiṣṭhanti*

> From the two of them that rise first and are called Pulaha and Kratu – from the middle of these two and the two that follow them a line [is drawn] from south to north, and in the same place one sees one of the lunar mansions Aśvinī etc., and [the Seven Ṛṣis] stand in conjunction with it for 100 human years.

[111] They attempt to interpret Varāhamihira's Śaka Era as an otherwise unattested era of the Persians that counted years from 550 BCE. T. S. Kuppanna Sastry has exposed the absurdity of this idea in: *Collected Papers on Jyotisha*, p. 255-317.

[112] *Śrīmadviṣṇupurāṇam*. With the commentary of Ratnagarbha Bhaṭṭācārya called *Vaiṣṇavākūtacandrikā*. Bombay: Śaka 1824 [1902].

Thus, a "straight line" (a great circle) is drawn through the celestial north pole and the centre of the rectangle of the Big Dipper – or, depending on the preferred interpretation, only through the middle between the first two stars of the constellation –, and this line intersects with some lunar mansion. Due to precession, this line changes ist position and direction and intersects with different *nakṣatras* over the millennia. However, the idea of a regular motion of 100 years per *nakṣatra* cannot be realised like this. In reality it is usually more than 1000 years per *nakṣatra*, and the motion is not regular either.[113]

Besides, this solution does not explain why the Viṣṇupurāṇa and Varāhamihira mention the "rising" of the Ṛṣis and the lunar mansion that is correlated with them. Varāhamihira even calls it a "rising in the *east*". The solution with the lines or great circles through the celestial pole, does not consider any "risings" of Ursa Major. Besides, this constellation is located so far in the north that it *cannot* rise in the east at all. Thus it seems that a different solution needs to be sought.

A rising of the Seven Ṛṣis is also mentioned in Harivaṃśa, just before Kṛṣṇa's fight with the demon Cāṇūra:

[113] I calculated the epochs for the Seven Ṛṣis in Maghā for both calculation methods and using *nakṣatra* boundaries based on the Lahiri *ayanāṃśa*:

1. The line is drawn through the midpoint between the first two stars of the Big Dipper (Kratu and Pulaha = α and β Ursae maioris = Dubhe and Merak). It intersected the ecliptic within Maghā between 850 BCE and 475 CE, hence for a period of more than 1300 years. The main star Regulus was hit by the line in the year 315 BCE.

2. The line is drawn through the midpoint of the rectangle of the Big Dipper (I use the midpoint between Kratu and Pulastya = α and γ Ursae Maioris = Dubhe and Phecda). Then the Maghā epoch lasted from 1705 BCE to 660 CE, and Regulus was hit in 1250 BCE.

These calculations cannot be completely precise because it is unknown where the zero point of the *nakṣatra* system must be assumed. The calculation for the star Regulus are accurate, though. In any case it is obvious that this approach does not result in periods of 100 years per lunar mansion. Cf. also the considerations by Aniket Sule et alii, "Saptarṣi's visit to different *Nakṣatras*: Subtle effect of Earth's precession".

अन्तर्धानगता देवा विमानैः कामरूपिभिः

चेरुर्विद्याधरैः सार्धं कृष्णस्य जयकाङ्क्षिणः

*antardhānagatā devā vimānaiḥ kāmarūpibhiḥ* |
*cerurvidyādharaiḥ sārdhaṃ kṛṣṇasya jayakāṅkṣiṇaḥ HV 2.30.40*

The gods went into invisibility with their celestial chariots that can assume any shape,
together with the Vidyādharas, desiring Kṛṣṇa's victory.

जयस्व कृष्ण चाणूरं दानवं मल्लरूपिणम्

इति सप्तर्षयः सर्वे ऊचुश्चैव नभोगताः

*jayasva kṛṣṇa cāṇūraṃ dānavaṃ mallarūpiṇam* |
*iti saptarṣayaḥ sarve ūcuścaiva nabhogatāḥ HV 2.30.41*

"Defeat the demon Cāṇūra, O Kṛṣṇa, who has the appearance of a wrestler",
so said the Seven Ṛṣis, too, after they had risen to the sky.

Do the texts quoted above refer to a *simultaneous rising* of the Seven Ṛṣis with a lunar mansion? As a matter of fact, such a correlation would again be subject to change, due to the precession of the equinoxes. However this approach has its own problems. The stars of Ursa Major are located so far in the north that the larger part of the constellation always remains above the horizon for Indian observers.[114] The rising of the stars in Ursa Major could have, at best been observable in southern India. Yet, even from there, the rising of those stars took place so slowly and their observation was so dependent on atmospheric conditions that their correlation with the rising of lunar mansions would have been extremely difficult to observe and could not be used for calendar making.

What other interpretations are possible? Could the "rising" be interpreted as the lower of upper culmination of the first stars of Ursa Major? Could it be possible for one to observe the moment at which they begin to rise or reach the culmination of their diurnal motion? This kind of observation, namely observations of meridian transits, are possible with high accuracy. They could also be linked to the

[114] In 3000 BCE, the southern-most star of Ursa Major touched the horizon only for observers south of 24°N, in 2000 BCE only for observers south of 22°N. Kurukṣetra is located at the geographic latitude 29N59, Mathurā at 27N30, Dvārakā at 22N23.

synchronous rising of a lunar mansion. However, when it is calculated which epoch the rising of Maghā was synchronous with a meridian transit of the first stars in Ursa Major, then the results are not convincing at all. Between 3000 and 1000 BCE and for the geographic latitude of Mathurā (27N30), lunar mansions in the area of sidereal Pisces, Aries, or Taurus (according to Lahiri) would match; or if the upper culmination is chosen, the lunar mansions match in the area of sidereal Libra and Scorpio. Maghā in Leo is far off from these areas.

Or could the "rising" of the Ṛṣis be interpreted as, the moment the first of them ascends above the altitude of the celestial north pole? Indeed, this moment was synchronous with the rising of Maghā for some time, but not for 100 years, it took over 1000 years.[115]

Another possible explanation for the motion of the Seven Ṛṣis was proposed by Abhyankar and Ballabh:

> Hence, if *Saptarṣis* (the Seven Ṛṣis; D.K.) are supposed to represent the summer solstice, i.e. the northernmost point on the ecliptic, and *nakṣatra* is taken as a *nakṣatra* of the moon, i.e. one day, then we can say that according to Vṛddha Garga the summer solstice shifted by one day, or one degree, backwards in 100 years. ... But it was not properly understood by later astronomers.[116]

Thus the calendar of the Seven Ṛṣis would originate from a precession theory that was based on a precession rate of 1° in 100 years or 1 day in 100 years,[117] which was later misinterpreted as 1 lunar mansion in 100 years, because the Moon moves at the speed of about one lunar mansion every day. This misunderstanding would have resulted in the idea that the Ṛṣis move at a speed of one lunar mansion per 100 years. Unfortunately, even this solution does not explain why according to the texts the Seven Ṛṣis *rise synchronously* with a lunar mansion.

---

[115] If the midpoint between the first two stars is chosen as point of reference, then Maghā is found on the eastern horizon synchronously between 1945 and 725 BCE, and Regulus in the year 1410 BCE. If, on the other hand, the midpoint of the rectangle of the Big Dipper is chosen, then this correlation is given between 2730 and 1680 BCE, and for Regulus in the year 2240 BCE.

[116] Abhyankar and Ballabh, "Kaliyuga, Saptarṣi, Yudhiṣṭhira and Laukika Eras", p. 29f.

[117] Ptolemy's precession rate was also 1° per 100 years.

## Seven Ṛṣis and Seven Planets

Both the fact that the Seven Ṛṣis are said to rise nor the fact that they are said to form conjunctions with lunar mansions are adverse to the stars of Ursa Major, because, strictly speaking, they never rise or set and never form conjunctions with any lunar mansion. Hence, it is obvious that the tradition has been corrupted since antiquity and that the Seven Ṛṣis, at least in Viṣṇupurāṇa 4.24 and its variations in other Purāṇas, do not represent Ursa Major but something else. Although they might represent Ursa Major in other texts, this can be ruled out at least in regards to the texts under discussion.

As the Seven Ṛṣis are said to form conjunctions with *nakṣatras* or junction stars and as they allegedly did so in Maghā at the beginning of the *kaliyuga*, the only reasonable conclusion must be that they represent the seven planets including the Sun and the Moon. This is particularly reasonable because the planetary theory of the Sūryasiddhānta assumes a super-conjunction at the beginning of the *kaliyuga*, and the Mahābhārata itself, states that during the great battle, which is said to have taken place at the end of the *dvāpara-yuga*, a super-conjunction occurred. Is it not interesting that the Purāṇic texts, while referring to the commencement of the *kaliyuga* and the Seven Ṛṣis, do not provide the slightest clue concerning the planetary configuration at the beginning of the yuga? If there *was* a super-conjunction, as even traditionalists believe, then why does the text not mention it? The fact that, instead, it mentions a conjunction of the Seven Ṛṣis in a lunar mansion must be considered a strong clue that the Seven Ṛṣis actually represent the five planets plus the Sun and the Moon, and not the stars of the Big Dipper. Only the planets can rise, set and form conjunctions with constellations as required by the texts themselves.

Viṣṇupurāṇa even provides some support for this interpretation. For, just before the text passage under discussion, it quotes the following verse, which is taken from the Mahābhārata (MBh 3.188 (189).87):

अत्रोच्यते

यथा चन्द्रश्च सूर्यश्च तथा तिष्यो बृहस्पतिः (BrAP तिष्यबृहस्पती)

एकराशौ समेष्यन्ति तदा भवति वै कृतम्

*atrocyate*
*yathā candraśca sūryaśca tathā tiṣyo bṛhaspatiḥ* (BrAP *tiṣyabṛhaspatī*)
*ekarāśau sameṣyanti tadā bhavati vai kṛtam (VP 4.24.102)*

About this they say:
"When the Moon and the Sun as well as Tiṣya (= Puṣya) and Jupiter will come together in one cluster, then the Kṛta age will be."

This verse is referencing the celestial configuration at the beginning of the *kṛtayuga*. Tiṣya is a name of the lunar mansion Puṣya, which is in sidereal Cancer.[118]

Hopkins assumes that the conjunction of the Sun, the Moon, and Jupiter in Tiṣya = Puṣya is alluding to the 60-year Bṛhaspati cycle, because this configuration occurs only once in this cycle.[119] Now, this cycle may be more of an idealisation than an accurate astronomical model. Still, it is a model of *yugas* based on the periodical

[118] Some translate this verse in the sense that "the Moon, the Sun, Tiṣya, and Jupiter come together in one *zodiac sign* (*rāśiḥ*)". However, it is not logical that a lunar mansion or junction star, viz. Tiṣya/Puṣya, should "come together" with the other bodies in some zodiac sign. Fixed stars do not move from one zodiac sign to another. Besides, zodiac signs are completely unknown to the Mahābhārata because it was written before Hellenistic times, hence before the time when Indians took over the zodiac signs from Greek-Egyptian astrology. The word *rāśiḥ* must therefore be used in its original sense as "heap, accumulation, cluster". In this sense it is often used in the Mahābhārata.

Some prefer the text variant *tiṣyabṛhaspatī* and translate it in the following sense: "when the Moon and the Sun as well as Jupiter, who is in Tiṣya, come together in one zodiac sign... ". But this translation is grammatically impossible, since *tiṣyabṛhaspatī* is a dvandva compound in dual number and means "Tiṣya and Jupiter".

Completely untenable is the Gitapress translation: "When the moon, the sun and the Jupiter rise together in one zodiacal house and the Puṣya constellation is in the ascendant". (Vol. II, p. 721) Also impossible is the online translation by Aanand Aadhar: "when the moon and the sun together with Jupiter ... in the same constellation ... enter the lunar mansion of Tiṣyā".

[119] "The passage ... which speaks of sun, moon, Jupiter and Tiṣya as being together, implies the recognition of the sixty-year Bṛhaspati cycle, as the sun, moon, and Bṛhaspati are in Puṣya once only in this cycle." (Hopkins, "Epic Chronology", p. 46)

conjunctions of celestial bodies. The fact that the verse appears at the beginning of a passage referencing the beginning of the *kali-yuga*, might suggest that the author thought of a conjunction of planets in this context. Indeed, a verse referring to a conjunction of all seven planets, including the Sun and the Moon, would be preferable, but in any case it does provide evidence of a conjunction-based *yuga* theory. Puṣya might have been chosen because in the 1st millennium BCE, when the Mahābhārata was composed, the winter solstice was located in Puṣya.

It is worthwhile to study the original context of this verse in the Mahābhārata, since more clues to a super-conjunction can be found:

अभावः सर्वभूतानां युगान्ते च भविष्यति

*abhāvaḥ sarvabhūtānāṃ yugānte ca bhaviṣyati (MBh 3.188(189).73)*

| |
|---|
| And at the end of the yuga, will be the destruction of all beings. |

दिशः प्रज्वलिताः सर्वा नक्षत्राणि चलानि च

ज्योतींषि प्रतिकूलानि वाताः पर्याकुलास्तथा

उल्कापाताश्च बहवो महाभयनिदर्शकाः

*diśaḥ prajvalitāḥ sarvā nakṣatrāṇi calāni ca*
*jyotīṃṣi pratikūlāni vātāḥ paryākulāstathā*
*ulkāpātāśca bahavo mahābhayanidarśakāḥ (74)*

| |
|---|
| **All directions (i. e. the horizon) will burn, and the movable stars.**<br>The planets will be hostile, and the winds will be wild.<br>[There will be] a lot of falling meteorites that will indicate great danger. |

The "movable stars" (*nakṣatrāṇi calāni*) are obviously the planets. They burn in the glow of the horizon in the evening or morning. This means they are near their heliacal setting or rising.

षड्भिरन्यैश्च सहितो भास्करः प्रतपिष्यति

तुमुलाश्चापि निर्ह्रादा दिग्दाहाश्चापि सर्वशः

कबन्धान्तर्हितो भानुरुदयास्तमये तदा

*ṣaḍbhiranyaiśca sahito bhāskaraḥ pratapiṣyati*
*tumulāścāpi nirhrādā digdāhāścāpi sarvaśaḥ*
*kabandhāntarhito bhānurudayāstamaye tadā (75)*

| |
|---|
| **And the Sun will burn, accompanied by six others.**<br>[There will be] turmoil and noise and burning of the directions (= the horizon) on all sides.<br>The Sun will be hidden by [cloud] vessels when he rises and sets. |

The “six others” are of course the Moon and the five planets. They gather about the Sun and form a conjunction.

अकालवर्षी च तदा भविष्यति सहस्रदृक्

सस्यानि च न रोक्ष्यन्ति युगान्ते पर्युपस्थिते

*akālavarṣī ca tadā bhaviṣyati sahasradṛk*
*sasyāni ca na rokṣyanti yugānte paryupasthite (76)*

| |
|---|
| And the thousand-eyed [deity] will let rain fall in the wrong season.<br>And the crops will not grow when the end of the *yuga* will approach. |

...

अपर्वणि महाराज सूर्यं राहुरुपैष्यति

युगान्ते हुतभुक्चापि सर्वतः प्रज्वलिष्यति

*aparvaṇi mahārāja sūryaṃ rāhurupaiṣyati*
*yugānte hutabhukcāpi sarvataḥ prajvaliṣyati (79)*

| |
|---|
| On the wrong day, O great king, will Rāhu approach the Sun.<br>And fire will burn at the end of the *yuga* on all sides. |

...

यदा चन्द्रश्च सूर्यश्च तथा तिष्यबृहस्पती

एकराशौ समेष्यन्ति प्रपत्स्यति तदा कृतम्

*yadā candraśca sūryaśca tathā tiṣyabṛhaspatī*
*ekarāśau sameṣyanti prapatsyati tadā kṛtam (87)*

| |
|---|
| **“When the Moon and the Sun as well as Tiṣya (= Puṣya) and Jupiter come together in one cluster, then the Kṛta age will be.”** |

This is the verse that is quoted in Viṣṇupurāṇa just before the passage concerning the wandering of the Seven Ṛṣis through the lunar mansions.

कालवर्षी च पर्जन्यो नक्षत्राणि शुभानि च

प्रदक्षिणा ग्रहाश्चापि भविष्यन्त्यनुलोमगाः

क्षेमं सुभिक्षमारोग्यं भविष्यति निरामयम्

*kālavarṣī ca parjanyo nakṣatrāṇi śubhāni ca*
*pradakṣiṇā grahāścāpi bhaviṣyantyanulomagāḥ*
*kṣemaṃ subhikṣamārogyaṃ bhaviṣyati nirāmayam (88)*

| |
|---|
| And the rain god will have rain fall during the right time, and the stars will shine beautifully.<br>And the planets will be very auspicious and will move in correct ways.<br>Safety, prosperity, and perfect health will be. |

कल्किर्विष्णुयशा नाम द्विजः कालप्रचोदितः

उत्पत्स्यते महावीर्यो महाबुद्धिपराक्रमः

*kalkirviṣṇuyaśā nāma dvijaḥ kālapracoditaḥ*
*utpatsyate mahāvīryo mahābuddhiparākramaḥ (89)*

| |
|---|
| And a twice-born by the name of Kalki, glory of Viṣṇu, brought forth through time,<br>will arise, of great force, great wisdom, and highest heroism. |

Kalki is said to be the next incarnation of Viṣṇu to arrive on earth.

Hence it seems that the doctrine of the conjunction of the Seven Ṛṣis and *kaliyuga* is a kind of precursor for the planetary theory of the Sūryasiddhānta, which is based on the idea that at the end of each yuga all planets meet at the same place in the sky. However the conjunctions mentioned in the texts about the Seven Ṛṣis occur a lot more often than those described in the Sūryasiddhānta. They take place every 100 years, not every 1'080'000 years.

## Super-Conjunctions at Intervals of 100 Years

Unfortunately, super-conjunctions do not occur every 100 years, nor do they move to the subsequent lunar mansion. Initially, the idea of a *nakṣatra* cycle lasting 27x100 years, does not seem realistic. For the sake of this work all super-conjunctions between 4000 BCE and 2500 CE, have been calculated, using exact astronomical algorithms, as well the times in which all planets and the Moon were (or will be) invisible. In appendices A and B, two lists of super-conjunctions have been provided. Conjunctions listed in Appendix A are inclusive of the Moon. The timing of the new moons and eclipses have also been noted. Conjunctions listed in Appendix B do not include the Moon. If a full moon or even a lunar eclipse occurred during the super-conjunction, it has also been noted. Time intervals between super-conjunctions can be seen in Appendix C. It turns out that super-conjunctions do not occur regularly at intervals of 100 years, however, they *tend to recur at intervals of 98 years*. Thus there actually is, although not completely consistent, a cycle of 98 years, besides secondary cycles of 18 and 80 (= 98) years, 38 and 60 (= 98) years, 179 (= 99 + 80) years etc. It seems likely that the 100-year cycle of the Seven Ṛṣis somehow relates to this.

The texts require that the Ṛṣis gather in the lunar mansion Maghā at the beginning of the *kaliyuga* and then move one lunar mansion forward every 100 years. However, planetary clusterings that occur at intervals of 100 years, never move forward by one lunar mansion, but rather by about 135 degrees. Moreover, within the time range considered they mostly occurred in the sidereal zodiac signs Gemini, Libra, and Aquarius, but hardly ever in the fire trigon, and never in Maghā. Super-conjunctions thus do not wander from lunar mansion to lunar mansion, nor did they ever occur in Maghā within the time range investigated.

But perhaps in the present context the definition applied to a super-conjunction is too strict. To begin with, it must be pointed out that Saturn and Jupiter act as timers for super-conjunctions. Since the two planets are the slowest and meet in a conjunction only every 20 years, therefore super-conjunctions can only recur after 18 years at the earliest, provided that the fast planets happen to be nearby at the same time.

Now, conjunctions of Jupiter and Saturn tend to recur in the same astrological element, i. e. in zodiac signs that are in a trigon aspect to each other. Every third conjunction occurs in the same zodiac sign. However, not exactly in the same place, rather it shifts by a couple of degrees, so that after an average of 221 years or slightly more than 11 conjunctions the subsequent astrological element or zodiac sign comes into play. Since every third conjunction takes place in the same sign, conjunctions in that sign end after either 9 or 12 conjunctions and then move ahead to the subsequent sign. This means that in the Jupiter-Saturn cycle a zodiac sign of 30° corresponds to a period of 221 years on average. It can therefore be calculated how many years correspond to a lunar mansion or a range of 13°20' on the ecliptic. The result is 98.2 years, exactly the number that is obtained empirically if one looks for typical intervals between super-conjunctions. Now, 98.2 years correspond to five Jupiter-Saturn cycles. Since only every third conjunction takes place in the same area of the sky, the following conclusion can be drawn: *If a conjunction of Jupiter and Saturn occurs in Maghā, then either the third or the sixth conjunction after that, thus either* *the conjunction 59 or 118 years later, occurs in the subsequent lunar mansion. On average, however, the transition to the next lunar mansion takes place every 98.2 years.* As a rule, each of these conjunctions also goes hand in hand with a tighter gathering of all the planets, even though not all the planets always disappear in the glare of the Sun, particularly Mars who by nature is often uncooperative.

Arabic astrologers of the middle ages (Mašā'allāh, Abū Ma'shar, 'Umar al-Ṭabarī) invented historical cycles based on this wandering of Jupiter-Saturn conjunctions. While they considered their wandering through the zodiac signs rather than through the lunar mansions, it is quite possible that ancient Indian astrologers observed the motion of the conjunctions through the lunar mansions and used them to define "historical" cycles.

The solution proposed above also explains why the texts say that only the two leading Ṛṣis rose near Maghā at first, before the other five joined them:

> सप्तर्षीणां तु यौ पूर्वौ दृश्येते ह्युदितौ दिवि
>
> तयोस्तु मध्ये नक्षत्रं दृश्यते यत्समं निशि
>
> *saptarṣīṇāṃ tu yau pūrvau dṛśyete hyuditau divi*
> *tayostu madhye nakṣatraṃ dṛśyate yatsamaṃ niśi (VP 4.24.105)*

> Of the first two of the Seven Ṛṣis who are seen rising in the sky,
> exactly in their middle is seen the junction star at night.

In most cases of super-conjunctions, Saturn and Jupiter make their heliacal rising before Venus, Mars, and Mercury. This can be explained by the fact that Venus and Mercury often appear as evening stars after a super-conjunction and that, Mars reappears very slowly after a conjunction with the Sun. In any case, as has been stated, the slow planets Jupiter and Saturn are the timers of super-conjunctions, as it were, because super-conjunctions can only occur approximately every 20 years, when the two form a conjunction.

The next question to be answered is whether or not planetary clusters where Maghā (Regulus) stood in between Jupiter and Saturn and the three of them made their heliacal rising shortly after each other can be found. It turns out that this occurs very rarely. As has been stated earlier, super-conjunctions in the strictest sense usually take place in different areas of the sky. Within the time range 3500 BCE

– 1 CE, only one date has been found that fits this condition well, although not perfectly. In the morning of 8th August, 999 BCE, Regulus was positioned exactly in the middle of Jupiter and Saturn. All the other planets, except Mercury, could be seen within 10° of Regulus. Three days later, the old Moon joined them. The cluster is not perfect, of course, because Mercury was not part of it. Furthermore, at no time that year did all planets disappear in the glare of the Sun. Still, no other configuration was as conspicuous as this one, within the time range considered.

Unfortunately, the year 999 BCE does not seem to fit the following statement, that refers to the same time at which the Seven Ṛṣis made their conjunction in Maghā:

> यावत्परीक्षितो जन्म यावन्नन्दाभिषेचनम्
>
> एतद्वर्षसहस्रं तु ज्ञेयं पञ्चदशोत्तरम् (VP 4.24.24)
>
> (एतद्वर्षसहस्रं तु ज्ञेयं पञ्चाशदुत्तरम् (BndP 2.74.227))
>
> (एतद्वर्षसहस्रं तु शतं पञ्चदशोत्तरम् (BhP 12.2.26))
>
> (एकमेव सहस्रं तु ज्ञेयं पञ्चशतोत्तरम् (MatsyaP 271.38))
>
> *yāvatparīkṣito janma yāvannandābhiṣecanam*
> *etadvarṣasahasraṃ tu jñeyaṃ pañcadaśottaram (VP 4.24.24)*
> (*etadvarṣasahasraṃ tu jñeyaṃ pañcāśaduttaram (BndP 2.74.227)*)
> (*etadvarṣasahasraṃ tu śataṃ pañcadaśottaram (BhP 12.2.26)*)
> (*ekameva sahasraṃ tu jñeyaṃ pañcaśatottaram (MatsyaP 271.38)*)

| From the birth of Parīkṣit until the inauguration of Nanda,<br>one must know, there are 1015 (var. 1050, 1115, 1500) years. |
|---|

The Nanda dynasty is assumed to have seized power in the 4th century BCE, however this is not 1000 years, but only 500 years after 999 BCE.

Interesting to note: If *1012 years* is added to 999 BCE and the configuration on 27th December 14 CE is examined, a precise conjunction of Jupiter and Saturn near the star Pūrvāṣāḍhā and a wide conjunction of all the planets can be found, in agreement with the requirements of the following verse:

प्रयास्यन्ति यदा चैते पूर्वाषाढां महर्षयः

(BhP: यदा मघाभ्यो यास्यन्ति पूर्वाषाढां महर्षयः

तदा नन्दात्प्रभृत्येष गतिवृद्धिं गमिष्यति

*prayāsyanti yadā caite pūrvāṣāḍhāṃ maharṣayaḥ*
(BhP: *yadā maghābhyo yāsyanti pūrvāṣāḍhāṃ maharṣayaḥ (32)*)
*tadā nandātprabhṛtyeṣa gativṛddhiṃ gamiṣyati (VP 4.24.112)*

When these [seven] great Ṛṣis enter the [lunar mansion] Pūrvāṣāḍhā,
(var. When the [seven] great Ṛṣis go from the Maghās to Pūrvāṣāḍhā,)
then, starting from Nanda, that [Kali age] will increasingly take its course.

Interesting to note: 1012 years is only three years less than 1015 years, which is the figure given in one of the four text variations. The closest clustering occurred around 10th/11th December, when all the planets were scattered across an area of 60 degrees, or even only 30° if Mars is overlooked. 1012 years would be 51 Jupiter-Saturn conjunctions, occurring approximately every 19.86 years. 51 is divisible by 3, and every third conjunction takes place in the same area of the sky, shifted by a couple of degrees. In this way, the conjunction of the Seven Ṛṣis did move ahead by 10 lunar mansions in 1000 years. It can be seen how nicely the explanation given above, regarding the wandering of the Seven Ṛṣis works, in principle.

The second-best conjunction, where Jupiter and Saturn made their heliacal rising with Regulus between them and a wide conjunction of all planets occurred near 8th August 1794 BCE. 1012 years later, in February/March 781 BCE, there was another conjunction of Jupiter and Saturn in Pūrvāṣāḍhā, however the closest clustering already occurred in December 782 BCE. Both clusterings are far less impressive than the ones of 999 BCE and 14 CE.

Unfortunately, the clustering of 781 BCE does not fit King Nanda's reign either, which must be dated to the 4th century BCE. It must be conceded that a perfect solution for these problems cannot be found. However, it must be understood that the Purāṇa text, which was written at the earliest, in the 4th century CE is not based on historical observations but rather on astrological historical speculations. There are two likely reasons why the conjunction at the beginning of the *yuga* could have been assumed in Maghā. A clue may be found in the following verse from the Mahābhārata:

मघाविषयगः सोमस्तद्दिनं प्रत्यपद्यत (var. प्रत्यदृश्यत)

दीप्यमानाश्च संपेतुर्दिवि सप्त महाग्रहाः

*maghāviṣayagaḥ somastaddinaṃ pratyapadyata* (var. *pratyadṛśyata*)
*dīpyamānāśca saṃpeturdivi sapta mahāgrahāḥ (MBh 6.17.2)*

On that day, the Moon god (Soma) entered the region of Maghā.
The seven great planets burned in the sky and flew together.

Perhaps it was this verse that lead to the conclusion that the super-conjunction had to have taken place in Maghā. Besides, the lunar mansion of Maghā played an important part in Vedic literature as in ancient times it was the lunar mansion of the summer solstice.

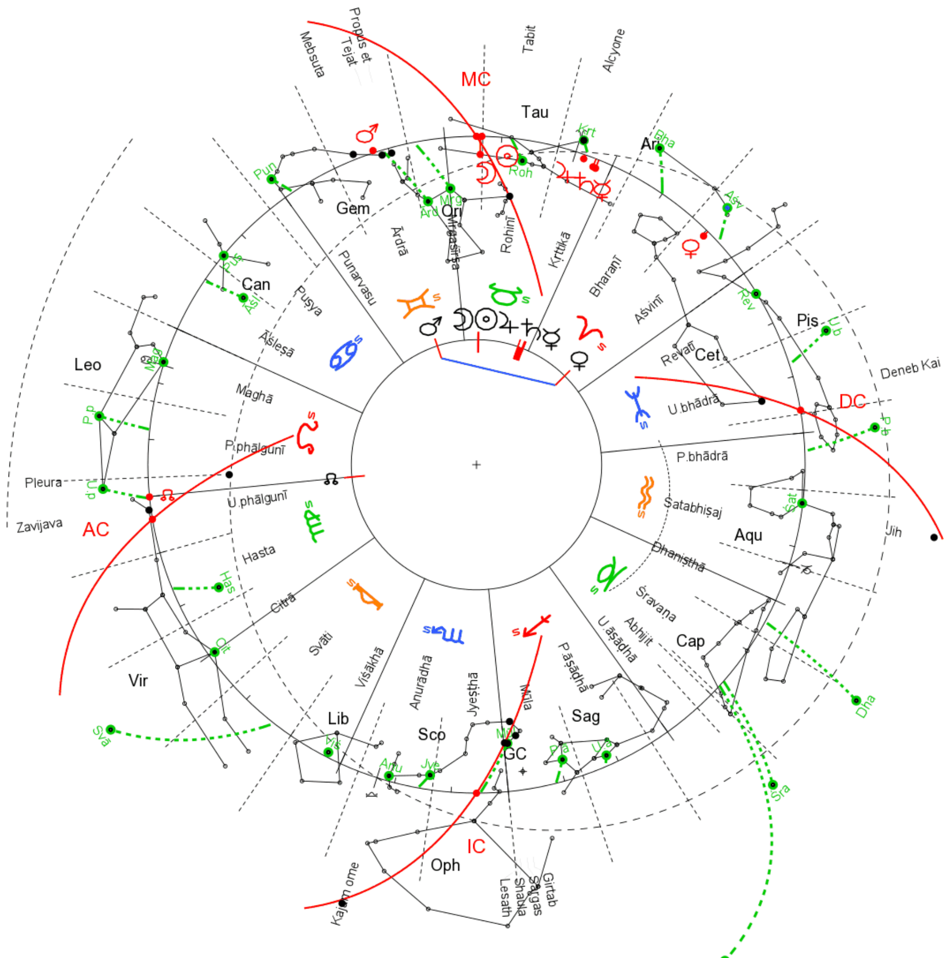
The question arises whether the "theory" of the Seven Ṛṣis in Maghā could go back to an ancient planetary theory that assumed that all planets met at the summer solstice point in Maghā at the end of each yuga. This theory would be comparable to the Sūryasiddhāntic tradition, which believes that a super-conjunction takes place at the end of each *yuga* in sidereal 0° Aries. At the time when the Sūryasiddhāntic system was defined in its older form, approximately 500 CE, the spring equinox was exactly in that location.

Revisiting the super-conjunction in mid-October 1198 BCE, which turned out to be the best candidate for the super-conjunction mentioned in the Mahābhārata, it can be found that super-conjunctions also occurred almost 100 years before and after it, viz. end of June, 1295 BCE and mid-January, 1099 BCE.

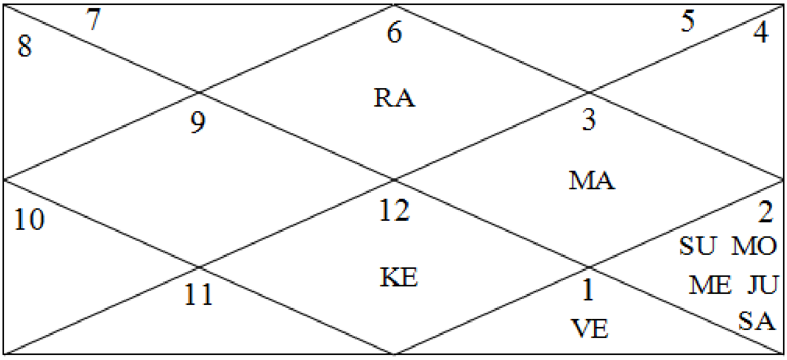
Incidentally, it is quite likely that ancient Indian pre-Siddhāntic astronomers really believed that during super-conjunctions all planets met in one point with the Sun. They could not observe the conjunction directly, because the light of the Sun made it invisible. Only a sophisticated planetary theory that would have allowed them to calculate planetary positions with sufficient accuracy could have granted them knowledge as to how accurate the conjunction truly was.

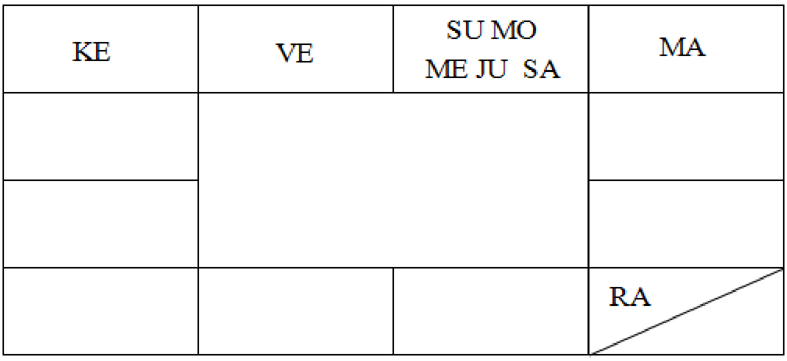
## The Clustering of the Planets in 2449 BCE

Returning to Varāhamihira for a moment, in Bṛhatsaṃhitā 13.3 he states that the inauguration of Yudhiṣṭhira, who became the first king after the great battle, took place 2526 years before the Śaka Era, which is counted from 78 CE. From this, it can be understood that Varāhamihira believed the battle to have taken place in 2449 BCE (-2448). P. C. Sengupta follows this dating and believes that the Mahābhārata battle actually took place in that year. Now, Sengupta is not interested in super-conjunctions of the planets. However, in that very year, at end of April, an interesting super-conjunction happened to occur. The conjunction was rather wide, and at no time in that year were all the planets invisible. It is interesting, however, that Jupiter and Saturn during their heliacal rising were in close conjunction, in the general vicinity of the vernal equinox, in the lunar mansion Kṛttikā, very close the Pleiades. Since Vedic texts assumed the spring equinox to be in the Pleiades, it must be asked whether Varāhamihira's date could go back to some older astronomical theory of planetary cycles, which adopted the zero point of the ecliptic at the Pleiades. Thus, various evidence has been found that there were old pre-Siddhāntic planetary cycles that were moored at important points of the zodiac.




Clustering of the planets on 27th April, 2449 BCE. According to Varāhamihira, Bṛhatsaṃhitā 13.3, this was the inauguration year of Yudhiṣṭhira. P.C. Sengupta believes this to be the year of the Mahābhārata War. At no time during this year did all the planets disappear in the glare of the Sun, and at no time were they all visible in the morning in conjunction with the old moon. Jupiter and Saturn made their heliacal rising around this date. Jupiter was located 2½° and Saturn 4½° before the equinoctial point, which was very close to the Pleiades.




Cluster in 2449 BCE (Varahamihira)
27 Apr 2449 BCE (-2448) jul., 12:00 LMT, Kurukshetra 76e51,29n59
JD (UT)=827042.7865278, JD (ET)=827043.4567898, delta_t=57910.6 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 322°20'56" (True Citra)
Sidereal time: 1:01:29 (15°22'12")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 153°57'08" | Kan/Vir 3°57'08" | UPh | | |
| Sun | 53°27'11" | Vrb/Tau 23°27'11" | Mrg | 9 | -0°00'05" |
| Moon | 53°32'54" | Vrb/Tau 23°32'54" | Mrg | 9 | -5°22'02" |
| Mercury | 32°31'41" | Vrb/Tau 2°31'41" | Krt | 9 | -2°27'30" |
| Venus | 9°36'28" | Mes/Ari 9°36'28" | Asv | 8 | -1°41'08" |
| Mars | 72°37'18" | Mit/Gem 12°37'18" | Ard | 10 | 0°38'14" |
| Jupiter | 35°05'12" | Vrb/Tau 5°05'12" | Krt | 9 | -1°09'24" |
| Saturn | 33°02'40" | Vrb/Tau 3°02'40" | Krt | 9 | -2°20'24" |
| Rahu | 150°01'11" | Kan/Vir 0°01'11" | UPh | 1 | |
| Ketu | 330°01'11" | Min/Pis 0°01'11" | PBh | 7 | |

# *New Moon, Full Moon, and Eclipses*

## New Moon in Jyeṣṭhā and Full Moon in the Month of Kārttika

At this point further details of the celestial configuration during the time of the great war will be examined.

Before the great battle, during the waning half-moon, Kṛṣṇa makes a last attempt to reconcile the parties. The negotiations fail, and the battle is scheduled for the new moon, seven days later:

सप्तमाच्चापि दिवसादमावास्या भविष्यति

संग्रामं योजयेत्तत्र तां ह्याहुः शक्रदेवताम्

*saptamāccāpi divasādamāvāsyā bhaviṣyati*
*saṃgrāmaṃ yojayettatra tāṃ hyāhuḥ śakradevatām (MBh 5.140(142).18)*

> After the seventh day will be the new moon.
> Then one has to harness battle, for that [new moon], they say, has Indra as its [presiding] deity.

As this new moon was ruled by Indra, it is believed that it occurred in the *nakṣatra* of Jyeṣṭhā. However, this statement is in obvious contradiction to the other verse, according to which on the first day of the battle the Moon was in the *nakṣatra* of Maghā. To quote that verse again:

मघाविषयगः सोमस्तद्दिनं प्रत्यपद्यत (var. प्रत्यदृश्यत)

दीप्यमानाश्च संपेतुर्दिवि सप्त महाग्रहाः

*maghāviṣayagaḥ somastaddinaṃ pratyapadyata* (var. *pratyadṛśyata*)
*dīpyamānāśca saṃpeturdivi sapta mahāgrahāḥ (MBh 6.17.2)*

> On that day, the Moon god (Soma) entered the region of Maghā.
> The seven great planets burned in the sky and flew together.

This verse creates quite a conundrum to the accepted traditional view. It requires the war to begin with the new moon in Jyeṣṭhā. The commentator Nīlakaṇṭha goes to some lengths in hopes to prove that this verse does not actually mean the Moon is in the *nakṣatra* Maghā. Through previous examination it has been concluded that possibly the Moon was in Maghā at the beginning of the super-conjunction, having Venus as the last planet to disappear in the glare of the Sun. Another possible solution was derived from the following version of the text:

> तथाविषयगः सोमस्तद्दिनं प्रत्यपद्यत (var. प्रत्यदृश्यत)
>
> ***tathāviṣayagaḥ*** *somastaddinaṃ pratyapadyata* (var. *pratyadṛśyata*)
> *dīpyamānāśca saṃpeturdivi sapta mahāgrahāḥ (MBh 6.17.2)*

| And the Moon, who had entered invisibility, emerged [again] on that day. The seven great planets burned in the sky and flew together. |
|---|

Thus the war would have begun on the first day after the astronomical new moon.

There are other problems, as well. According to MBh 6.2.23, the battle did not begin on a new moon in Jyeṣṭhā but shortly after a full moon in the *nakṣatra* Kṛttikā – or perhaps a full moon of the month of Kārttika, which would have had to occur in one of the two *nakṣatras*, Kṛttikā or Rohiṇī. To quote the verse again:

> अलक्ष्यः प्रभया हीनः पौर्णमासीं च कार्त्तिकीम्
>
> चन्द्रोऽभूदग्निवर्णश्च समवर्णे नभस्तले
>
> *alakṣyaḥ prabhayā hīnaḥ paurṇamāsīṃ ca kārttikīm*
> *candro 'bhūdagnivarṇaśca samavarṇe nabhastale (MBh 6.2.23)*

| The Moon lost his [hare] sign and became devoid of light on the full moon of the month of Kārttika (or: in the nakṣatra Kṛttikā), and fiery in colour at the firmament, which was of the same colour. |
|---|

Sengupta believes that this observation was made on the day the war broke out and that therefore the battle could not really have begun on a new moon in Jyeṣṭhā. He tries to postpone the outbreak of the war by two weeks, to the day on which the Moon was in Kṛttikā. However, he notes himself that the Moon in Kṛttikā after a Jyeṣṭhā new moon could not have been a full moon yet, and he concludes that the text must refer to the lunar position *one day before* the full moon. In reality, it would rather have been *two days* before full moon, because the full moon following a new moon in Jyeṣṭhā would rather have occurred in Mṛgaśīrṣa, which is *two* lunar mansions after Kṛttikā. That Kṛttikā night could hardly have been considered a "full moon" (*paurṇamāsī*).[120] Besides, Sengupta

[120] Sengupta writes: "The moon was about 13 days old and not full. Vyāsa by looking at such a moon thought the night to be *Paurṇamāsī* no doubt, but it was

had dated the Jyeṣṭhā new moon to the beginning of the month of Agrahāyaṇa (Mārgaśīrṣa). If two weeks later and one day before full moon the Moon had been in Kṛttikā and on the following day in Rohiṇī, then this full moon would have been assigned to the month of Kārttika, which *preceded* Agrahāyaṇa. Therefore if the text is interpreted in the sense that it refers to a full moon or near-full moon in Kṛttikā, then it is incompatible with a preceding Jyeṣṭhā new moon. In reality, the new moon in Jyeṣṭhā would not *precede,* but *follow*, the Kārttika full moon. Moreover, the text seems to indicate that this Kārttika full moon was a lunar eclipse ("devoid of light", "fiery in colour"). This will be examined shortly in more detail. However, a lunar eclipse occurs only during a full moon, not a day or two before. And finally, it must be assumed that, if the war had actually been postponed, the narrator would no doubt have explicitly stated it and given the reasons for it. For all these reasons, I do not believe that Sengupta do justice to the text.

So should the conclusion be that the battle began on the new moon in Jyeṣṭhā, but that a lunar eclipse had occurred two weeks earlier on the Kārttika full moon, which had to be interpreted as an inauspicious celestial omen? The verse quoted above seems to indicate that the lunar eclipse occurred some time, perhaps a couple of days, but certainly less than a month, *before* the beginning of the battle.

Does the text give further evidence with regard to the question whether the battle began on a new moon or full moon? It does, but unfortunately these are contradictory, too. The following verses, which refer to the evening of the first day of battle, apparently point to a new moon:

---

of the *Anumati* type and not of the type *Rākā*." (Sengupta, *Ancient Indian Chronology*, p. 5) *Anumati* is the deity who rules the day before full moon, *Rākā* the deity who rules the full moon. However, even the battle calendar given by Sengupta (p. 16ff.) reveals that it must have been two days. On 21st October 2449 BCE (-2448), a new moon occurred very close to Jyeṣṭhā (but of course not directly observable by the naked eye). During the night of 2nd/3rd November the Moon could be seen in Kṛttikā, during the following night in Rohiṇī. But before sunrise, the Moon was still 12.5° away from opposition. It was not until the second night that the Moon became full in Mṛgaśīrṣa.

ततः सैन्येषु भग्नेषु मथितेषु च सर्वशः

प्राप्ते चास्तं दिनकरे न प्राज्ञायत किंचन

*tataḥ sainyeṣu bhagneṣu mathiteṣu ca sarvaśaḥ*
*prāpte cāstaṃ dinakare na prājñāyata kiṃcana (MBh 6.45(49).62)*

> Then, when the troops were all broken and bruised
> and the Sun had set, nothing could be seen anymore.

भीष्मं च समुदीर्यन्तं दृष्ट्वा पार्था महाहवे

अवहारमकुर्वन्त सैन्यानां भरतर्षभ

*bhīṣmaṃ ca samudīryantaṃ dṛṣṭvā pārthā mahāhave*
*avahāramakurvanta sainyānāṃ bharatarṣabha (63)*

> And after the sons of Pṛthā had seen Bhīṣma up in arms in the great battle,
> they made a withdrawal of troops, O best of the Bhāratas.

After sunset, it is dark and nothing can be seen anymore. This rather indicates that the battle began on a new moon. For, if it had begun on the full moon or the following day, then the bright moon would have risen soon after sunset, and the warriors could have seen something. On the other hand, this conclusion would be wrong if the lunar eclipse occurred after sunset. And, as has been seen, this actually is what seems to have happened. On the other hand, it seems that the lunar eclipse did not occur on the first day of the battle but a couple of days before it. Therefore the Moon would have been waning when the battle began and would possibly have risen a long time after sunset.

The verse immediately after the "flying together of the planets" reads:

द्विधाभूत इवादित्य उदये प्रत्यदृश्यत

ज्वलन्त्या शिखया भूयो भानुमानुदितो दिवि

*dvidhābhūta ivāditya udaye pratyadṛśyata*
*jvalantyā śikhayā bhūyo bhānumānudito divi (MBh 6.17.3)*

> The Sun was seen split in two, as it were, in his rising.
> With a burning crest (or: burning flame) rose the shining one again in the sky.

It will be seen later that this verse probably describes an eclipse at sunrise. This, again, would indicate a new moon at the beginning of the battle. There are more verses that indicate a solar eclipse at or just before the beginning of the battle, e.g.:

अभीक्ष्णं कम्पते भूमिरर्कं राहुस्तथाग्रसत्

श्वेतो ग्रहस्तथा चित्रां समतिक्रम्य तिष्ठति

*abhīkṣṇaṃ kampate bhūmirarkaṃ rāhustathāgrasat*
*śveto grahastathā citrāṃ samatikramya tiṣṭhati (MBh 6.3.11)*

| |
|---|
| The earth shook again and again, and Rāhu swallowed the Sun.<br>The white Planet (or: a white planet) just entered Citrā and is standing there. |

And:

चतुर्दशीं पञ्चदशीं भूतपूर्वां च षोडशीम्

इमां तु नाभिजानामि अमावास्यां त्रयोदशीम्

*caturdaśīṃ pañcadaśīṃ bhūtapūrvāṃ ca ṣoḍaśīm*
*imāṃ tu nābhijānāmi amāvāsyāṃ trayodaśīm (MBh.6.3.28)*

| |
|---|
| [New moons] on the 14th, 15th or 16th there have been before.<br>But this new moon on the 13th day I do not know. |

चन्द्रसूर्यावुभौ ग्रस्तावेकमासे त्रयोदशीम्

अपर्वणि ग्रहावेतौ (var. ग्रहेणैतौ) प्रजाः संक्षपयिष्यतः

(var. अपर्वणि ग्रहं यातौ प्रजासंक्षयमिच्छतः)

*candrasūryāvubhau grastāvekamāse trayodaśīm*
*aparvaṇi grahāvetau* (var. *graheṇaitau*) *prajāḥ saṃkṣapayiṣyataḥ (29)*
(var. *aparvaṇi grahaṃ yātau prajāsaṃkṣayamicchataḥ*)

| |
|---|
| Both the Moon and the Sun were eclipsed (swallowed) in one and the same month on the 13th [of the fortnight],<br>on a wrong date: these two eclipses[121] will destroy the creatures. |

Also interesting is the following verse:

सोमस्य लक्ष्म व्यावृत्तं राहुरर्कमुपेष्यति

*somasya lakṣma vyāvṛttaṃ rāhurarkamupeṣyati (MBh 5.141.10)*

| |
|---|
| The [hare] sign of the Moon has disappeared. Rāhu is approaching the Sun. |

This does not mean that a solar eclipse was observed but that people expected that the next new moon could become a solar eclipse. In

[121] *grahau*; the other solution would be: "these two planets (i.e. the Sun and the Moon) will destroy the creatures". However, the text variants seem to indicate that *grahaḥ* here means "eclipse": "By means of an eclipse at the wrong time (*aparvaṇi graheṇa*) will the two (i.e. the Sun and the Moon) destroy the creatures." And: "By producing an eclipse at the wrong time (*aparvaṇi grahaṃ yātau*), they want the destruction of the creatures."

the context of this verse, Kṛṣṇa refers to the new moon in Jyeṣṭhā that he expects in seven days (MBh 5.140(142).18; quoted on p. 216) Thus it can be concluded that the solar eclipse fell on the new moon in Jyeṣṭhā and on the date that Kṛṣṇa had appointed for the great battle.

All this seems to indicate that the battle began on a new moon and on the day of a solar eclipse. At the same time it appears that a lunar eclipse had occurred already two weeks earlier.

The following somewhat difficult text also seems to point to a new moon at the beginning of the battle:

> ज्वलितार्केन्दुनक्षत्रं निर्विशेषदिनक्षपम् (var. निर्विवेश दिनक्षिपम्)
>
> अहोरात्रं मया दृष्टं तत्क्षयाय भविष्यति
>
> *jvalitārkendunakṣatraṃ nirviśeṣadinakṣapam* (var. *nirviveśa dinakṣipam*)
> *ahorātraṃ mayā dṛṣṭaṃ tatkṣayāya bhaviṣyati (MBh 6.2.22)*

> The indistinguishable [transition between] day and night, in which the Sun, the Moon and the stars (= planets?) glow,
> (var. Sun, Moon, and stars (planets?) caught fire and entered the end of the day)
> – I have seen it day and night. This might indicate annihilation.

The verse indicates that the Moon is near the Sun together with the planets, and this points to a new moon.

However, the epic also provides more passages that support a beginning of the war on a full moon in the *nakṣatra* of Kṛttikā or Rohiṇī. One of these passages describes the events of the night that follows the 14th day of battle: The hero Ghaṭotkaca, who fights on the side of the Pāṇḍavas, is killed at midnight. It is very dark, but the warriors continue to fight until they drop from exhaustion. They decide on a truce for a few hours and lie down to sleep, planning to continue the fight in the early morning after the rising of the Moon.

Now, the rising of the Moon in the early morning is only possible during the waning moon shortly before the new moon. It follows that 14 days earlier cannot have been a new moon, but only a full moon. Thus, the battle would have started on a full moon. If, however, that full moon took place in Kṛttikā, then the subsequent new moon, which would have taken place on the 15th day, would have been a Jyeṣṭhā new moon. Could the order of astronomical events in the text have been distorted by mistake?

The original text reads as follows:

निद्रान्धास्ते महाराज परिश्रान्ताश्च संयुगे

नाभ्यपद्यन्त समरे कांचिच्चेष्टां महारथाः

*nidrāndhāste mahārāja pariśrāntāśca saṃyuge*
*nābhyapadyanta samare kāṃciccesṭāṃ mahārathāḥ (MBh 7.159(184).12)*

| |
|---|
| Blind by sleepiness, O great king, and exhausted by the fight,<br>the great warriors did not undertake any action in battle. |

त्रियामा रजनी चैषा घोररूपा भयानका

सहस्रयामप्रतिमा बभूव प्राणहारिणी

वध्यतां च तथा तेषां क्षतानां च विशेषतः

*triyāmā rajanī caiṣā ghorarūpā bhayānakā*
*sahasrayāmapratimā babhūva prāṇahāriṇī*
*vadhyatāṃ ca tathā teṣāṃ kṣatānāṃ ca viśeṣataḥ (13)*

| |
|---|
| The night was in the third watch, with a terrible and fearsome appearance,<br>it became as long as 1000 watches, the life-destroying [night],<br>especially for those who were struck and for the wounded. |

अहो (var. अर्ध-)रात्रिः समाजज्ञे निद्रान्धानां विशेषतः

सर्वे ह्यासन्निरुत्साहाः क्षत्रियाः दीनचेतसः

तव चैव परेषां च गतास्त्रा विगतेषवः

*aho (var. ardha-)rātriḥ samājajñe nidrāndhānāṃ viśeṣataḥ*
*sarve hyāsannirutsāhāḥ kṣatriyāḥ dīnacetasaḥ*
*tava caiva pareṣāṃ ca gatāstrā vigateṣavaḥ (14)*

| |
|---|
| Midnight announced itself to them, who were extremely blind by sleepiness.<br>For, all of them were exhausted, the warriors, of miserable mood,<br>and, besides, your enemies (i. e. the Pāṇḍavas) had run out of weapons and arrows. |

Then, a bit later, Arjuna said:

श्रान्ता भवन्तो निद्रान्धाः सर्वे एव सवाहनाः

तमसा चावृते सैन्ये रजसा बहुलेन च

*śrāntā bhavanto nidrāndhāḥ sarva eva savāhanāḥ*
*tamasā cāvṛte sainye rajasā bahulena ca (23)*

| |
|---|
| You are tired and blind by sleepiness, all [of you] with [your] animals,<br>while the armies are wrapped in darkness and a lot of dust. |

→

ते यूयं यदि मन्यध्वमुपारमत सैनिकाः

निमीलयत चात्रैव रणभूमौ मुहूर्तकम्

*te yūyaṃ yadi manyadhvamupāramata sainikāḥ*
*nimīlayata cātraiva raṇabhūmau muhūrtakam (24)*

If you think so, then rest, O soldiers,
shut [your eyes] here on the battle ground for a while!

ततो विनिद्रा विश्रान्ताश्चन्द्रमस्युदिते पुनः

संसाधयिष्यथान्योन्यं स्वर्गाय कुरुपाण्डवाः

*tato vinidrā viśrāntāścandramasyudite punaḥ*
*saṃsādhayiṣyathānyonyaṃ svargāya kurupāṇḍavāḥ (25)*

Then after moonrise you shall again, without sleep and without fatigue,
clash with each other in order to [attain] heaven, O Kurus and Pāṇḍavas.

ततः कुमुदनाथेन कामिनीगण्डपाण्डुना

नेत्रानन्देन चन्द्रेण माहेन्द्री दिगलम्कृता

*tataḥ kumudanāthena kāminīgaṇḍapāṇḍunā*
*netrānandena candreṇa māhendrī digalamkṛtā (42)*

Then the direction, which is [presided] by the great Indra, was adorned by the Moon, who is a delight for the eyes,
the Lord of the white lily, who is pale as the cheek of a loving woman.

ततो मुहूर्ताद्भगवान्पुरस्ताच्छशलक्षणः

अरुणं दर्शयामास ग्रसञ्ज्योतिःप्रभं प्रभुः

*tato muhūrtādbhagavānpurastācchaśalakṣaṇaḥ*
*aruṇaṃ darśayāmāsa grasañjyotiḥprabhaṃ prabhuḥ (43)*

After some time, the holy one with the hare's sign[122], the Lord, appeared in the East and nourished himself of the rosy dawn that shone forth with light.

अरुणस्य तु तस्यानुजातरूपसमप्रभम्

रश्मिजालं महच्चन्द्रो मन्दं मन्दमवासृजत्

*aruṇasya tu tasyānujātarūpasamaprabham*
*raśmijālaṃ mahaccandro mandaṃ mandamavāsṛjat (44)*

Gradually the Moon sent out a large web of rays,
which was similar in appearance to that rosiness and glowed in the same way.

[122] The Indians believe that the surface of the Moon shows the picture of a hare.

उत्सारयन्तः प्रभया तमस्ते चन्द्ररश्मयः

पर्यगच्छञ्छनैः सर्वा दिशः खं च क्षितिं तथा

*utsārayantaḥ prabhayā tamaste candraraśmayaḥ*
*paryagacchañchanaiḥ sarvā diśaḥ khaṃ ca kṣitiṃ tathā (45)*

The moon rays chased away the darkness by their light
and slowly walked around to all directions and into the atmosphere and on the earth.

ततो मुहूर्ताद्भुवनं ज्योतिर्भूतमिवाभवत्

अप्रख्यमप्रकाशं च जगामाशु तमस्तथा

*tato muhūrtādbhuvanaṃ jyotirbhūtamivābhavat*
*aprakhyamaprakāśaṃ ca jagāmāśu tamastathā (46)*

Then, after a while, the world became [full of] light, as it were,
and the darkness, the ineffable and lightless one, passed just as quickly.

प्रतिप्रकाशिते लोके दिवाभूते निशाकरे

विचेरुर्न विचेरुश्च राजन्नक्तंचरास्ततः

*pratiprakāśite loke divābhūte niśākare*
*vicerurna viceruśca rājannaktaṃcarāstataḥ (47)*

When the world was relumined [and] the Moon had merged into daylight, O king, some night-running [animals] were still running about, others were not running about anymore.

बोध्यमानं तु तत्सैन्यं राजंश्चन्द्रस्य रश्मिभिः

बुबुधे शतपत्त्राणां वनं महदिवाम्भसि

*bodhyamānaṃ tu tatsainyaṃ rājaṃścandrasya raśmibhiḥ*
*bubudhe śatapattrāṇāṃ vanaṃ mahadivāmbhasi (48)*

And that army, O king, awakened by the rays of the moon,
woke up like a big thicket of hundred-petalled [lotuses] in the water.

यथा चन्द्रोदयोद्भूतः क्षुभितः सागरो भवेत्

तथा चन्द्रोदयोद्भूतः स बभूव बलार्णवः

*yathā candrodayodbhūtaḥ kṣubhitaḥ sāgaro bhavet*
*tathā candrodayodbhūtaḥ sa babhūva balārṇavaḥ (49)*

Like the sea rises and is stirred up at the rising of the moon,
in the same way the tide of violence rose at the rising of the moon.

ततः प्रववृते युद्धं पुनरेव विशां पते

लोके लोकविनाशाय परं लोकमभीप्सताम्

*tataḥ pravavṛte yuddhaṃ punareva viśāṃ pate*
*loke lokavināśāya paraṃ lokamabhīpsatām (50)*

Then the fight returned again, O ruler of the people,
to the world, for the destruction the world, among those who aspire to the highest world.

The text leaves no doubt that the Moon appears just before dawn and sunrise on the eastern horizon. It is just before the new moon, and as it is during the 14th night of the battle, the battle must have begun on a full moon. The description is based on a very careful observation of nature. There is little doubt that the author of these lines was of the opinion that the war began on a full moon, probably on the above-mentioned full moon in the lunar mansion Kṛttikā or in the month of Kārttika.

However, these verses are not quite consistent within their context. For, one day earlier (on the 14th), a solar eclipse seems to have occurred; however this can be ruled out because the Moon was visible the next morning. After Arjuna's son Abhimanyu had been killed on the 13th day, Arjuna had sworn that he would kill the man responsible, Jayadratha, before the evening of the following day, and if he would fail, he would light himself on fire. When it became foreseeable, that Arjuna could not defeat Jayadratha before sunset, Kṛṣṇa caused a solar eclipse to occur and made Jayadratha believe that the day was over. In this moment, Arjuna could kill him. (MBh 7.121(145)).

Another solar eclipse seems to be mentioned on the 13th day during a fight between Bhīma and Karṇa. (MBh 7.114(138).20ff.) And other places also explicitly mention a solar eclipse on the 13th. (MBh 6.3.28) All these statements in the epic itself are not consistent. There cannot be two solar eclipses on two consecutive days and then the crescent of the old moon appears in the next morning. Still, all these passages indicate that the new moon occurred in these days and that, therefore, the beginning of the war must have occurred shortly after a full moon.

Also to be mentioned is the following verse, which refers to the 10th day of the battle, the day of Bhīṣma's fall:

अपसव्यं ग्रहाश्चक्रुरलक्ष्माणं निशाकरम् (var. दिवाकरम्)

अवाक्शिराश्च भगवानुदतिष्ठत (var. उपातिष्ठत) चन्द्रमाः

*apasavyaṃ grahāścakruralakṣmāṇaṃ niśākaram (var. divākaram) avākśirāśca bhagavānudatiṣṭhata (var. upātiṣṭhata) candramāḥ (MBh 6.108(113).12)*

| |
|---|
| The planets circumambulated the inauspicious Moon (var. Sun) to the right. Lord Moon rose with his head bent down. |

Here, the Moon seems to move towards the cluster of the planets that could be seen in the eastern morning sky. That means that the Moon was moving towards the new moon, and therefore the battle would have begun on the full moon.

Another valuable clue is the following: On the 18th day of the battle, Kṛṣṇa's brother Balarāma witnessed the fight between Duryodhana and Bhīma. Having just returned from a 42-day pilgrimage, he makes the following astronomical observation:

चत्वारिंशदहान्यद्य द्वे च मे निःसृतस्य वै

पुष्येण सम्प्रयातोऽस्मि श्रवणे पुनरागतः

*catvāriṃśadahānyadya dve ca me niḥsṛtasya vai*
*puṣyeṇa samprayāto'smi śravaṇe punarāgataḥ (MBh 9.33(34).5)*

| |
|---|
| Today it has been 42 days since I departed.<br>With [the Moon in] Puṣya I left, and with [the Moon in] Śravaṇa I returned again.[123] |

This statement is astronomically consistent. At least, if 42 *nakṣatras* are counted back from Śravaṇa, arriving at Puṣya. The verse does not contain any information regarding moon phases, but it states that the Moon on the 18th day of the battle was in Śravaṇa. So, where was the Moon on the first day of battle? Counting back *nakṣatras*, it can be found that on the 1st day, the Moon was in Mṛgaśīrṣa. The previous day it was in Rohiṇī, which would have been the full moon occurring immediately before the war assigned to the month of Kārttika. Balarama's statement is thus compatible with a Kārttika's full moon, which had to take place either in Kṛttikā or in Rohiṇī.

[123] Cf. MBh 9.34(35).9ff.

Thus, there are quite a few indications that the war actually began after a Kārttika full moon. Yet, there are also other indications that the war began on a new moon in the lunar mansion of Jyeṣṭhā. It seems every attempt to solve these contradictions is hopelessly impossible. The fact that the narrative contradicts itself in this regard might indicate that early epic traditions were already divided as to whether the new moon or the full moon should be given preference. The reason for this disunity might have been that there were different calendrical traditions, one where the months began on new moons, the other on full moons. It will be shown that in fact both calendrical traditions are known to the Mahābhārata. *People just wanted to have this important war begin on the first day of the month and the first day of the year. For, as has been seen, it also marked the beginning of a new age, the* kaliyuga.

Now, what is a lot more interesting than the exact day the war began is the fact that the war began near a Jyeṣṭhā new moon and a full moon in the month of Kārttika. This fact can help in dating the war. As long as the point of view of an astrologer is not taken, it is not necessarily expected that such an important historical event would take place precisely on an astrologically significant date. It is imaginable that astrologers in retrospect associated this important war with this rare and spectacular celestial configuration.

The Mahābhārata itself proves that the sky was carefully observed in ancient India, and if there *was* a super-conjunction, then it must undoubtedly have been perceived. Besides, it is not astonishing but rather to be expected that such a celestial occurrence was subsequently associated with an important historical event like a great war, provided that the temporal distance between them was not too large.

Even ancient astrologers did not necessarily assume that an event on earth *coincided exactly* with the celestial event with which it correlated astrologically. The interpretation of celestial omens rather resembled that of Mesopotamian astrologers who believed that celestial omens indicated earthly events in *the near future*. It can be sited throughout the Mahābhārata, that certain omens were considered to herald disaster. For example, in the following passage, which has already been examined:

आसीद्रुधिरवर्षं च  अस्थिवर्षं च भारत

*āsīdrudhiravarṣaṃ ca  asthivarṣaṃ ca bhārata (MBh 6.2.30cd)*

There was a rain of blood and a rain of bones, O Bhārata.

...

व्यावृत्तं लक्ष्म सोमस्य भविष्यति महद्भयम्

*vyāvṛttaṃ lakṣma somasya bhaviṣyati mahadbhayam (32)*

The sign of the Moon had disappeared. There will be great danger (or fear).

Here, a lunar eclipse was observed as an omen, for an event to take place in the future. Yet the epic wants the battle to begin on a full or new moon, probably, as has been said, because one of these dates was considered the beginning of the year. However, it is not impossible that the date of the great battle was scheduled by the warring parties on the basis of astrological considerations. Kṛṣṇa himself recommended to start the war with the new moon in Jyeṣṭhā. Therefore the possibility that the battle really began during a new moon in Jyeṣṭhā or a full moon in the month of Kārttika cannot be ruled out.

The celestial configuration was thus either considered an omen that predicted war, or the warring parties decided to start the war during this celestial configuration, because they hoped for an auspicious outcome. Unfortunately, the text does not give us clear hints that favour either solution. Perhaps a combination of both would be more accurate. The celestial omens were seen and the start of the battle was scheduled on the date of the new or full moon.

## Super-Conjunction with Eclipses in 1198 BCE

Despite all the quandary it has become abundantly clear from the text that a new moon in Jyeṣṭhā and a full moon assigned to the month of Kārttika occurred somewhere near the time of war. It has also become evident that the new moon was accompanied by a solar eclipse and the full moon by a lunar eclipse. Furthermore, it has been shown that the war must have taken place during a super-conjunction. All the planets disappeared in the glare of the Sun, re-emerged, and gathered around the old moon.

Interestingly, ancient astrologers brought super-conjunctions into connection with eclipses, too. Some even believed that super-conjunctions adumbrated eclipses. Vṛddhagarga writes:[124]

ग्रहपञ्चकसंयोगं दृष्ट्वा न ग्रहणं वदेत्

यदि न स्याद्बुधस्तत्र तं दृष्ट्वा ग्रहणं वदेत्

*grahapañcakasaṃyogaṃ dṛṣṭvā na grahaṇaṃ vadet*
*yadi na syādbudhastatra taṃ dṛṣṭvā grahaṇaṃ vadet*

> When one sees a conjunction of the five planets, one should not predict an eclipse
> if Mercury is not there. However, if one sees him, then one should predict an eclipse.

A similar statement is made by Parāśara in a list of omens for an imminent eclipse (*grahaṇanimittāni*):

... पञ्चताराग्रहादिभिः रोहिणीपीडनमिति चन्द्रग्रहणे

*... pañcatārāgrahādibhiḥ rohiṇīpīḍanamiti candragrahaṇe*

> ... [as well as] torturing of Rohiṇī by the five planets etc. are [indications] of a lunar eclipse. (according to Utpala)

... पञ्चताराग्रहोदयो रोहिणीपीडनं चन्द्रग्रहणे

*... pañcatārāgrahodayo rohiṇīpīḍanaṃ candragrahaṇe*

> ... rising of the five planets [in conjunction] and torturing of Rohiṇī are [indications] of a lunar eclipse. (according to Vallālasena)[125]

Varāhamihira does not share the same view, for he says:

पञ्चग्रहसंयोगान्न किल ग्रहणस्य सम्भवो भवति

*pañcagrahasaṃyogānna kila grahaṇasya sambhavo bhavati (BS 5.17)*

> The emergence of an eclipse is not from a conjunction of the five planets.

Or maybe this verse is a misunderstood rendering of Vṛddhagarga's statement. In any case, the idea of a super-conjunction that was accompanied by eclipses was well-known in ancient astrology.

As has been found already, in the time range from 4000 BCE to the year 0 only two super-conjunctions occurred that fulfil the conditions described in the text: one in the year 2966 BCE, the other in 1198 BCE. The latter matches our new insights concerning syzygies and

---

[124] Bhat, *Varāhamihira's Bṛhatsaṃhitā*, p. 46.

[125] Iyengar, *Parāśaratantra*, p. 86 and p. 91.

eclipses, *so strikingly well that it would be downright absurd to believe it was nothing but a coincidence*.

On the evening of 13th October, Venus was the last planet to disappear in the glare of the Sun. The Moon was in Maghā on this day. For the next 11 days all planets remained invisible. In the meantime, on 21st October, a new moon occurred in Anurādhā, just 7° from the star Jyeṣṭhā (Antares). This new moon was a partial eclipse with a coverage of 87%. On the morning of 25th October, Jupiter was the first planet to make its heliacal rising. On 4th November, a full moon took place in Rohiṇī. It was assigned to the month of Kārttika and was accompanied by a partial lunar eclipse with a coverage of 71%. On the morning of 18th November, before sunrise, all planets could be seen gathered around the old moon in the eastern sky, scattered over an area of only about 19°. On p. 242ff., sky maps are given for some dates during this super-conjunction.

All this coincides remarkably well with the details given in the text. The extreme rarity of super-conjunctions of this type has previously been described. It is unexpected that one of the two candidates would have been accompanied by a new moon and a full moon in the right sky area and even by locally observable eclipses – except of course under the assumption that the information given by the Mahābhārata goes back to historical astronomical observations.

This work is not the first to time the war with a super-conjunction in the year 1198 BCE. K. G. Sankar suggested as early as 1931 that the first day of the war was during the Kārttika full moon in 1198 BCE.[126] Sankar's astronomical calculations and other information is partly wrong, as he was obviously not an expert in astronomy.[127] His dating of the new moon on 16th October is probably a typo and must be corrected to 10th October ("0" and "6" can be confused in handwriting). 10th October, 1198 BCE in the Gregorian calendar corresponds to the Julian calendar's 21st October, the correct date of the new moon. Sankar's statement that the seven planets could be seen together on this day if a cloud covered the Sun is, of course,

---

[126] Sankar, K. G., "Some Problems of Indian Chronology", p. 349ff.

[127] E.G. with all calculations that are based on the precession, he uses a precession rate of 61 (sic) instead of 71.6 years per degree.

wrong. However, they could be seen on 18th November, when all planets were in conjunction with the Moon in the morning sky.

In 1942, K.L. Daftari also dated the Mahābhārata battle to the year 1198 BCE, in his book *The Astronomical Method and Its Application To The Chronology of Ancient India*. However, according to him the war began during the new moon on 21st *November*, which is one month after our new moon in Anurādhā-Jyeṣṭhā, during the day of the first crescent of the month of Mārgaśīrṣa (*śuklapratipad*). He arrived at this date as a result of his particular interpretation of the following verse, which has already been discussed and interpreted differently:

> मघाविषयगः सोमस्तद्दिनं प्रत्यपद्यत
>
> दीप्यमानाश्च संपेतुर्दिवि सप्त महाग्रहाः
>
> *maghāviṣayagaḥ somastaddinaṃ pratyapadyata*
> *dīpyamānāśca saṃpeturdivi sapta mahāgrahāḥ (MBh 6.17.2)*

> On that day, the Moon god (Soma) entered the region of Maghā.
> The seven great planets burned in the sky and flew together.

Daftari translated the verse as follows:

> the Moon was in the constellation whose subject is the same as that of the Maghā, *i.e.*, in the constellation named Mūla.[128]

To explain this, Daftari refers to a doctrine of the Atharvajyotiṣa, which divides the 27 *nakṣatras* into three groups of nine. From this division, it follows that Maghā "corresponds" to Mūla and Aśvinī.

It is undecided whether this explanation can be accepted. Unfortunately it is unknown for certain what exactly the term *viṣayaḥ* means here. In this work it is interpreted as "region", whereas Daftari translates it as "subject", probably meaning the same as "theme". A detailed discussion of this verse is given on p. 139ff.

Whatever the exact meaning of this verse may be, Daftari correctly recognized that it was in reference to a super-conjunction. He stated that the planets and the Moon gathered at a certain distance from the Sun:

---

[128] Daftari, *The Astronomical Method...*, p. 26f.

> If an observer can see all of them at once except the Sun just before sunrise, when facing the East, he would feel that all the seven planets met together.[129]

In Daftari's opinion, this was the case on 19th November, the morning of the last crescent before the new moon. The Moon was in the *nakṣatra* Mūla, or at least close to its principle star, and was lined up with Mars, Mercury, Rāhu, Venus, Jupiter and Saturn like a string of pearls. This would indeed have been a very impressive sight. However, Daftari overlooked that on this day the Moon already stood too close to the Sun and could not be observed. In reality, the old moon was visible for the last time on the previous day. The view was even more stunning, as the Moon stood in the middle of the planets.

Moreover Daftari's interpretation of the verse is not really accurate in that the planets were already about to separate from each other on this date, whereas the verse was talking about a "flying together" (*saṃpetur*) of the planets. Daftari's configuration would work a lot better with the statement made in Karṇaparva, which refers to the 16th day of the battle:

> निश्चरन्तो व्यदृश्यन्त सूर्यात्सप्त महाग्रहाः
>
> *niścaranto vyadṛśyanta sūryātsapta mahāgrahāḥ (MBh 8.26(37).34ab)*

| The seven planets were seen coming out of the Sun. |
|---|

This verse describes the end of a super-conjunction, where the planets re-emerge from the Sun and "fly apart" rather than "fly together". In reality, the two verses talk about different phases of the super-conjunction. However, these are only minor shortcomings of Daftari's theory.

Interestingly, Daftari believed that the new moon on 20th November was the Jyeṣṭhā new moon mentioned in the epic. According to current definitions of the *nakṣatras*, this new moon actually took place in Mūla, but already close to Pūrvāṣāḍhā. Daftari thus assumed that the details of the epic were wrong. Since a new moon could not be observed directly, this may be acceptable. However, the error would be quite large, especially if the reference stars of the *nakṣatras* are taken into consideration.

[129] Daftari, *The Astronomical Method...*, p. 26f.; p. 55-57.

Another disadvantage with Daftari's solution is the fact that the eclipse mentioned in the epic does not take place on this new moon but on the preceding one. The epic wants the war to start on the day after a solar eclipse.

## Solar and Lunar Eclipses at the Time of the Great War

To examine, in detail the eclipses that allegedly took place during the war, the following verses, will be referenced once again:

> चतुर्दशीं पञ्चदशीं भूतपूर्वां च षोडशीम्
>
> इमां तु नाभिजानामि अमावास्यां त्रयोदशीम्
>
> *caturdaśīṃ pañcadaśīṃ bhūtapūrvāṃ ca ṣoḍaśīm*
> *imāṃ tu nābhijānāmi amāvāsyāṃ trayodaśīm (MBh.6.3.28)*

> [New moons] on the 14th, 15th or 16th there have been before.
> But this new moon on the 13th day I do not know.

> चन्द्रसूर्यावुभौ ग्रस्तावेकमासे त्रयोदशीम्
>
> अपर्वणि ग्रहावेतौ (var. ग्रहेणैतौ) प्रजाः संक्षपयिष्यतः
>
> (var. अपर्वणि ग्रहं यातौ प्रजासंक्षयमिच्छतः)
>
> *candrasūryāvubhau grastāvekamāse trayodaśīm*
> *aparvaṇi grahāvetau* (var. *graheṇaitau*) *prajāḥ saṃkṣapayiṣyataḥ (29)*
> (var. *aparvaṇi grahaṃ yātau prajāsaṃkṣayamicchataḥ*)

> Both the Moon and the Sun were eclipsed (swallowed) in one and the same month on the 13th [of the fortnight],
> on a wrong date: these two eclipses[130] will destroy the creatures.

Thus during the month of the war, a solar as well as a lunar eclipse allegedly occurred. Both or at least one of them took place two days earlier than expected, on the 13th of its half-month, which was considered a bad omen. Sengupta believed that this information was not authentic because astronomically it was impossible.[131] This phenomenon will be discussed shortly. However, Sengupta wanted to get rid of the eclipses all together because they are not compatible with his dating of the Mahābhārata War. It is true of course

[130] *grahau*; see my explanations in footnote 121, p. 220.

[131] Sengupta, *Ancient Indian Chronology*, p. 28f.

that the eclipses are not the most credible part in the information given by the epic, as due to their apocalyptic connotations, they could well be a poetic means to create a gloomy atmosphere.

However, during a super-conjunction that includes a lunar node, double eclipses are likely to happen. Even double eclipses of the Sun and the Moon within two weeks of each other are by no means unusual. As has been said, such a double eclipse did occur during the super-conjunction of 1998 BCE, both a solar and a lunar eclipse could be observed within two weeks from Kurukṣetra. The solar eclipse occurred in the early afternoon on 21st October and reached a magnitude of 86%. A fortnight later, on the evening of 4th November, a partial lunar eclipse of 70% could be observed.

The lunar eclipse, which occurred during a Kārttika full moon, is described as follows.

> अलक्ष्यः प्रभया हीनः पौर्णमासीं च कार्त्तिकीम्
>
> चन्द्रोऽभूदग्निवर्णश्च समवर्णे नभस्तले (var. पद्मवर्णे)
>
> *alakṣyaḥ prabhayā hīnaḥ paurṇamāsīṃ ca kārttikīm*
> *candro'bhūdagnivarṇaśca samavarṇe (*var. *padmavarṇe) nabhastale (MBh 6.2.23)*

| |
|---|
| The Moon lost his [hare] sign and became devoid of light on the full moon of the month of Kārttika (or: in the *nakṣatra* Kṛttikā), and fiery in colour at the firmament, which was of the same colour (or: of the colour of the lotus). |

This verse describes a full moon projecting dim light and reddish colour. This description indicates a lunar eclipse. The firmament is said to be either "of the same colour", as the reddish Moon, or, according to a text variant, "the colour of the lotus". Here, the colour of the lotus is certainly not white, but reddish. Hence it must be concluded that the firmament itself is "fiery in colour" near the horizon, because the eclipse takes place either at dusk or at dawn.

Interestingly, the Kārttika lunar eclipse on 4th November, 1198 BCE began in the evening after sunset. Yet it could not be observed exactly as the text described it. The Moon rose at 5:15 pm, and the Sun set at 5:25 pm. The partial phase of the eclipse began at 6:20 pm, and the maximum magnitude of 70% was reached at 7:44 pm. At the beginning of the partial eclipse, the Sun was already 12°43' below the horizon. It was already the end of the nautical twilight, and the afterglow was still visible, if the atmospheric conditions were favourable. However, by the time the eclipse had reached its maximum, the Sun was already 31° below the horizon, and it was completely dark. Besides, the eclipsed part of the Moon might not have appeared reddish, but almost black. Only when the lunar disk is almost completely eclipsed and the bright part of the Moon does not make contrast anymore, then the eye can perceive the reddish colour of the eclipse. However, perfect precision in an epic text should not be expected. What is important is that there was a lunar eclipse in the month of Kārttika, and the partial phase began during the afterglow.

The ominous character of this can be explained as follows. The night of the Kārttika full moon was actually especially auspicious:

तेषां पुण्यतमा रात्रिः पर्वसंधौ स्म शारदी

तत्रैव वसतामासीत्कार्त्तिकी जनमेजय

*teṣāṃ puṇyatamā rātriḥ parvasaṃdhau sma śāradī*
*tatraiva vasatāmāsītkārttikī janamejaya (MBh 3.179(182).16)*

> When they (the Pāṇḍavas) stayed there, it was the night that was most sacred to them, on the full moon transition in the fall in the month of Kārttika, O Janamejaya.

It seems that exactly for this reason it became extremely inauspicious when it coincided with a lunar eclipse.

Concerning the lunar eclipse: What details then are known about the solar eclipse? The great battle is associated with a solar eclipse in several places (MBh 6.3.28f.; 5.141.10; MBh 6.3.11).

The solar eclipse on 21st October 1198 BCE lasted from 12:05 until 3:20 pm and reached a maximum obscuration of 87% at 1:46 pm. It is interesting to note, that only 11 years later, on the morning of 27th March, 1187 BCE, just around sunrise, and just 5 days before the spring equinox, a *total* solar eclipse occurred that could be observed from a larger area around Kurukṣetra. Total solar eclipses are incomparably more impressive than partial ones, and anyone who has seen one, should have been deeply impressed. Total solar eclipses are extremely rare for a given geographic location. Because the earth's rotational angle (ΔT) is uncertain for the remote past, it is difficult to tell exactly which total eclipses before 1000 BCE were observable from Kurukṣetra. According to P. J. Huber, the uncertainty of Δt (the estimated standard error) for the year 1187

BCE was about +–1030 seconds or +–4°18’ in geographic longitude.[132] This is the amount by which the path of totality could shift towards east or west. In any case, if the Δt model of Morrison und Stephenson (2004) is used, then the totality occurred at sunrise in Kurukṣetra. It is therefore quite likely that in retrospect this spectacular event was also associated with the great war. If so, the Mahābhārata actually mixes up two different solar eclipses: the one of 1198 BCE and the one of 1187 BCE.

The latter could be alluded to in the following verse:

> द्विधाभूत इवादित्य उदये प्रत्यदृश्यत
>
> var. D3: विगतांशुस्तथादित्य उदये प्रत्यदृश्यत
>
> ज्वलन्त्या शिखया भूयो भानुमानुदितो दिवि
>
> *dvidhābhūta ivāditya udaye pratyadṛśyata*
> var. $D_3$: *vigatāṃśustathāditya udaye pratyadṛśyata*
> *jvalantyā śikhayā bhūyo bhānumānudito divi (MBh 6.17.3)*

> The Sun was seen split in two, as it were, in his rising.
> *Var.:* Without rays[133] appeared the Sun in his rising.
> With a burning crest (or: flame) rose the shining one again in the sky.

The “split-in-two” Sun (*dvidhābhūta iva*) could refer to the total eclipse (cf. p. 285ff.), as could also the quoted variant, stating that the Sun rose, with [his] rays gone away“ (*vigatāṃśuḥ*). Furthermore, it is stated that the Sun rose with a “burning crest”. This could allude to the corona that appears during a total solar eclipse. What is particularly interesting it the statement that the phenomenon occurred at sunrise. Is it describing a total solar eclipse at sunrise?

A solar eclipse also took place during the hour of Jayadratha’s death, on the 14th day of the war. Examining the events on the 13th day, the Sindhu king Jayadratha managed to kill Arjuna’s son Abhimanyu. Arjuna had therefore sworn to either kill Jayadratha by sunset of the next day, or otherwise, if he should not succeed, to

---

132 Huber, P. J., “Modeling the Length of Day and Extrapolating the Rotation of the Earth”, Astronomical Amusements, Edited by F. Bonoli, S. De Meis, & A. Panaino, Rome, (2000). Huber’s formula for estimating the standard error is also found on the Fred Espenak’s website:
http://eclipse.gsfc.nasa.gov/SEcat5/uncertainty.html .

133 *vigatāṃśuḥ*, litterally: “while his rays had gone away”.

burn himself on a pyre. Now, the Kauravas tried to protect Jayadratha no matter what the cost, especially since they did not see any other way to defeat Arjuna, who inflicted devastating losses to them. As the day drew to a close and Arjuna's efforts to fulfil his vow began to appear hopeless, Kṛṣṇa used his yoga powers to create a solar eclipse and made Jayadratha and his protectors believe that the Sun had set. At this moment, before the reappearance of the Sun, Arjuna jumped at the chance, killed Jayadratha and managed to fulfil his vow after all.

The original text, which does not appear in the critical edition, but is given in quite a lot of manuscripts, reads as follows (MBh 7.121(145), after verse 15; appendix No. 16):

योगमत्र विधास्यामि सूर्यस्यावरणं प्रति

अस्तं गत इति व्यक्तं द्रक्ष्यत्येकः स सिन्धुराट्

*yogamatra vidhāsyāmi sūryasyāvaraṇaṃ prati (5)*
*astaṃ gata iti vyaktaṃ drakṣyatyekaḥ sa sindhurāṭ (6)*

> "I shall perform a yoga here, aiming at a hiding of the Sun.
> The one king of the Sindhus (Jayadratha) will believe that [the Sun] has apparently set.

हर्षेण जीविताकाङ्क्षी विनाशार्थं तव प्रभो

न गोप्स्यति दुराचारः स आत्मानं कथं चन

*harṣeṇa jīvitākāṅkṣī vināśārthaṃ tava prabho (7)*
*na gopsyati durācāraḥ sa ātmānaṃ kathaṃ cana (8)*

> In joy, desiring life for the sake of your destruction, O lord,
> he will not protect himself [and make himself] inaccessible in any way anymore.

तत्र छिद्रे प्रहर्तव्यं त्वयास्य कुरुसत्तम

व्यपेक्षा नैव कर्तव्या गतोऽस्तमिति भास्करः

एवमस्त्विति बीभत्सुः केशवं प्रत्यभाषत

*tatra chidre prahartavyaṃ tvayāsya kurusattama (9)*
*vyapekṣā naiva kartavyā gato 'stamiti bhāskaraḥ (10)*
*evamastviti bībhatsuḥ keśavaṃ pratyabhāṣata (11)*

> In this his weak moment you shall strike, O best one of the Kurus,
> and you shall not make up the thought that the Sun has set."
> "So be it", spoke Arjuna to Kṛṣṇa.

ततोऽसृजत्तमः कृष्णः सूर्यस्यावरणं प्रति

योगी योगेन संयुक्तो योगिनामीश्वरो हरिः

*tato 'sṛjattamaḥ kṛṣṇaḥ sūryasyāvaraṇaṃ prati (12)*
*yogī yogena saṃyukto yogināmīśvaro hariḥ (13)*

Then Kṛṣṇa emitted a darkness aiming at a hiding of the Sun,
the yogī, harnessed in yoga, Hari, the lord of the yogis.

सृष्टे तमसि कृष्णेन गतोऽस्तमिति भास्करः

त्वदीया जहृषुर्योधाः पार्थनाशान्नराधिप

*sṛṣṭe tamasi kṛṣṇena gato 'stamiti bhāskaraḥ (14)*
*tvadīyā jahṛṣuryodhāḥ pārthanāśānnarādhipa (15)*

After Kṛṣṇa had emitted the darkness, then [believing], the Sun had set, your (Dhṛtarāṣṭra's) warriors rejoiced over the destruction of Arjuna, O king of men.

ते प्रहृष्टा रणे राजन्नापश्यन्सैनिका रविम्

उन्नाम्य वक्त्राणि तदा स च राजा जयद्रथः

*te prahṛṣṭā raṇe rājannāpaśyansainikā ravim (16)*
*unnāmya vaktrāṇi tadā sa ca rājā jayadrathaḥ (17)*

Shouting out with joy in battle, those warriors did not see the Sun, O king, having raised their faces, including King Jayadratha.

वीक्षमाणे ततस्तस्मिन्सिन्धुराजे दिवाकरम्

पुनरेवाब्रवीत्कृष्णो धनंजयमिदं वचः

*vīkṣamāṇe tatastasminsindhurāje divākaram (18)*
*punarevābravītkṛṣṇo dhanaṃjayamidaṃ vacaḥ (19)*

Then, while the king of the Sindhus looked towards the Sun,
Kṛṣṇa spoke to Arjuna the following words:

पश्य सिन्धुपतिं वीरं प्रेक्षमाणं दिवाकरम्

भयं विपुलमुत्सृज्य त्वत्तो भरतसत्तम

*paśya sindhupatiṃ vīraṃ prekṣamāṇaṃ divākaram (20)*
*bhayaṃ vipulamutsṛjya tvatto bharatasattama (21)*

"See the hero, the king of the Sindhus, who is looking toward the sun,
giving up his great fear of you, O best one of the Bhāratas!

→

अयं कालो महाबाहो वधायास्य दुरात्मनः

छिन्धि मूर्धानमस्याशु कुरु साफल्यमात्मनः

*ayaṃ kālo mahābāho vadhāyāsya durātmanaḥ (22)*
*chindhi mūrdhānamasyāśu kuru sāphalyamātmanaḥ (23)*

> This is the moment, O Arjuna, for the destruction of this [man] of evil nature! Quickly cut off his head, do your own aim!"

Arjuna thus attacked quickly and killed Jayadratha and his protectors. After that, the following verses can be read, again only in some of the manuscripts (immediately after MBh 7.121(145).41):

ततो विनिहते राजन्सिन्धुराजे किरीटिना

तमस्तद्वासुदेवेन संहृतं भरतर्षभ

*tato vinihate rājansindhurāje kirīṭinā*
*tamastadvāsudevena saṃhṛtaṃ bharatarṣabha*

> After the king of the Sindhus had been killed by Arjuna, O king,
> Kṛṣṇa withdrew the darkness, O best one of the Bhāratas.

पश्चाज्ज्ञातं महीपाल तव पुत्रैः सहानुगैः

वासुदेवप्रयुक्तेयं मायेति नृपसत्तम

*paścājjñātaṃ mahīpāla tava putraiḥ sahānugaiḥ*
*vāsudevaprayukteyaṃ māyeti nṛpasattama*

> After that, O king, your sons and their followers realised
> that this was an illusion (*māyā*) born out of Kṛṣṇa's yoga, O best one of the kings.

The passage seems to talk about a total solar eclipse shortly before sunset. What is strange, however, with this description is the fact that the warriors have to "raise" (*unnāmya*, Z. 17) their faces, in order to look "to the Sun". It therefore appears that the Sun had not reached the horizon yet, but still stood quite a bit above it. Could the eclipse thus have occurred in mid-afternoon? One also must remember that the Sanskrit term *astaṃ gam-*, "to go home, set (in astronomical sense) ", could be understood as "to perish", or "to be destroyed". In view of this linguistic ambiguity there may have arisen doubts whether a solar eclipse had to be considered as a "setting" of the Sun. Hence, the possibility that this description goes back to the solar eclipse on the early afternoon of 21st October, 1198 BCE cannot be ruled out, although it did not really become total only reaching a magnitude of 87%.

On the other hand, a solar eclipse shortly before sunset could be indicated by the following verses:

स कर्णं कर्णिना कर्णे पीतेन निशितेन च

विव्याध युधि राजेन्द्र भीमसेनः पतत्रिणा

*sa karṇaṃ karṇinā karṇe pītena niśitena ca*
*vivyādha yudhi rājendra bhīmasenaḥ patatriṇā (MBh 7.114(138).3)*

| |
|---|
| Bhīma pierced the ear of Karṇa in battle, O king of kings, using a feathered, sharp and oiled arrow,[134] |

स कुण्डलं महत्कर्णात् कर्णस्यापातयद्भुवि

तपनीयं महाराज दीप्तं ज्योतिरिवाम्बरात्

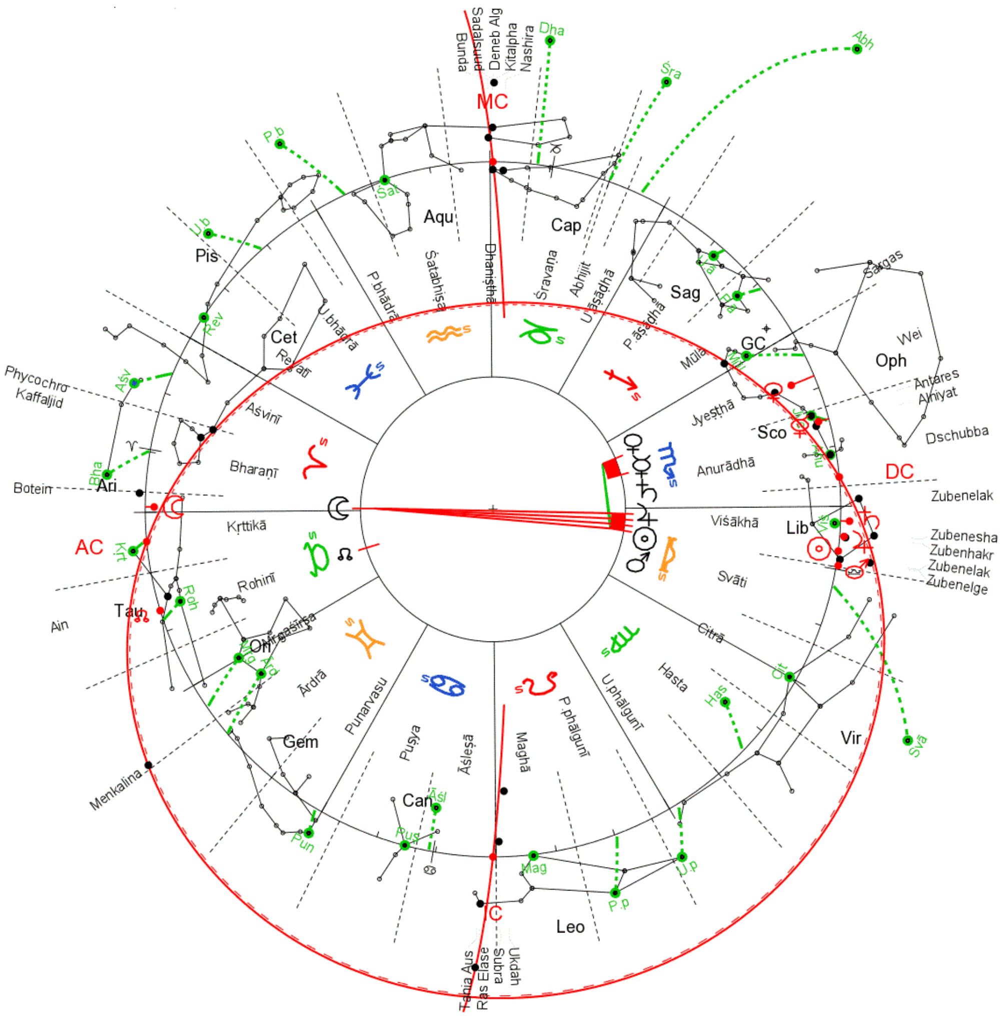
*sa kuṇḍalaṃ mahatkarṇāt karṇasyāpātayadbhuvi*
*tapanīyaṃ mahārāja dīptaṃ jyotirivāmbarāt (4)*

| |
|---|
| and caused the great ring from Karṇa's ear to fall down on the earth, like a hot, shining light [falls] from the sky, O king. |

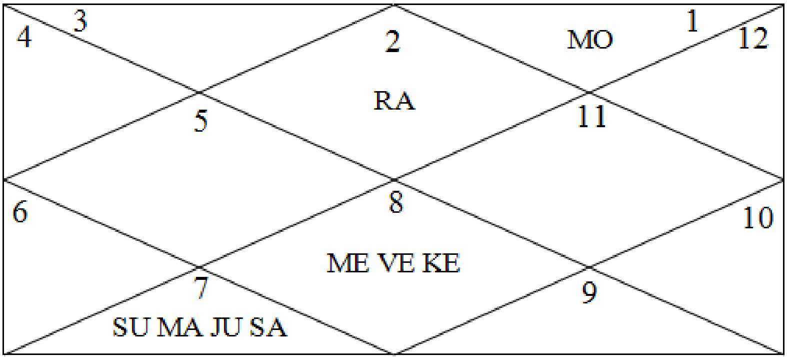
Karṇa was the son of the Sun god Sūrya and the virgin Kuntī. Using the words of the epic, he was actually even *tīkṣṇāṃśor bhāskara-syāṃśaḥ*, "a part of the sharp-rayed Sun god" (MBh 1.126.3). His name means "ear", and he was allegedly born with a great golden earring (*kuṇḍalam*). The image of a golden earring that falls from the sky is clearly reminiscent of an annular eclipse near sunset.

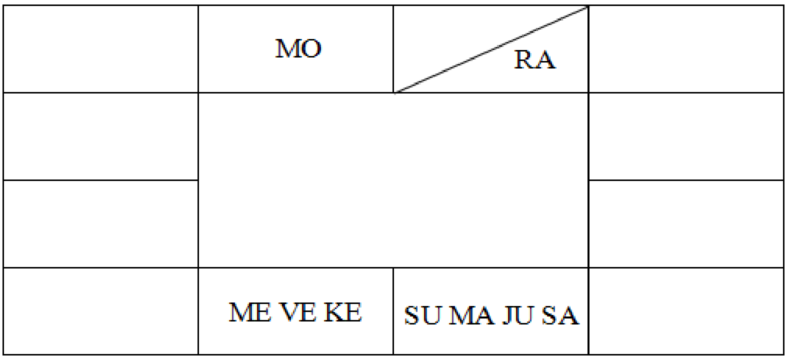
Were there any annular solar eclipses that occurred near sunset and were observable from Kurukṣetra? In fact, there was one, on 17th April, 1132 BCE in Kṛttikā. This is remarkable, because this phenomenon is extremely rare for a given geographic location. In the 12th century BCE, Kurukṣetra saw three really extraordinary solar eclipses: a total eclipse at sunrise in the year 1187, an annular one at sunset in 1132 BCE, and a 87% partial eclipse during the spectacular super-conjunction of 1198 BCE. All the three of them might have entered our epic.

[134] A wordplay: *sa karṇaṃ karṇinā karṇe vivyādha*. Karṇa's name means "ear". The arrow used is called *karṇin*, i.e. "having ear(s)".



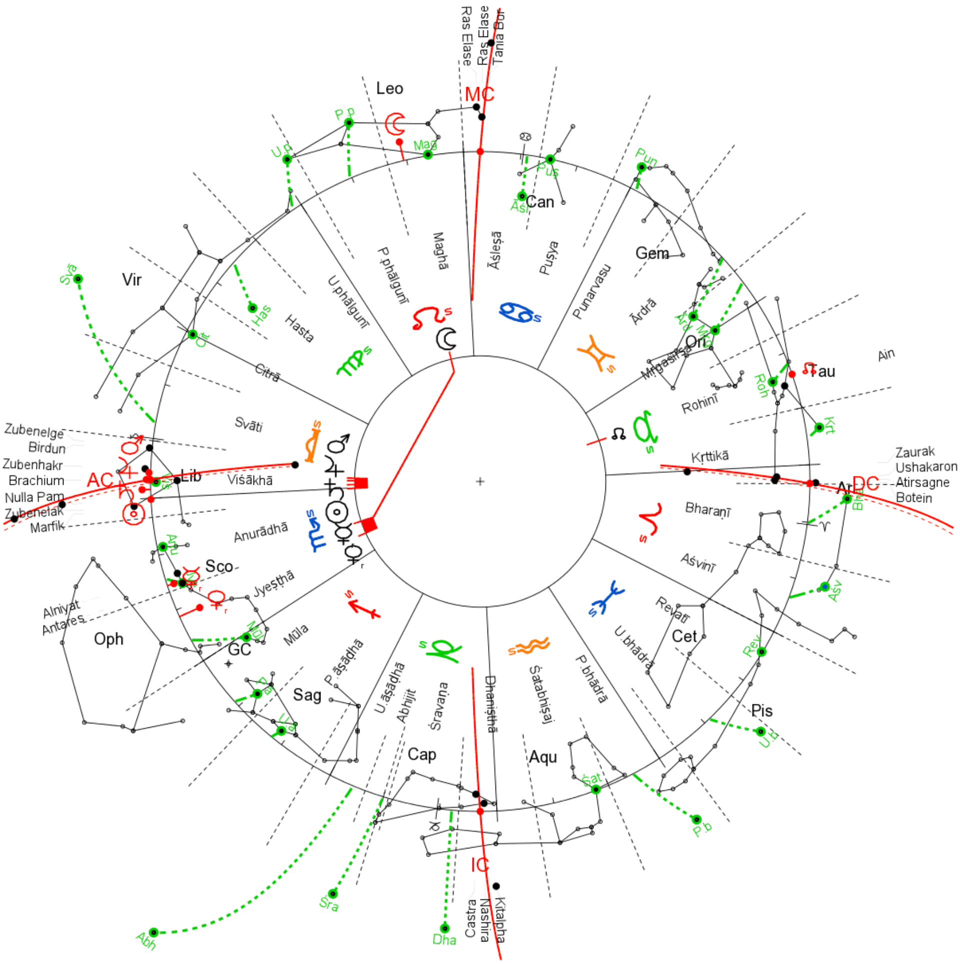

Configuration on the evening of 6th October, 1198 BCE at moonrise (*ayanāṃśa* = -20°29'). The exact full moon took place during the day in Bharaṇī. However, the following night it was seen in Kṛttikā. For ancient observers it was difficult to determine in which lunar mansion it was. It could have been the Kārttika full moon, although the next full moon could also have been assigned to the month of Kārttika. The planets gathered around the Sun. Mercury and Venus still stood a bit offside, but they were to join the gathering in the following days. Two days earlier was the autumn equinox.




Full Moon Rising in Bharani/Krttika in October 1198 BCE
6 Oct 1198 BCE (-1197) jul., 18:25 LMT, Kurukshetra 76e51,29n59
JD (UT)=1284132.0538889, JD (ET)=1284132.3885238, delta_t=28912.5 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 339°31'58" (True Citra)
Sidereal time: 18:39:24 (279°51'07")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 34°50'03" | Vrb/Tau 4°50'03" | Krt | | |
| Sun | 202°36'06" | Tul/Lib 22°36'06" | Vis | 6 | -0°00'07" |
| Moon | 29°05'18" | Mes/Ari 29°05'18" | Krt | 12 | -2°20'14" |
| Mercury | 224°36'14" | Vrk/Sco 14°36'14" | Anu | 7 | -2°45'14" |
| Venus | 232°05'38" | Vrk/Sco 22°05'38" | Jye | 7 | -6°24'25" |
| Mars | 200°13'15" | Tul/Lib 20°13'15" | Vis | 6 | 0°30'43" |
| Jupiter | 205°04'01" | Tul/Lib 25°04'01" | Vis | 6 | 1°07'04" |
| Saturn | 207°35'25" | Tul/Lib 27°35'25" | Vis | 6 | 2°18'35" |
| Rahu | 46°26'13" | Vrb/Tau 16°26'13" | Roh | 1 | |
| Ketu | 226°26'13" | Vrk/Sco 16°26'13" | Anu | 7 | |

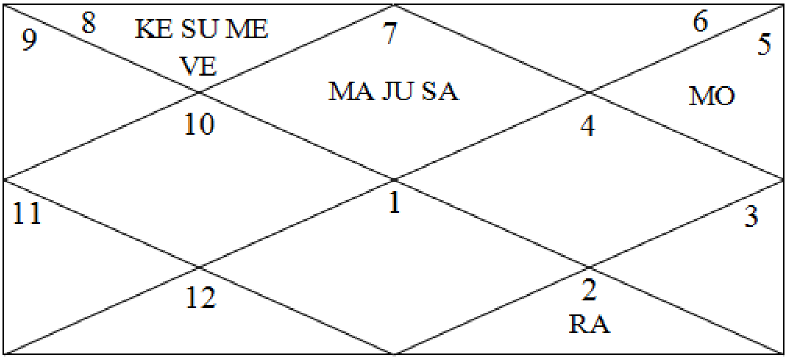


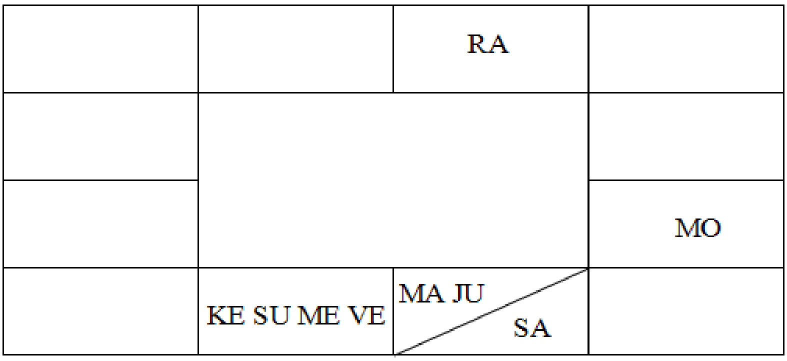

*“After the seventh day will be the new moon.*
*Then one has to harness battle, for that [new moon], they say, has Indra as its [presiding] deity.”* (MBh 5.140(142).18)

Configuration on the morning of 14th October, 1198 BCE. The waning half-moon was seen behind Maghā (Regulus). From this, it could be concluded that new moon would take place “on the seventh day” in Jyeṣṭhā, the lunar mansion of Antares, which is presided by Indra.

*“On that day, the Moon god (Soma) entered the region of Maghā.*
*The seven great planets burned in the sky and flew together.”* (MBh 6.17.2)

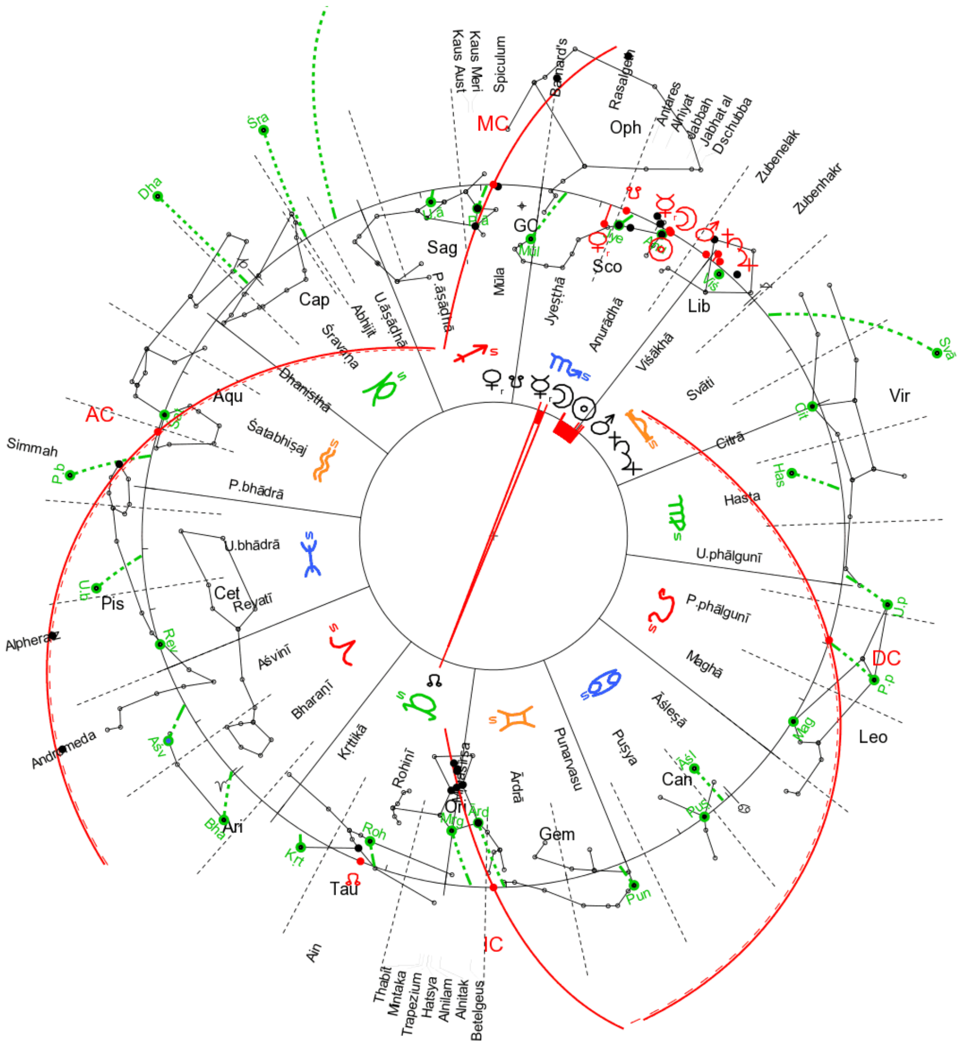
On the previous evening, on 13th October, Venus was the last planet to be seen for the last time. Thus on the 14th, the super-conjunction became perfect.



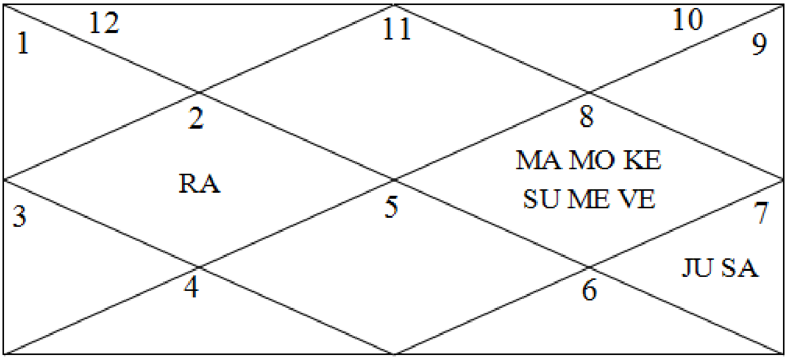

Seven Days Before New Moon
14 Oct 1198 BCE (-1197) jul., 5:45 LMT, Kurukshetra 76e51,29n59
JD (UT)=1284139.5261111, JD (ET)=1284139.8607415, delta_t=28912.1 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 339°32'00" (True Citra)
Sidereal time: 6:28:52 (97°13'01")

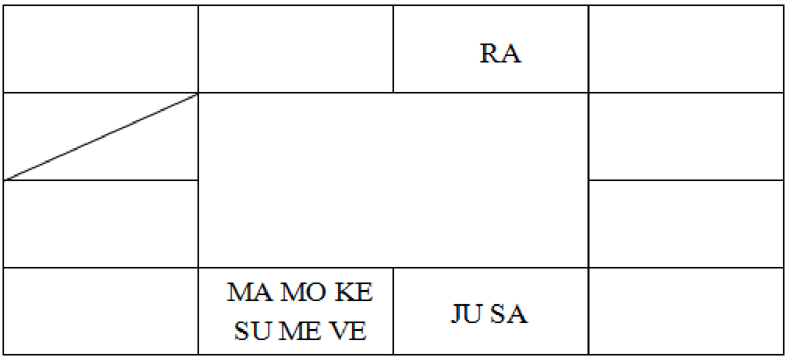
| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 206°45'06" | Tul/Lib 26°45'06" | Vis | | |
| Sun | 210°10'04" | Vrk/Sco 0°10'04" | Vis | 2 | 0°00'00" |
| Moon | 130°28'34" | Sim/Leo 10°28'34" | Mag | 11 | 5°13'56" |
| Mercury | 225°29'18" | Vrk/Sco 15°29'18" | Anu | 2 | -1°52'34" |
| Venus | 231°15'58" | Vrk/Sco 21°15'58" | Jye | 2 | -6°04'39" |
| Mars | 205°32'53" | Tul/Lib 25°32'53" | Vis | 1 | 0°26'32" |
| Jupiter | 206°44'08" | Tul/Lib 26°44'08" | Vis | 1 | 1°06'46" |
| Saturn | 208°27'50" | Tul/Lib 28°27'50" | Vis | 1 | 2°18'27" |
| Rahu | 46°02'26" | Vrb/Tau 16°02'26" | Roh | 8 | |
| Ketu | 226°02'26" | Vrk/Sco 16°02'26" | Anu | 2 | |




"*After the seventh day will be the new moon.*
*Then one has to harness battle, for that [new moon], they say, has Indra as its [presiding] deity.*" (MBh 5.140(142).18)

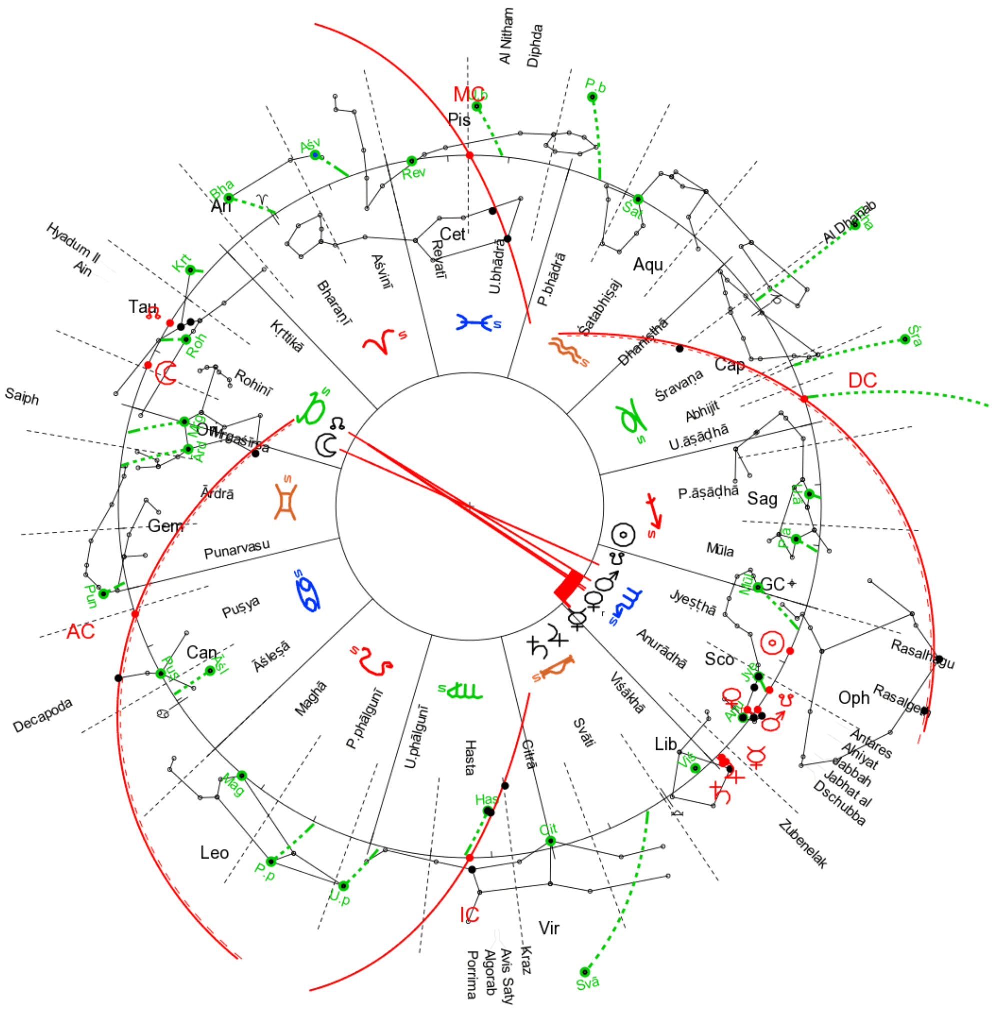
Mahābhārata war: Super-conjunction of 21st October, 1198 BCE (1:48 pm) with the new moon in Anurādhā near Jyeṣṭhā, the lunar mansion ruled by Indra. All the planets had disappeared in the glare of the Sun and did not become visible at night. Besides, there was a partial solar eclipse of magnitude 86%, which was observable from Kurukṣetra.



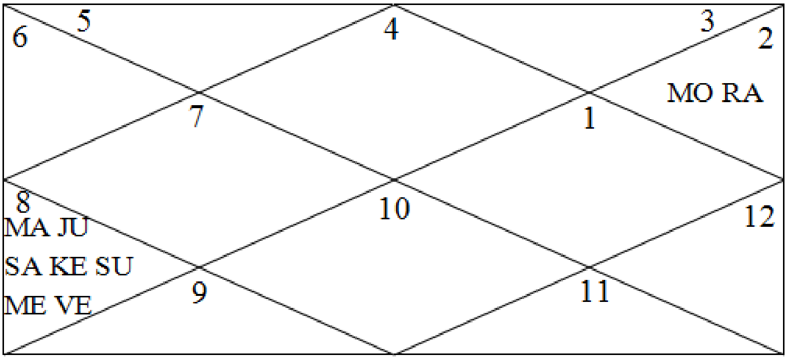

All Planets Cluster with New Moon and Solar Eclipse Near Jyestha
21 Oct 1198 BCE (-1197) jul., 13:47:41 LMT, Kurukshetra 76e51,29n59
JD (UT)=1284146.8613079, JD (ET)=1284147.1959338, delta_t=28911.7 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 339°32'02" (True Citra)
Sidereal time: 15:00:28 (225°07'03")

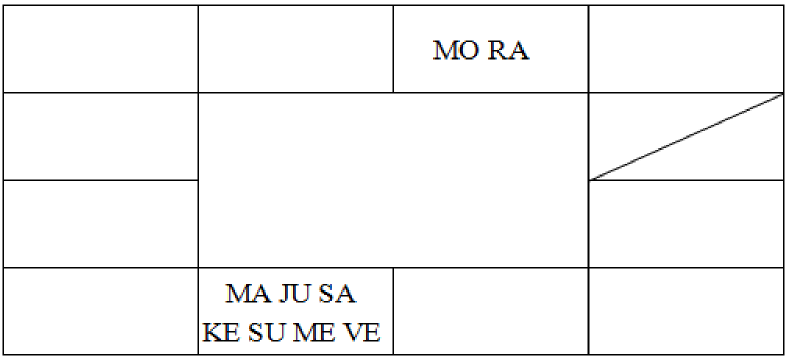
| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 320°55'14" | Kum/Aqu 20°55'14" | PBh | | |
| Sun | 217°36'48" | Vrk/Sco 7°36'48" | Anu | 10 | -0°00'05" |
| Moon | 217°38'08" | Vrk/Sco 7°38'08" | Anu | 10 | 0°02'41" |
| Mercury | 217°56'28" | Vrk/Sco 7°56'28" | Anu | 10 | 0°19'19" |
| Venus | 228°20'41" | Vrk/Sco 18°20'41" | Jye | 10 | -5°09'54" |
| Mars | 210°49'13" | Vrk/Sco 0°49'13" | Vis | 10 | 0°22'12" |
| Jupiter | 208°22'10" | Tul/Lib 28°22'10" | Vis | 9 | 1°06'33" |
| Saturn | 209°19'11" | Tul/Lib 29°19'11" | Vis | 9 | 2°18'29" |
| Rahu | 45°39'06" | Vrb/Tau 15°39'06" | Roh | 4 | |
| Ketu | 225°39'06" | Vrk/Sco 15°39'06" | Anu | 10 | |




“The Moon lost his [hare] sign and became devoid *of light on the full moon of the month of Kārttika (or: in the nakṣatra Kṛttikā), and fiery in colour at the firmament, which was of the same colour (or: of the colour of the lotus).”* (MBh 6.2.23)

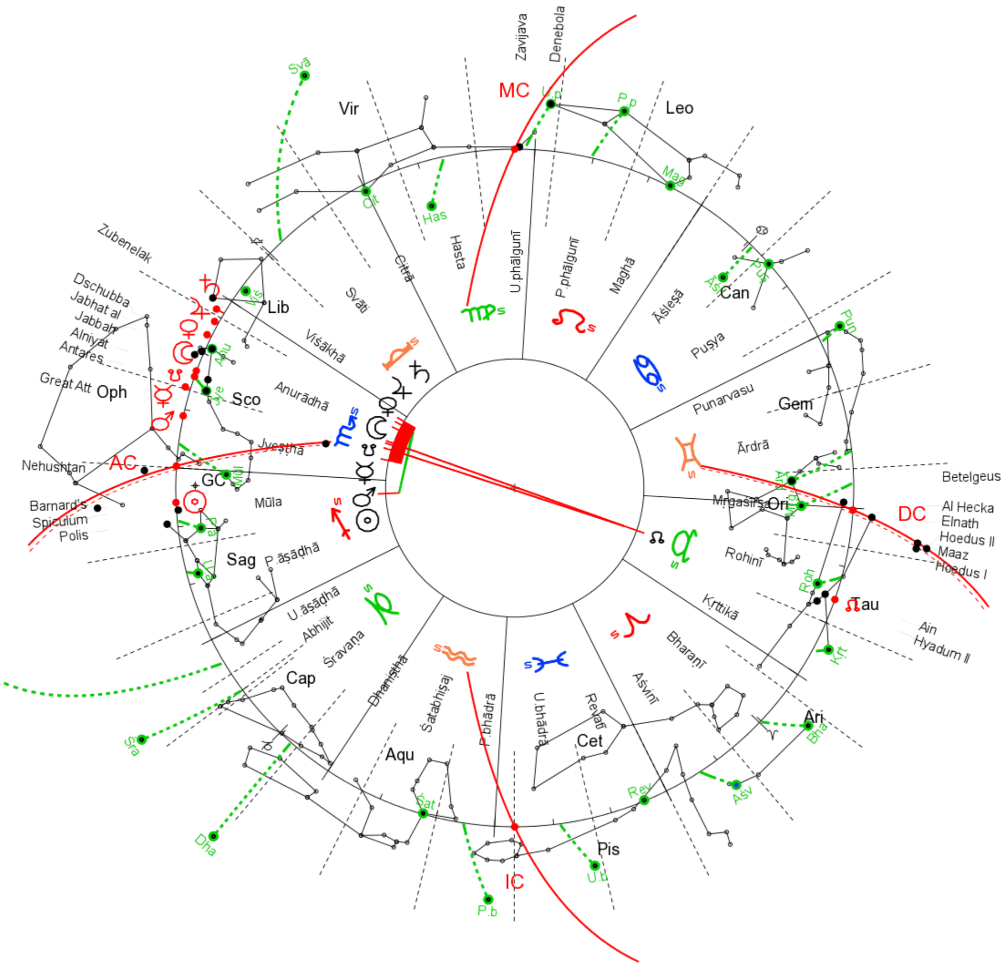
Mahābhārata war: Full moon of the month of Kārttika on the evening of 4th November 1198 BCE (7:44 pm). By this time, all the planets except Mars had reappeared in the morning sky. Mars was delayed by two to three weeks. There was a lunar eclipse on this date with a magnitude of 70%, observable from Kurukṣetra.




All Planets Cluster with Karttika Full Moon and Lunar Eclipse
4 Nov 1198 BCE (-1197) jul., 19:43:44 LMT, Kurukshetra 76e51,29n59
JD (UT)=1284161.1085648, JD (ET)=1284161.4431821, delta_t=28910.9 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 339°32'08" (True Citra)
Sidereal time: 21:52:42 (328°10'23")

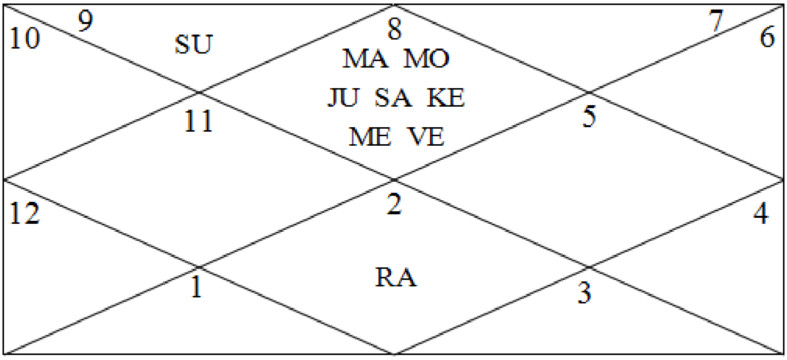
| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 94°07'12" | Kar/Can 4°07'12" | Pus | | |
| Sun | 232°07'22" | Vrk/Sco 22°07'22" | Jye | 5 | -0°00'05" |
| Moon | 52°38'10" | Vrb/Tau 22°38'10" | Roh | 11 | -0°00'43" |
| Mercury | 211°29'56" | Vrk/Sco 1°29'56" | Vis | 5 | 2°38'02" |
| Venus | 220°11'18" | Vrk/Sco 10°11'18" | Anu | 5 | -1°52'51" |
| Mars | 221°10'54" | Vrk/Sco 11°10'54" | Anu | 5 | 0°13'26" |
| Jupiter | 211°29'57" | Vrk/Sco 1°29'57" | Vis | 5 | 1°06'29" |
| Saturn | 210°56'53" | Vrk/Sco 0°56'53" | Vis | 5 | 2°19'02" |
| Rahu | 44°53'44" | Vrb/Tau 14°53'44" | Roh | 11 | |
| Ketu | 224°53'44" | Vrk/Sco 14°53'44" | Anu | 5 | |

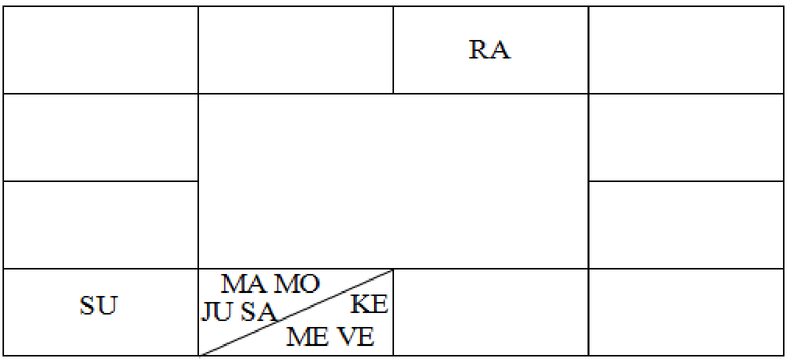



*"The seven planets were seen coming out of the Sun."* (MBh 8.26(37).34)

Mahābhārata war: View of the old moon on 18th November, 1198 BCE, 6 am in Kurukṣetra, just before sunrise on the 14th day of battle, counted from the last full moon. The configuration perfectly fits the day Karṇa entered the battle, when "the seven planets were seen coming out of the Sun", although the Moon did not come out of the Sun but actually entered it. The first crescent was 3 days later.

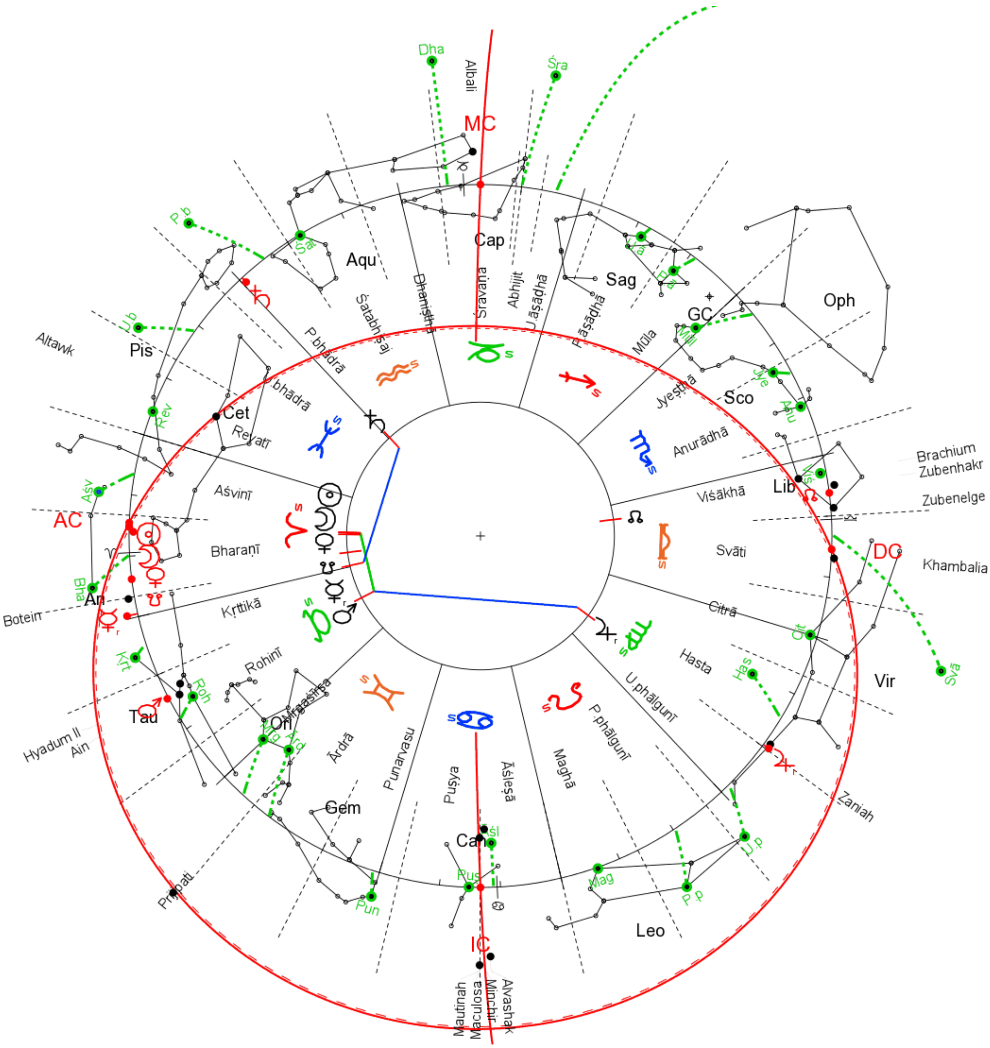
Daftari dates the new moon in Jyeṣṭhā one day later, on 19th November. He thinks that this configuration is the "flying together" of the seven planets mentioned in MBh 6.17.2: In his opinion, the war began on the first crescent on 21st November. However, in reality the planets were not "flying together" here anymore, but already separating and "flying apart".



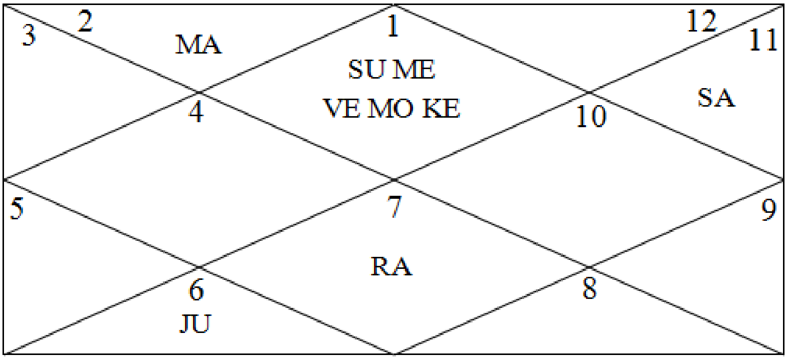

Cluster Around Old Moon
18 Nov 1198 BCE (-1197) jul., 6:00 LMT, Kurukshetra 76e51,29n59
JD (UT)=1284174.5365278, JD (ET)=1284174.8711369, delta_t=28910.2 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 339°32'14" (True Citra)
Sidereal time: 9:01:54 (135°28'31")

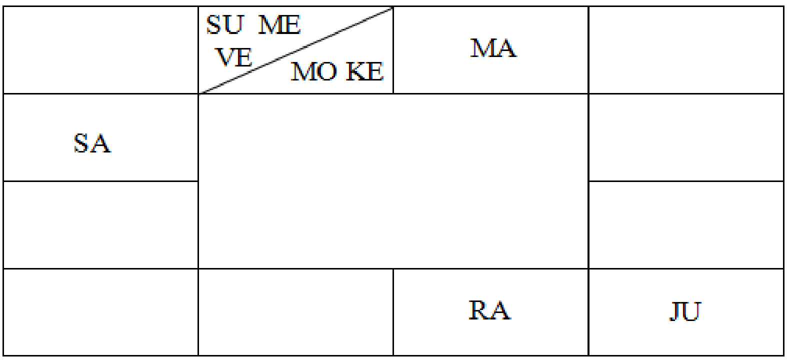
| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 239°38'57" | Vrk/Sco 29°38'57" | Jye | | |
| Sun | 245°50'11" | Dha/Sag 5°50'11" | Mul | 2 | -0°00'00" |
| Moon | 223°10'24" | Vrk/Sco 13°10'24" | Anu | 1 | 0°04'43" |
| Mercury | 226°18'46" | Vrk/Sco 16°18'46" | Anu | 1 | 1°26'44" |
| Venus | 216°52'41" | Vrk/Sco 6°52'41" | Anu | 1 | 1°15'13" |
| Mars | 231°05'22" | Vrk/Sco 21°05'22" | Jye | 1 | 0°04'44" |
| Jupiter | 214°20'43" | Vrk/Sco 4°20'43" | Anu | 1 | 1°06'49" |
| Saturn | 212°24'01" | Vrk/Sco 2°24'01" | Vis | 1 | 2°20'09" |
| Rahu | 44°10'58" | Vrb/Tau 14°10'58" | Roh | 7 | |
| Ketu | 224°10'58" | Vrk/Sco 14°10'58" | Anu | 1 | |




*"The Sun was seen split in two, as it were, in his rising.*
*With a burning crest rose the shining one in the sky*." (MBh 6.17.3)

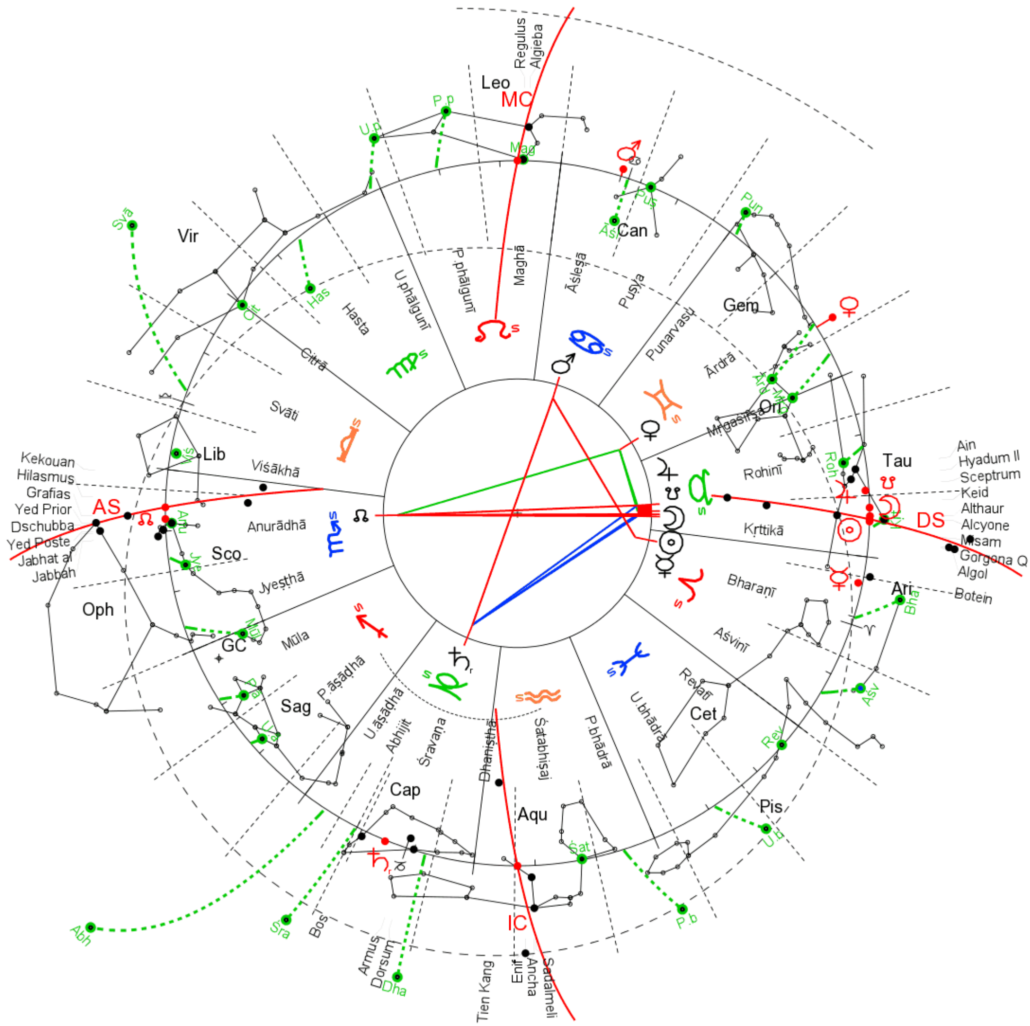
Total solar eclipse at sunrise on 27th March, 1187 BCE, observable from Kurukṣetra.



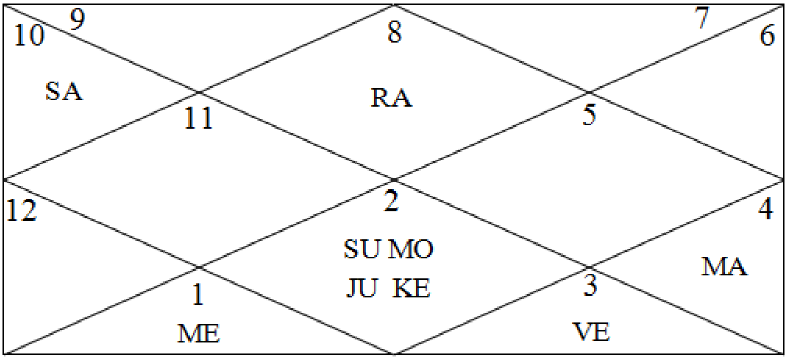

Total Solar Eclipse at Sunrise in Kuruksetra, 1187 BCE
27 Mar 1187 BCE (-1186) jul., 6:12 LMT, Kurukshetra 76e51,29n59
JD (UT)=1287956.5448611, JD (ET)=1287956.8771745, delta_t=28711.9 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 339°41'16" (True Citra)
Sidereal time: 17:44:48 (266°11'58")

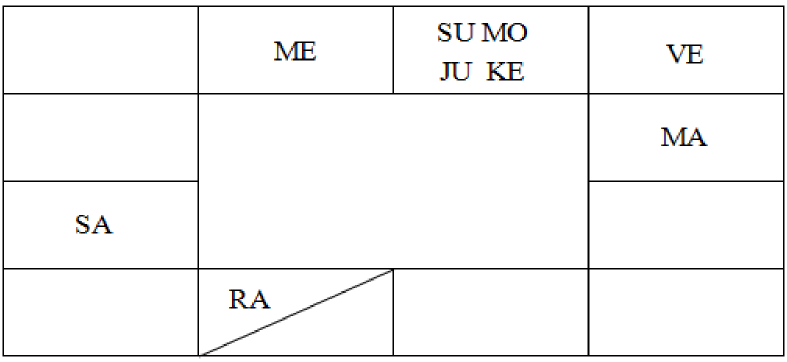
| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 14°44'29" | Mes/Ari 14°44'29" | Bha | | |
| Sun | 15°10'55" | Mes/Ari 15°10'55" | Bha | 1 | -0°00'07" |
| Moon | 15°11'37" | Mes/Ari 15°11'37" | Bha | 1 | -0°00'19" |
| Mercury | 29°27'52" | Mes/Ari 29°27'52" | Krt | 1 | 2°47'14" |
| Venus | 16°00'18" | Mes/Ari 16°00'18" | Bha | 1 | -1°06'00" |
| Mars | 44°09'10" | Vrb/Tau 14°09'10" | Roh | 2 | 0°21'40" |
| Jupiter | 160°18'06" | Kan/Vir 10°18'06" | Has | 6 | 1°43'15" |
| Saturn | 329°24'28" | Kum/Aqu 29°24'28" | PBh | 11 | -1°31'33" |
| Rahu | 203°44'53" | Tul/Lib 23°44'53" | Vis | 7 | |
| Ketu | 23°44'53" | Mes/Ari 23°44'53" | Bha | 1 | |




*"He (:Bhīma) caused the great ring from Karṇa's ear fall down on the earth, like a hot, shining light [falls] from the sky, O king."* (MBh 7.114(138).4)

Annular solar eclipse at sunset on 17th April, 1132 BCE, possibly visible from Kurukṣetra.




Annular Eclipse in Kuruksetra, 1132 BCE
17 Apr 1132 BCE (-1131) jul., 18:16 LMT, Kurukshetra 76e51,29n59
JD (UT)=1308067.0476389, JD (ET)=1308067.3678774, delta_t=27668.6 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 340°26'42" (True Citra)
Sidereal time: 7:16:10 (109°02'32")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 216°06'25" | Vrk/Sco 6°06'25" | Anu | | |
| Sun | 35°44'06" | Vrb/Tau 5°44'06" | Krt | 7 | -0°00'01" |
| Moon | 35°42'30" | Vrb/Tau 5°42'30" | Krt | 7 | -0°00'57" |
| Mercury | 25°33'07" | Mes/Ari 25°33'07" | Bha | 6 | -1°06'55" |
| Venus | 68°54'05" | Mit/Gem 8°54'05" | Ard | 8 | 4°47'12" |
| Mars | 109°56'58" | Kar/Can 19°56'58" | Asl | 9 | 1°53'43" |
| Jupiter | 40°48'22" | Vrb/Tau 10°48'22" | Roh | 7 | -0°53'48" |
| Saturn | 285°03'54" | Mak/Cap 15°03'54" | Sra | 3 | 0°17'14" |
| Rahu | 217°59'50" | Vrk/Sco 7°59'50" | Anu | 1 | |
| Ketu | 37°59'50" | Vrb/Tau 7°59'50" | Krt | 7 | |

## Problems concerning the Eclipses and the Calendar in 1198 BCE

As has already been mentioned, regarding the configuration of 1198 BCE, although matching the Mahābhārata strikingly well, it still has some problems. In the following chapters this will be examined in detail. First looking at 21st October 1198 BCE, the planets were gathering around the Sun so closely that they were all invisible, and they could not be observed all night, from dusk to dawn. The Moon and the Sun were in conjunction, i.e. it was a new moon, and a partial solar eclipse of a great magnitude (87%) occurred, which was observable from Kurukṣetra.[135] The new moon took place near the star Anurādhā (δ Scorpionis), roughly 7° before the star Jyeṣṭhā (Antares).

Now, the question arises whether this new moon really could be judged as a Jyeṣṭhā new moon, i.e. assigned to the lunar mansion of Jyeṣṭhā, or whether it was assigned to Anurādhā. As it was not possible to observe the position of a new moon directly, it had to be estimated or predicted. That it was nothing but a prediction is even stated in the text. In seven days, said Kṛṣṇa, a new moon would occur in Jyeṣṭhā (MBh 5.140(142).18). In what way such predictions were done, exactly, is unknown. Sengupta thinks that this prediction must have been made during the waning half-moon in Maghā.[136] However, a different method could also have been used.

---

[135] It is not known exactly what methods were used to observe eclipses at the time of the Mahābhārata War. In the rare case of total eclipses, there is no problem, of course, as they can be safely observed by the naked eye. Partial solar eclipses, however, cannot be observed by the naked eye except at sunrise, sunset, or through a thin cloud veil. In the middle of the day, one can observe solar eclipses either through blackened glass or through a suitable semi-transparent gemstone. Safer for the eye is the usage of some method of projection. For example, one can drill a hole with a needle through a sheet of paper. When the Sun shines through that whole, it projects an image of the partially eclipsed solar disk on the ground. Another very convenient method is to sit under a tree whose canopy of leaves is not completely closed. The holes between the leaves function like a pinhole cameras and project images of the partially eclipsed sun disc on the ground.

[136] Sengupta, *Ancient Indian Chronology*, p. 4.

The exact astronomical calculation for this date supports Sengupta's proposal. The new moon near the star Anurādhā occurred on 21st October. Seven days earlier, on the morning of the 14th, the waning half-moon was visible behind the star Maghā (Regulus), or near the end of the *nakṣatra*, if the Lahiri *ayanāṃśa* is used. If it is assumed that the Moon is moving with her average speed, or about one *nakṣatra* per day, then it would have been at the end of the *nakṣatra* Anurādhā (Lahiri again) seven days later. This is exactly where the star Jyeṣṭhā (Antares) is found. So, Kṛṣṇa has made a plausible prediction. True, the calculation for the exact new moon in the afternoon of the seventh day shows that the Moon was near the star Anurādhā, because during these few days it moved more slowly than average. Still, this could not be predicted without a complicated astronomical theory, and of course not be observed.

Or, would it have been possible to rule out a new moon near Jyeṣṭhā on the basis of the previous full moon? The full moon occurred on the morning of 6th October. During the previous night, the Moon was seen in Bharaṇī. Since the Moon set already *before* sunrise and only on 7th, set *after* sunrise, observers knew that the full moon had occurred during the day that began at sunrise on 6th October. Therefore, it could be concluded that it had to have occurred in Kṛttikā. Hence, day number 1 (*pratipad*) was 7th October. Consequently, the new moon on 21st October fell on day number 15. Furthermore, when lunar mansions are counted from the previous full moon, the new moon results in Jyeṣṭhā, too. The Moon entered Kṛttikā during the full moon day, on 6th October. If one counts one lunar mansion per day from this date until the 21st, one arrives at Jyeṣṭhā. Hence it is reasonable that this new moon was considered to have taken place in Jyeṣṭhā.

The calculation can be done with even more accuracy. The Moon was observed on the night before the full moon in Bharaṇī. She crossed the meridian shortly before midnight, about 5 minutes before the star Bharaṇī (35 Arietis), and remained visible until just before sunrise. The following night, the Moon culminated synchronously with Kṛttikā (the Pleiades). From this it could be concluded that the Moon entered the lunar mansion Kṛttikā within this period of time. Since the Moon *set before* sunrise on 6th October, but *rose after* sunset, one could also conclude that the exact full moon had occurred between sunrise and sunset. Exactly at what time was difficult to determine. If it was assumed that the full moon occurred at the beginning of Kṛttikā, thus near sidereal 27°40' (in Aries), then the new moon was to be expected at an distance of about 195° from there, i.e. at 222°40' ( = 12°40' Scorpio). Antares (Jyeṣṭhā) was located very close to that point, at 225°55' (= 15°55' Scorpio, Lahiri zodiac). Hence, even from this point of view, it made sense to assign that new moon to Jyeṣṭhā. Of course it is unknown whether such sophisticated considerations were actually made.

However, now there is a problem in that there are *two* full moons that could be assigned to the month of Kārttika, the one of 6th October, just mentioned as well as the one on 4th November that took place in Rohiṇī which was accompanied by a lunar eclipse. How would this situation have been rectified? Would a leap month have been inserted?

With more sophisticated techniques, however, it would have been found that in reality the new moon took place near the star Anurādhā. For, the previous full moon occurred about two days after the autumnal equinox, which was located at 200°29' (20°29' Libra, Lahiri) in the sidereal reference frame. The new moon was therefore to be expected about 17° after the autumn equinox, somewhere between 217° and 218° (7°–8° Scorpio), thus close to the star Anurādhā (δ Scorpionis), which was at 218°43'. This consideration would, indeed, have ruled out a new moon in Jyeṣṭhā. Note, however, that this is a rather sophisticated consideration. It is uncertain if it was part of the calendrical calculations.

It is also worthwhile to investigate the situation with regard to the preceding full moon. On the morning of 7th September, the Moon set shortly *after* sunrise. By that time, she was very close to the star Revatī (ζ Piscium). The full moon must have occurred during the previous night. Hence it would have been assigned to the month of Bhādrapada. However, then the subsequent full moon of 6th October would have been assigned to the month of Āśvina, i.e. rather to the lunar mansion Bharaṇī than Kṛttikā, and then the new moon on 21st October would likely have been assumed in Anurādhā rather than in Jyeṣṭhā.

Finally, the full moon that followed the eclipse on 21st October could provide another criterion. It took place on 4th November near the end of Rohiṇī. There could not be any doubt about its exact position, because it was accompanied by a partial lunar eclipse with a large magnitude (71%), which could be easily observed in Kurukṣetra after sunset. Although it could not be assigned to the lunar mansion Kṛttikā, it could be assigned to the month of Kārttika, if a Kārttika full moon had to take place either in Kṛttikā or Rohiṇī. But, as has been seen, the previous full moon could be assigned to the month of Kārttika as well.

This also raises another problem. Usually, the Kārttika full moon should precede, not follow, a new moon in Jyeṣṭhā. And our epic, too, does not leave any doubt that the Kārttika lunar eclipse *preceded* the solar eclipse.

सोमस्य लक्ष्म व्यावृत्तं राहुरर्कमुपेष्यति

*somasya lakṣma vyāvṛttaṃ rāhurarkamupeṣyati (MBh 5.141.10)*

| The [hare] sign of the Moon has disappeared. Rāhu is approaching the Sun. |
|---|

The verse states that a lunar eclipse had already occurred and that a solar eclipse could occur within a couple of days. As can be seen from the context, this statement was made seven days before the new moon in Jyeṣṭhā. So, this must be the new moon of which a solar eclipse was expected.

When shortly before the war Kṛṣṇa departs to Hastināpura for peace negotiations, the following clue is given:

ततो व्यपेते तमसि सूर्ये विमल उद्गते

मैत्रे मुहूर्ते संप्राप्ते मृद्वर्चिषि दिवाकरे

*tato vyapete tamasi sūrye vimala udgate*
*maitre muhūrte saṃprāpte mṛdvarciṣi divākare (MBh 5.81(83).6)*

| After the darkness had passed and the spotless Sun had risen,<br>the hour Maitra was reached, the Sun shone still mildly, |
|---|

कौमुदे मासि रेवत्यां शरदन्ते हिमागमे,

स्फीतसस्यमुखे काले ...

*kaumude māsi revatyāṃ śaradante himāgame,*
*sphītasasyamukhe kāle ... (7)*

| in the month Kaumuda, when [the Moon was] in Revatī, at the end of autumn and beginning of winter,<br>at the time whose beginning is full of corn... |
|---|

According to the commentator Nīlakaṇṭha, Kaumuda is the month Kārttika. Daftari objects that this identification is not mandatory.[137] However, if it is assumed that Nīlakaṇṭha is right, then if the Moon is in Revatī in the month of Kārttika, it is three to four days before the Kārttika full moon. A few days later, when the waning half-moon is in Maghā, Kṛṣṇa predicted the Jyeṣṭhā new moon. From this, it follows, just the way it would be expected, that in the epic's opinion the Kārttika full moon precedes the new moon in Jyeṣṭhā.

The above verses, which attribute the Moon to Revatī, also pose a problem if compared to the configuration of the year 1198 BCE. They then seem to refer to the morning of 4th October. However, the full moon was to take place only slightly more than two days, not three or four days after that configuration, as has been suggested above.

On the 18th day, the last day of the war, Balarāma returns from a pilgrimage and says that the Moon is in the *nakṣatra* Śravaṇa. This statement is incompatible with an outbreak of war on a new moon in Jyeṣṭhā, but compatible with an outbreak of war on a Kārttika full moon or one day later at the beginning of the month. It now may be asked which of the two potential Kārttika full moons in the year 1198 BCE matches best with Balarāma`s statement. The one on 6th October, which occurred *before* the Jyeṣṭhā-Anurādhā new moon, does not come into question because, counting 18 days from there, the Moon would fall into the *nakṣatra* Mūla or Pūrvāṣāḍhā. So, how about the other full moon on 4th November, which was accompanied by an eclipse? Here, the 18th day will fall on 22nd November. The *nakṣatra* position of the Moon for this date is somewhat difficult to determine. According to Lahiri's definition, the Moon falls into Uttarāṣāḍhā, the *nakṣatra* that precedes Śravaṇa. However, the positions of the *nakṣatra* principle stars may be more relevant than the Lahiri *nakṣatra* boundaries. The reference star Uttarāṣāḍhā is far away from the Moon. The reference star Śravaṇa is far from the ecliptic, but if it is projected onto the ecliptic in polar projection, then the Moon is found only a few degrees before Śravaṇa in the morning before sunrise. In any case, the full moon on 4th November took place in Rohiṇī, and if 18 *nakṣatras* are

[137] Daftari, *The Astronomical Method...*, p. 21f.

counted from there, Śravaṇa will be found. It thus can be concluded that Balarāma's statement is consistent with an outbreak of war on the day after the full moon on 4th November.

To summarize the results of this chapter: According to the text, the Kārttika full moon and lunar eclipse precedes the new moon and solar eclipse that allegedly took place in the lunar mansion Jyeṣṭhā. In the year 1198 BCE, however, the situation was reversed. Here, the solar eclipse, which occurred near the star Jyeṣṭhā, in actuality a lot closer to the star Anurādhā, preceded the Kārttika lunar eclipse. Thus the reality is not completely in line with the text.

However, it has also been seen that for ancient sky observers there *were* clues that the new moon, which could not be directly observed, would occur in Jyeṣṭhā. Kṛṣṇa predicted the new moon in Jyeṣṭhā seven days in advance, either because he had seen the Moon in conjunction with Regulus (Maghā) or because he had observed the previous full moon, which had occurred in the boundary region of Bharaṇī and Kṛttikā. Both full moons, the one before the eclipse and the one that followed it were borderline cases, the one taking place towards the end of Bharaṇī, the other towards the end of Rohiṇī. Besides, it should be noted that the above considerations are based on a current definition of the lunar mansions (Lahiri *ayanāṃśa*), while it is unknown exactly where the boundaries between the lunar mansions were assumed at the time of the great war. Last but not least, the fixed stars that modern scholars identify as the reference stars of the lunar mansions are perhaps not correct in every case, although the identity of Jyeṣṭhā (Antares), Kṛttikā (Pleiades) and Maghā (Regulus) are certainly reliable.

Still, the sequence of these eclipses is clearly in contradiction with the text itself. In the text, the lunar eclipse precedes the solar eclipse, whereas in the year 1198 BCE it is the other way around. The very fact that in the year of the war a solar eclipse in Jyeṣṭhā seemed to precede a Kārttika lunar eclipse, which is usually impossible, may have led to confusion, and it may have motivated the author to "correct" this wrong sequence.

The fact that the chronological order of these new and full moons is so unclear might also explain the ambiguities and contradictions of the epic. Evidence has been seen that indicates the war started on a new moon, and other evidence has been seen that indicates that the battle began on a full moon and a solar eclipse took place on the 14th day thereafter. The traditional view was obviously mixed up, perhaps because the calendar dates were just not clear. More things seemed to happen in that year that were actually against the laws of nature. Eclipses allegedly took place on the 13th of the fortnight. Grains and fruits ripened at the wrong time, animals and humans gave birth to grotesque creatures, etc. In this context, the seemingly unnatural reversal of Kārttika full moon and new moon in Jyeṣṭhā seems to fit very well.

## Eclipses on the 13th of the Fortnight

According to the following verse, the lunar eclipse preceded the solar eclipse:

सोमस्य लक्ष्म व्यावृत्तं राहुरर्कमुपेष्यति

*somasya lakṣma vyāvṛttaṃ rāhurarkamupeṣyati (MBh 5.141.10)*

| The [hare] sign of the Moon has disappeared. Rāhu is approaching the Sun. |
|---|

The verse states that a lunar eclipse has already occurred and that a solar eclipse might occur within a couple of days. As can be seen from the context, this statement was made seven days before the new moon in Jyeṣṭhā. Hence, this must have been the new moon for which a solar eclipse was expected. Although it has been seen that in reality the order of the eclipses were reversed, the exact statements made within the text itself should be kept in mind for the further investigations.

Moreover, the text informs us that at least one of the two eclipses, if not both of them, occurred on the 13th day of its fortnight. This is a very strange phenomenon which must be explained. Quoting the verses once again:

चतुर्दशीं पञ्चदशीं भूतपूर्वां च षोडशीम्

इमां तु नाभिजानामि अमावास्यां त्रयोदशीम्

*caturdaśīṃ pañcadaśīṃ bhūtapūrvāṃ ca ṣoḍaśīm*
*imāṃ tu nābhijānāmi amāvāsyāṃ trayodaśīm (MBh.6.3.28)*

| [New moons] on the 14th, 15th or 16th there have been before.<br>But this new moon on the 13th day I do not know. |
|---|

चन्द्रसूर्यावुभौ ग्रस्तावेकमासे (var. एकमासीं; एकाह्ना हि) त्रयोदशीम्

अपर्वणि ग्रहावेतौ (var. ग्रहेणैतौ) प्रजाः संक्षपयिष्यतः

( var. अपर्वणि ग्रहं यातौ प्रजासंक्षयमिच्छतः)

*candrasūryāvubhau grastāvekamāse* (var. *ekamāsīṃ*) *trayodaśīm*
(var. *ekāhnā hi*)
*aparvaṇi grahāvetau* (var. *graheṇaitau*) *prajāḥ saṃkṣapayiṣyataḥ (29)*
(var. *aparvaṇi grahaṃ yātau prajāsaṃkṣayamicchataḥ*)

Both the Moon and the Sun were eclipsed (swallowed) in one and the same month[138] on the 13th [of the fortnight],
on a wrong date: these two eclipses[139] will destroy the creatures.

Before the problem of the 13th day is tackled, it must be considered what these verses state about the sequence of the eclipses. Within a month, both a solar eclipse and a lunar eclipse occur. If the underlying calendar uses months that end on full moon, then the solar eclipse precedes the lunar eclipse. But if, as has been stated, the lunar eclipse is to precede the solar eclipse, then the months of the underlying calendar must end on new moon. This interpretation is also consistent with the fact that the text assigns the lunar eclipse to the month of Kārttika and at the same time places the new moon in the lunar mansion Jyeṣṭhā. For, a Kārttika full moon, i. e. a full moon that takes place in one of the two lunar mansions Kṛttikā or Rohiṇī, always precedes a new moon that takes place in Jyeṣṭhā.

However, in 1198 BCE this rule did not seem to be correct, as has been shown. As the expected Jyeṣṭhā new moon occurred a bit too early in Anurādhā, the subsequent full moon fell into the lunar mansion Rohiṇī and could therefore be assigned to the month of Kārttika. Thus, something seemed to happen that usually would be impossible, namely that a new moon in Jyeṣṭhā *preceded* the Kārttika full moon. Also it has been concluded that this confusion in the calendar may have been the reason why the text makes contradictory statements about the beginning of the battle, namely that it dates it partly to a full moon and partly to a new moon. Thus, it is also conceivable and understandable that the sequence of eclipses was addled.

[138] Var. "on one and the same day" (*ekāhnā*). Since a solar and a lunar eclipse must be at least two weeks apart, they cannot take place on the same day. Or does it mean that both took place on 13th of their respective fortnight?

[139] *grahau*; see explanations in footnote 121, p. 220.

In principle, however, the text indicates that the lunar eclipse preceded the solar eclipse. Since both eclipses occurred in the same month, a calendar must have been used in which months ended on the new moon. Some authors believe that a *second* lunar eclipse followed the solar eclipse in the same eclipse season and that the solar eclipse was accompanied by two lunar eclipses. In this case a full moon calendar would seem to be possible. However, this can be ruled out. Firstly, the text does not mention any additional lunar eclipse, and secondly, it is not possible in such cases to observe *both* lunar eclipses. At least one of them, if not both, will be penumbral and not perceptible to the naked eye. Only in rare cases one of the two just reaches the partial phase. Usually both are penumbral and it never happens that both exceed a magnitude of 0.55. Even eclipse fanatics need a magnitude of at least 0.6 in order to "see" a penumbral eclipse.[140]

Now, according to the text, at least the solar eclipse occurred on the 13th day, counted from the previous full moon or the preceding lunar eclipse. The second verse, however, seems to indicate that both eclipses take place on the 13th of their respective fortnight.

In the Yahoo-Forum *IndiaArchaeology*, R. N. Iyengar in reference to Utpala's commentary on Varāhamihira's *Bṛhatsaṃhitā* pointed out that the passage was interpreted to mean that the two eclipses did not occur on the 13th day, but in the 13th *month*, which would have been a leap month.[141] Utpala quotes the verse MBh 6.3.29 as follows:

> चन्द्रसूर्यावुभौ ग्रस्तावेकमासे त्रयोदशे
>
> अपर्वणि ग्रहावेतौ प्रजाः संक्षपयिष्यतः
>
> *candrasūryāvubhau grastāvekamāse* ***trayodaśe***
> *aparvaṇi grahāvetau prajāḥ saṃkṣapayiṣyataḥ (29)*

| |
|---|
| Both the Moon and the Sun were eclipsed (swallowed) in one and the same *13th month*,<br>untimely: these two eclipses will destroy the creatures. |

Thus he reads *ekamāse trayodaśe* instead of *ekamāse trayodaśīm*. Iyengar also kindly submitted a page from the unpublished *Viśvāmitrasaṃhitā* (chapter on *rāhucāra*), which quotes the verse in the same wording.

[140] The time range 5000 BCE to 5000 CE was checked for this phenomenon.

[141] http://groups.yahoo.com/neo/groups/IndiaArchaeology/conversations/topics/7345.

Besides, Utpala quotes the following verse from Vṛddhagarga:

मासि त्रयोदशे दृश्यौ सोमार्कौ ग्रहणं गतौ

क्षत्राण्यनेकानि तदा मृज्यन्ते भूमिपक्षये

*māsi trayodaśe dṛśyau somārkau grahaṇaṃ gatau*
*kṣatrāṇyanekāni tadā mṛjyante bhūmipakṣaye*

> If one sees the Moon and the Sun gone into eclipse in the 13th month, then numerous warriors will be killed during a destruction of kings.

This interpretation is not without problems. In the previous verse 28, it is stated that new moons on the 14th, 15th and 16th day of the fortnight were common, whereas this new moon on the 13th day was completely exceptional. Hence the context indicates that there is talk of the 13th day, not the 13th month. While it would be possible to translate *amāvāsyāṃ trayodaśīm* as "the 13th new moon", there is certainly no 14th, 15th and 16th new moon or month. Besides, it is not uncommon in the Mahābhārata that dates are mentioned in the accusative rather than the locative. (cf. MBh 13.87, esp. 16) The translation "new moon on the 13th day" is therefore easily possible.

Moreover, the critical edition does not mention the wording *trayo-daśe* in the apparatus on verse 29. In order to justify it, one would have to assume that the above-mentioned authors relied on an earlier version of the Mahābhārata, which has been lost and did not contain the previous verse 28. One could also argue that the arrangement of verses is a bit confounded in the extant manuscripts. Verse 29 appears twice within only a few verses, whereas verse 28 appears only once. It seems, however, that at least the first half of verse 28, which mentions the 14th, 15th and 16th, is present in all manuscripts that were included in the critical edition.

Moreover, it seems that Varāhamihira himself did not interpret the eclipses "at the wrong time" as eclipses in the 13th month. For, he notes that eclipses at the wrong time can only occur if there is an error in the calendar or eclipse calculation.[142] It must therefore be concluded that Varāhamihira himself read *trayodaśīm* and believed that it referred to the 13th day. The following verses by Vṛddha-garga also prove that the wording *trayodaśīm* must be very old:

[142] The author refers to his explanations further below on p. 284f.

दृश्येते च त्रयोदश्यां चन्द्रार्कौ ग्रहणं गतौ

छत्त्राण्यनेकानि तदा मृज्यन्ते भूमिपक्षये

*dṛśyete ca trayodaśyāṃ candrārkau grahaṇaṃ gatau*
*chattrāṇyanekāni tadā mṛjyante bhūmipakṣaye*

When one sees the Moon and the Sun eclipsed on the thirteenth,
then many royal umbrellas are wiped away in destruction of kings.

सपुत्रदारा नश्यन्ति संग्रामे लोमहर्षणे

अनेन वनितायाः स वैधव्यान्तकरोऽधिकम्

*saputradārā naśyanti saṃgrāme lomaharṣaṇe*
*anena vanitāyāḥ sa vaidhavyāntakaro'dhikam*

Together with their sons and wives they are annihilated in a bloodcurdling (lit. hair-bristling) battle.
Thereby it even puts an end to the beloved wife's widowhood.[143]

It is therefore quite likely that the original wording was *trayodaśīm*, but that an ancient astronomical tradition corrected it to *trayodaśe*, precisely because it did not seem to make any sense astronomically. After all, that correction would have solved the astronomical problems that result from an alleged eclipse on the 13th.

The phenomenon that solar eclipses occur "untimely" (*aparvaṇi*), i.e. on a calendar date which is actually not possible in the lunar calendar, is also mentioned in other places in the epic:

राहुश्चाग्रसदादित्यमपर्वणि विशां पते

*rāhuścāgrasadādityamaparvaṇi viśāṃ pate (MBh 9.55.10; cf. 2.71.26)*

Rāhu swallowed the Sun untimely, O ruler of the people.

दिवोल्काश्चापतन्घोरा राहुश्चार्कमुपाग्रसत्

अपर्वणि महाघोरं प्रजानां जनयन्भयम्

*divolkāścāpatanghorā rāhuścārkamupāgrasat*
*aparvaṇi mahāghoraṃ prajānāṃ janayanbhayam (MBh 2.72.21)*

In the sky flew dreadful meteors, and Rāhu swallowed the Sun
untimely and produced extremely terrible fear among the people.

This phenomenon is apparently a stereotype, most probably a literary topos that had to be part of a poetic description for an apocalyptic celestial configuration. Its historical credibility is therefore not very

[143] According to Vallālasena, *Adbhutasāgara*, p. 85f.

high. Still, it is worthwhile to consider what phenomenon could lie behind it astronomically.

Some authors interpret the text in such a way that a lunar and a solar eclipse occurred within only 13 days. Unfortunately, this is problematic because a full moon and a new moon are always at least 13.8 days apart.

NB Achar dates the eclipses of the Mahābhārata War to the year 3067 BCE. In that year, a lunar eclipse occurred in Kṛttikā (on 29th September) and a solar eclipse in Jyeṣṭhā (on 14th October), seemingly in agreement with information given in the epic. The subsequent full moon (on 28th October) was also a lunar eclipse, and the time difference of this lunar eclipse from the solar eclipse was allegedly smaller than 14 days. For, Achar states:

> The last one occurred within an interval of less than fourteen days after the solar eclipse in *jyeṣṭha*. Such an "*aparvaṇi*" occurrence can happen only if the eclipse is a penumbral eclipse, because, for a penumbral eclipse, the interval of duration of the eclipse need not include the instant of opposition "parva". It is clear therefore, that it was this last pair of eclipses that *Vyāsa* was referring to.[144]

Unfortunately, this solution has serious problems.

– According to the text, the eclipse took place “on the thirteenth”, which indicates a *calendar date*, not a time difference. One also has to keep in mind that it was not really trivial to determine the precise time of an astronomical event without accurate (modern) timekeeping. In the current case, time differences were most probably based on whole calendar days.

– If the calendar dates of the events are considered, then the lunar eclipse clearly occurred on the 14th of the half-month, not on the 13th. Day number 1 (*pratipad*) would have begun at sunrise on 15th October, and 28th October would have fallen on the 14th.

– According to the text, what occurs on the 13th day of the fortnight is a solar, not a lunar eclipse. The text may even indicate that both a solar and a lunar eclipse took place on the 13th of their respective fortnight and within the same month. However, it explicitly states

[144] Achar, B. N., “Date of the Mahābhārata War based on Simulations using Planetarium Software”, p. 20.

that a new moon occurred on the 13th. Hence, if in Achar's example only the lunar eclipse takes place on the 13th, but not the solar eclipse, then his theory is not in agreement with the text.

– The text mentions only two, not three eclipses. Achar's lunar eclipse "on the thirteenth" is not the one that took place in Kṛttikā, and therefore cannot be the one mentioned in the text.

Besides, if the dates proposed by Achar are considered, it turns out that none of these eclipses were actually observable from Kurukṣetra:

– The solar eclipse of 14th October 3067 BCE was not observable from Kurukṣetra with 99% probability. Achar's contention that the eclipse could have been visible due to the uncertainty of Δt is only his wishful thinking.[145] The small uncertainty in the lunar ephemeris does not help this eclipse either.[146]

– The two lunar eclipses of 29th September and 28th October were penumbral, of very low magnitude (0.10 and 0.27), and therefore imperceptible to the naked eye. A minimum magnitude of 0.6 would have been required for them to be observable.[147] And, of course,

[145] For the epoch 3067 BCE, the standard error in current estimations of ΔT corresponds to an offset of the visibility zone by +–39° in geographic longitude (according to the formula by P. J. Huber). In order to get a solar eclipse of a minimum magnitude of 10% for Kurukṣetra, one would have to shift the eclipse path by 86° in eastern direction. The probability of such a huge error in ΔT in this direction can be estimated to about 1%. A total eclipse can be ruled out in any case, because the core shadow remained far south of the latitude of Kurukṣetra. The maximum magnitude that was reached on the same latitude was only 63%. Cf. author's discussion with Mr. Achar,
http://groups.yahoo.com/group/akandabaratam/message/65202 .

[146] In order to estimate the uncertainty of modern lunar ephemerides for the year 3067 BCE, the most recent JPL ephemerides DE431 (2013), DE422 (2009), and DE406 (1998) were compared for the year 3000 BCE. The maximum difference found was about 80 arc seconds. This difference can be neglected for the visibility zones and magnitudes of the eclipses of 3067.

[147] http://eclipse.gsfc.nasa.gov/LEcat5/figure.html .

However, Fred Espenak notes that a penumbral eclipse with low magnitude could be noticed *very subtly* at the rising or setting of the Moon, when the sky is still bright and does not form a sharp contrast with the disk of the Moon. In a mail of 5th April 2013 to Sunil K. Bhattacharjya, he wrote: "Such a small penumbral eclipse would not be visible in a dark sky. But if the Moon is just rising or setting in a twilight sky, then it might be possible to detect sove (some; D.K.) VERY SUBTLE shading along one limb of the Moon." This was his answer to the uncertainty of $\Delta t$ has no influence on the magnitudes of lunar eclipses.[148]

– Even Achar's assertion that the solar and the second lunar eclipse were a little less than 14 days apart is incorrect, according to

---

a question asked by Bhattacharjya on 6th March: "I am interested in knowing the visibility of Penumbral Lunar eclipse, even when the Penumbral magnitude is around 0.22, particularly in case of such an eclipse which reportedly was observed in 3139 BCE."

Is this possibility given in the current case? The solar eclipse requires a correction of $\Delta T$ of 5.75 hours in eastern direction. On this condition, the penumbral lunar eclipse of 29th September took place near midnight in a dark sky and therefore was not observable. On the other hand, the eclipse of 28th October took place at moonrise and at a time when the penumbral magnitude was only 0.04! A greater correction of $\Delta T$ makes the magnitude of the lunar eclipse even smaller, a smaller correction has the effect that the magnitude of the solar eclipse sinks below 0.1. The scenario is just not plausible for the eclipses described in Mahābhārata. On the other hand, if one assumes an extremely high error of 11 hours in $\Delta T$ in eastern direction, then the first lunar eclipse could have been visible immediately after sunset, but then the second lunar eclipse would have taken place during the day and below the horizon. No matter how one looks at it, Achar's eclipses just do not work out!

148 In his publication of 2014, Achar tries to cope with this kind of criticism. He insists that local observability cannot be judged with certainty for the remote past, assuming *huge* errors in current astronomical calculations (in particular in $\Delta T$). Moreover, he refers to a study by Stephenson and Fatoohi which says that ancient Mesopotamian, Chinese, and Arab astronomers systematically overestimated magnitudes of low-magnitude *partial* (!) lunar eclipses. He draws the conclusion that the magnitude values calculated by this author for the *penumbral* (not partial!) eclipses of 3067 BCE could be underestimated and the eclipses could actually have been observed. (Achar, *Date of the Mahabharata War* (2014), p. 64) This argument is unfortunately confused, because the magnitudes were not estimated, but *calculated*. Besides, there are opportunities *every year* to test whether lunar eclipses in *penumbral* phase and of comparable magnitude can be observed. Astronomers interested in eclipses are doing that all the time! The problem is that one cannot see anything! To make these penumbral eclipses partial and observable, one would have to assume a huge error in current lunar ephemerides. Nor does it help when Achar says that the ancients had better eyes and saw a sky without light pollution. Clear skies can be found even today, and there are also people with extremely sharp eyes.

What is particularly problematic is that Achar presents images of his penumbral lunar eclipses that *give the false impression* that they were observable like partial eclipses.

calculations using the Swiss Ephemeris.[149] In the case of the solar eclipse on 14th October, the Moon's shadow left the earth's surface at 15:57 UT (= 15th Oct., 13:03 TT). After that, no solar eclipse could be observed anymore from anywhere on earth. The subsequent penumbral lunar eclipse on 28th October began at 16:00 UT (= 29th Oct., 13:06 TT). It follows that the time difference between the two eclipses was greater than 14 days for all geographic locations. The uncertainty of ΔT is irrelevant to this kind of consideration.

A somewhat similar, but more sophisticated, approach is maintained by S. Balakrishna. He provides a list of double eclipses that could be observed from Kurukṣetra and were a few hours less than 14 days apart.[150] At the same time, he tries to take account of the problem of exact timekeeping by giving preference to eclipses that occurred near sunrise or sunset. Among these, he considers the following eclipse pair as the best candidate:

| BCE | | Begin | Max | End | Sun↑↓ | Interval |
|---|---|---|---|---|---|---|
| 11 Aug. 3129 | Solar | 18:54 | 19:48 | 20:39 | 19:22 | |
| 25 Aug. 3129 | Lunar | 16:59 | 18:22 | 19:44 | 19:17 | 13d20h20m |

Kurukṣetra 76E49, 29N59

Balakrishna explains:

> On Julian August 11 afternoon, a solar eclipse begins 20 minuets (sic!) before sunset and it is still on going at sunset. Fourteen days later (On Julian August 25) in the evening at sunset a lunar eclipse is already occurring. It clearly suggests that eclipse started on the 13th day after the previous eclipse! Obviously the end of lunar and start of solar eclipses were less than 14 days period, or occurred in 13 days. This could be concluded without the benefit of modern clocks.

First of all, it has to be noted that here, again, it is a *lunar* eclipse (full moon) that occurs on the 13th of the fortnight, whereas the Mahābhārata mentions a *solar* eclipse (new moon) on the 13th. Nevertheless the example needs to be studied in detail.

[149] Calculations using the Swiss Ephemeris agree with Espenak's canon of solar eclipses with an accuracy of a few seconds only for the whole time range of 2000 BCE to 2000 CE. Although the canon does not list any eclipses before 2000 BCE, it can be concluded that the Swiss Ephemeris provides data of similar quality even for 3067 BCE.

[150] Balakrishna, S., "Dating Mahabharata - Two Eclipses in Thirteen Days".

The Sun set eclipsed, and 14 days later the Moon rose eclipsed. Hence the solar eclipse ended *after* sunset, but the lunar eclipse began *before* sunset. The time difference between the two eclipses was therefore smaller than 14 days. As Balakrishna says, "this could be concluded without the benefit of modern clocks". However, it has to be noted that, if *the eclipse dates* are considered and days are counted from sunrise, then the eclipses were actually 14, not 13 days apart. It is rather unlikely that the information given in the text is based on observations and calculations accurate by the hour. The text explicitly says that the new moon occurred *"on the thirteenth"*. This obviously is a calendar date.

Besides, through the author of this work's calculation, the lunar eclipse ended already at 4:57 pm, almost two hours before moonrise (6:54 pm), and the solar eclipse ended at 6:16 pm, long before sunset (7:00 pm[151]). While the uncertainty of Δt does not allow us to rule out that the eclipses were taking place around sunset, this remains at least speculative. However Balakrishna's theory requires that this condition be fulfilled. Only if the eclipses occurred around sunset, the 13-day distance between the eclipses was easily observable, without the use of modern clocks.

The second-best eclipse pair proposed by Balakrishna is the following:

| BCE | | Begin | Max | End | Sun↑↓ | Interval |
|---|---|---|---|---|---|---|
| 27 June 2559 | Lunar | 03:30 | 05:14 | 06:58 | 05:07 | |
| 11 July 2559 | Solar | 03:51 | 04:36 | 05:25 | 05:12 | 13d20h08m[152] |

Now, these dates are interesting, indeed. For, if the Moon set eclipsed on 27th June around sunrise, then 28th June could be considered as day number 1 (*pratipad*). If the Sun rose eclipsed on the 14th day and the date is considered to change at sunrise, then the solar eclipse had actually begun on the previous day. The new moon could therefore have been dated to the 13th day.

In fact the eclipse pair of 2559 BCE fits the text a lot better than the one of 3129 BCE, because as has been stated it is the *solar eclipse*,

---

[151] Note, Balakrishna assumes sunset at 7:17 pm.

[152] In Balakrishna's table of eclipse pairs, the year is erroneously given as 2529 instead of 2559. The correct year is mentioned in other places in his article.

i.e. the *new moon*, that has to fall on the 13th, not the lunar eclipse and the full moon. Among the six eclipse pairs considered by Balakrishna, the pair of 2559 BCE is the only one that fulfils this condition.

However, different data is being derived at again for this pair of eclipses. The solar eclipse ended more than an hour before sunrise. Now, this is still within the range of uncertainty for Δt, which amounts to 10 minutes in 1000 BCE, more than an hour in 2000 BCE, and 2½ hours in 3000 BCE. However, there is no certainty that the two eclipses really occurred at sunrise. Such calculations remain speculative for epochs before 1500 BCE. More eclipse pairs of this kind are listed in Appendix M and marked by +*.

Moreover Balakrishna's war dates are problematic in that the eclipses take place in the wrong seasons and not in the month of Kārttika, as required by the text. Besides, the planetary configurations for those years do not accord with those described in the text.

A similar approach is chosen by S.B. Dikshit. However, other than Balakrishna, Dikshit tries to do justice to the fact that the solar eclipse had to take place on the 13th of its fortnight, as well as to the fact that in Vedic calendars the day began at sunrise. He explains the eclipse on the 13th by the fact that if the lunar eclipse occurred shortly after sunrise and the solar eclipse occurred 13.8 days later shortly before sunrise, then the latter fell on the 13th of the fortnight because the day of the lunar eclipse itself was not counted.[153] Now, there is the problem that in this case the solar eclipse would have occurred during the night and therefore would not have been observable. Dikshit therefore believes that astronomers of the time of the great battle were able to *calculate* full moons and new moons as well as solar eclipses in advance with hourly precision. And he believes that they used astronomical methods that were about as advanced as those in the Sūryasiddhānta.

However, the Sūryasiddhānta was written long after the Mahābhārata War and belongs to a different period of Indian astronomy. This is evident in the fact that it mentions elements of Greek astronomy (e.g. the zodiac signs) which are unknown to the Mahābhārata Epic.

[153] Dikshit, *Bharatiya Jyotish Shastra*, I, p. 114ff.

Also, there is no evidence for such advanced astronomical knowledge in that remote past. To the contrary, astronomy and the calendar of the Mahābhārata rather correspond to the body of knowledge that is laid down the Vedāṅgajyotiṣa, an older astronomy textbook that was far less advanced. Dikshit's interpretation of the solar eclipse on the 13th is thus anachronistic.

Even those who do not accept this historical argumentation will have to agree that all solar eclipses mentioned in the epic which allegedly took place on a 13th, give the impression that they were *observed*, not calculated. There is not the slightest indication in the text that any such calculations were made. Dikshit's explanation therefore does not make any viable sense.

V. N. Sharma proposed the following solution for the 13-day fortnight:

> It is rather easy to decide when the Moon is new as there is no light in it that night. However, in the case of a full moon it is difficult to judge when the Moon is 100% illuminated. A simple criterion can eliminate the uncertainty, however, whether the day had been indeed a full moon. The criterion is to watch the rise time of the Moon in relation to the setting of the Sun. If the Moon rises just before sunset, the day is a full moon or a *pūrṇimā*, and if it rises just after the sunset, the day is one day past the full moon or one day past the *pūrṇimā*.[154]

Unfortunately, this approach does not really work either. First of all it must be stated that celestial observations can take place only when the sky is clear. A reliable determination of the date of the full moon based on observation can not always be guaranteed. This is an important point because, in the context of celestial omens that were observed shortly before the war, clouds are mentioned that hid the Sun during sunrise and sunset. (p. 109; also p. 289f.) Methods like those described by Sharma could therefore work only *partially*, and the question arises what procedure was chosen under atmospheric conditions that did not allow direct observations of the Sun and the Moon. Most probably, the full moon would have been assumed on the 15th. The method specified by Sharma could then have served to correct the calendar. Making it obvious that an eclipse on the 13th could come about not only if the fortnight was exceptionally short, but also with ordinary fortnights, if, due to unfavourable weather conditions, 15 days were counted per fortnight over a

[154] Sharma, V. N., "On Astronomical References in the Mahābhārata", p. 25.

longer period of time. Of course, it is also conceivable that a more sophisticated method was chosen for the determination of the full moon under poor observing conditions. For example 14 days rather than 15 could have been counted every other fortnight. By this method, the risk of a solar eclipse on the 13th would have been averted. But unfortunately, this remains mere speculation. Since no meteorological or astronomical diaries are extant from the time of the great war, it would be naive to believe that the method proposed by Sharma could contribute much to the dating of the war.

There are other serious problems with Sharma's explanation of the 13th day. Firstly, a new moon always takes two to three days and therefore cannot be observed and dated accurately unless an *observable solar eclipse* takes place. Sharma's method for determining the full moon is also useless, because the day was counted from sunrise, not from sunset. If observations are made only in the evening then the criterion as to whether the full moon takes place before or after sunset is not sufficient to determine its date. The method provides a precision of about 24 hours, reckoned from sunset. But as the day begins at sunrise, only about 12 hours before or after sunset, the time span of 24 hours before or after a sunset always covers two partial calendar days, and it is impossible to determine the full moon with daily precision. It is therefore, very unlikely that Sharma's method was used in this way.

The correct way to determine the date of the full moon would have been to observe the Moon at *sunrise*. On the day the Moon sets *before* sunrise for the last time, the Moon is full. The day, however, when the Moon sets *after* sunrise for the first time, is day number 1 after the full moon (*pratipad*).[155] In practice, this observation is a bit problematic, because the full moon near daybreak becomes invisible

---

[155] If one observes both the moonset at sunrise and the moonrise at sunset, one can even determine whether the full moon occurs during the day or night. If the Moon sets before sunrise and rises after sunset, the full moon has taken place during the day. And if the Moon rises before sunset and sets after sunrise, then the full moon has taken place during the night. One could object that this is not always really true because of the ecliptic latitude of the Moon. However, this effect is small, especially in eclipse seasons. Moreover, as mentioned, there is the problem that the full moon is usually not visible when it stands exactly at the horizon. But this is also a minor effect, and this method at least provides a usable definition of what is to be considered a full moon day or night.

before reaching the horizon. Still, this is a plausible method to determine the day of the full moon. So, let it first be assumed that a solar eclipse takes place shortly after sunrise. On the 13th day thereafter, the Moon will still set before sunrise. However, the exact full moon can occur 13.8 days after a new moon, which would be shortly before the sunrise of the 14th day. In the morning of the 14th day, the Moon could therefore already set after sunrise. In this case, indeed, a 13-day half-month is given. If a lunar eclipse starts before sunrise, then this is, of course, another clear sign that a full moon is taking place, which in the current case would fall on the 13th. Examples of this kind of double eclipses are found in Appendix N and are indicated by –# at the beginning of the line.

In the yahoo group *JyotishGroup*, Sunil K. Bhattacharjya held the view that there was such a 13-day fortnight between the solar eclipse of 1st September 3139 BCE and the subsequent lunar eclipse, which took place in the afternoon of 15th September. Since this date is 36 years before the traditional beginning of the *kaliyuga* and therefore of great public interest, I shall discuss it briefly. Unfortunately, however, Bhattacharjya is subject to an illusion, resulting from the fact that he uses VN Sharma's unreliable method, which consists of lunar and solar observations in the *evening* instead of the morning. Considering the moonset at sunrise, it turns out that the full moon took place on 15th September. Now, let it be assumed that days began at sunrise and the days be counted from the solar eclipse that occurred after sunrise on 1st September. Then 2nd September is counted as day number 1 (*pratipad*), and the full moon took place on the 14th, not the 13th day.[156] Bhattacharjya's "solution" also has some other serious problems, which shall be discussed later. (p. 302ff.)

The text, however, makes it very clear that what is needed is a *new moon and a solar eclipse* on the 13th day, *not* a full moon or a lunar eclipse. Also 36 years after the war, when Dvārakā perished and her inhabitants slayed each other, there was a solar eclipse that took place on the 13th, not a lunar eclipse. Therefore a new moon on the 13th day is required.

---

[156] The author's discussion with Mr. Bhattacharjya can be found here: http://groups.yahoo.com/group/akandabaratam/message/63313 .

Here, however, V. N. Sharma's method seems to fail. The solar eclipse can occur at the earliest 13.8 days after the sunrise of the full moon day. However, then it falls into the night before the 14th day, and therefore it cannot be observed. If, on the other hand, it occurs after sunrise, then it falls on the 14th day. At best, edge cases are conceivable, where the Sun rises eclipsed on the 14th day while it is clear that the maximum eclipse took place before sunrise and the Moon is already separating from the lunar disk. This is the case when the crescent of the Sun is observed above the lunar disk. In this situation, the eclipse and the new moon could be dated on the previous day. On the other hand, when the solar crescent stood below the lunar disk, the eclipse could be dated on the dawning day. In the former case, the new moon could, in principle, fall on the 13th day. Of course, it is also conceivable, that in every case, when the Sun rose eclipsed, the new moon was dated to the previous day. Such edge cases are of course extremely rare, especially when the preceding full moon is supposed to be a lunar eclipse that is observable locally.

Moreover, the possibility must be considered that, even if the Moon sets after sunrise, at this time a lunar eclipse could still be in progress or could have just begun. If so, this day may have been considered a full moon and hence the following day may have been counted as day number 1. If the next new moon was a solar eclipse and occurred at sunrise, it could also have been dated to the 13th of the fortnight.

Since the eclipse had to take place at sunrise in these cases, the scenario does not fit the Jyeṣṭhā eclipse of 1198 BCE. However, the question arises whether the spectacular total solar eclipse on 27th March, 1187 BCE, occurring at sunrise, could not have taken place on a 13th. Unfortunately, this is not the case. The solar eclipse was not preceded but followed by a lunar eclipse; besides, the lunar eclipse was not observable from Kurukṣetra because it began more than three hours after sunrise and moonset. Counting the days from the preceding full moon, also offers no clarification. Since totality occurred at sunrise, the eclipse might well have been dated to the previous day. However, the previous full moon occurred too early. On 12th March, sunrise occurred 11 minutes before moonset. The full moon therefore took place on the previous day, and day number 1 (*pratipad*) began already on 12th March. Consequently, the solar eclipse of 27th March took place at the end of the 15th and the beginning of the 16th day. Even if day number 1 had been assumed to be one day later due to bad visibility of the Moon, the solar eclipse could not have been dated before the 14th.

There is another date, however, that satisfies the requirements and is perhaps not too far off from the Mahābhārata battle. On 12th February, 1156 BCE, there was a solar eclipse at sunrise, with its maximum occurring before sunrise, so that the new moon could have been assumed on the previous day. A fortnight earlier, in the morning of 29th January, the Moon set almost exactly at sunrise, shortly after a partial lunar eclipse had begun. Therefore 30th January might have been counted as day number 1, and the solar eclipse could therefore be dated on the 13th. More double eclipses of this kind can be found in Appendix M; they are indicated by +*.[157]

A new moon and a solar eclipse on the 13th would have been a lot easier to observe if the day had not begun at sunrise but at sunset, as was the case with Middle Eastern calendars. Then, the method proposed by V. N. Sharma could have been used and the moonrise observed at sunset. When the Moon rises just before sunset, then the full moon or lunar eclipse can take place just after sunset at the beginning of the new day. About 13.8 days later, in the afternoon of the 13th day, a solar eclipse could occur.

The Mahābhārata has the day begin at sunrise, as is seen from the following verse from Aśvamedhikaparva:

> अहः पूर्वं ततो रात्रिर्मासाः शुक्लादयः स्मृताः
>
> श्रविष्ठादीनि )var. श्रवणादीनिऋक्षाणि ऋतवः शिशिरादयः (
>
> *ahaḥ pūrvaṃ tato rātrirmāsāḥ śuklādayaḥ smṛtāḥ*
> *śraviṣṭhādīni* (var. *śravaṇādīni*) *ṛkṣāṇi ṛtavaḥ śiśirādayaḥ (MBh 14.44.2)*

> First [comes] the day, then the night; the months begin with the bright [fortnight], according to tradition.
> The lunar mansions begin with Śraviṣṭhā, the [six] seasons with Śiśira (coldness).

[157] E. g. similar cases occurred in the years 1209 BCE and 1180 BCE. However, because of the uncertainty of Δt it cannot be known whether they were observable from Kurukṣetra.

However, it is not impossible that in ancient times there was a tradition that began the day at sunset. Interestingly, Vedic texts mention “nights and days” more often than “days and nights”, and the same holds true in the Mahābhārata epic. Even time itself is often not counted as a number of days, but as a number of nights.[158] The following passage from the Śatapathabrāhmaṇa may also indicate that there was a tradition that began the calendar days in the evening:

> तद्वै पौर्णमास्यामेव। असौ वै चन्द्रः पशुस्तं देवाः पौर्णमास्यामालभन्ते यत्रैनं देवा आलभन्ते तदेनमालभा इति तस्मात्पौर्णमास्यां यद्वेव पौर्णमास्यां पौर्णमासी ह वाव प्रथमा व्युवास तस्माद्वेव पौर्णमास्याम्
>
> *tadvai paurṇamāsyāmeva. asau vai candraḥ paśustaṃ devāḥ paurṇamāsyāmālabhante yatrainaṃ devā ālabhante tadenamālabhā iti tasmātpaurṇamāsyāṃ yadveva paurṇamāsyāṃ paurṇamāsī ha vāva prathamā vyuvāsa tasmādveva paurṇamāsyām* (ŚB 6.2.2.17)

| |
|---|
| And therefore [he is sacrificed] on the full moon night: Yonder Moon is the victim. The gods sacrifice him on the full moon night. “At the same time when the gods sacrifice him, I want to sacrifice him”: out of this [consideration, he is sacrificed] on a full moon night. And [the fact] that [they sacrifice him] on the full moon night: The full moon night shone forth (or: began) first: for this reason [he is sacrificed] on a full moon night. |

> तद्वै फाल्गुन्यामेव। एषा ह संवत्सरस्य प्रथमा रात्रिर्यत्फाल्गुनी पौर्णमासी योत्तरैषोत्तमा या पूर्वा मुखत एव तत्संवत्सरमारभते
>
> *tadvai phālgunyāmeva. eṣā ha saṃvatsarasya prathamā rātriryatphālgunī paurṇamāsī yottaraiṣottamā yā pūrvā mukhata eva tatsaṃvatsaramārabhate* (18)

| |
|---|
| And therefore [he is sacrificed] on the Phalgunī [full moon night]: For, this is the first night of the year, namely the second night of the Phalgunī full moon. The first [Phalgunī night] is the last [night of the year]. Then the year begins anew. |

And there is also a similar passage in the Taittirīyabrāhmaṇa:

> एषा वै जघन्या रात्रिः संवत्सरस्य यत्पूर्वे फल्गुनी ...
>
> एषा वै प्रथमा रात्रिः संवत्सरस्य यदुत्तरे फल्गुनी
>
> *eṣā vai jaghanyā rātriḥ saṃvatsarasya yatpūrve phalgunī ...*
> *eṣā vai prathamā rātriḥ saṃvatsarasya yaduttare phalgunī* (TaiBr 1.1.2.9)

| |
|---|
| The last night of the year is Pūrvaphalgunī. ...<br>The first night of the year is Uttaraphalgunī. |

[158] Hopkins, “Epic Chronology”, p. 14f.

Hence did the year, and therefore the day, start in the evening? At least, the question must be asked why the beginning of the year is associated with a night here.

But even then, there would not be an eclipse on the 13th in the year 1198 BCE, not even in 1187 BCE, the year of the spectacular sunrise eclipse. However, there is an interesting case in the middle between these two years. On 7th January, 1192 BCE, the Moon rose partially eclipsed (32%) shortly after sunset (12:05 UT), and on the next new moon, 21st January, the Sun set partially eclipsed (17%, 12:18 UT). If the day had begun in the evening, the first day after the full moon would have begun on 8th January after sunset. Then, the 13th day would have ended with the solar eclipse on 21st January. This phenomenon was also extremely rare. The last time it had happened was perhaps[159] over 1000 years earlier in April 2332 BCE. The next time it was going to happen was already in February 1138 BCE.[160]

All cases discussed so far are based on the assumption, which is in agreement with the text of the Mahābhārata, that the lunar eclipse precedes the solar eclipse. However, if one doubts that and believes that the solar eclipse, which occurred on the 13th, preceded the lunar eclipse, then one has to determine the full moon that *preceded* the solar eclipse by observing the moonset at sunrise and then count 13 days from there. (Or if one were to assume the beginning of the day at sunset, one would observe the moonrise at sunset.) Such a solar eclipse on the 13th followed by an observable lunar eclipse is also very rare. Neither the eclipse of 1198 BCE nor the one of 1187 BCE fits this solution. However, a fitting example occurred in 1321 BCE. On 22nd May the Moon set after sunrise for the first time, and hence this was day number 1 (*pratipad*). On 4th June, the Sun rose partially eclipsed. The new moon could thus be attributed to the previous day, and the solar eclipse fell on the 13th of the fortnight. In the early morning hours of 19th June a partial lunar eclipse was seen. Whether this occurrence could be observed in Kurukṣetra,

---

[159] In 2000 BCE, the uncertainty of Δt, unfortunately, already amounts to more than an hour, so that it is not possible to calculate this phenomenon with certainty for this epoch. In 1000 BCE, the uncertainty is only about 10 minutes.

[160] In the evening of 9th February, the Moon rose partially eclipsed (10%), and on 23rd February, and there was a partial solar eclipse before sunset. The solar eclipse falls on the 13th day.

is not known for certain because of the uncertainty of Δt. The next possible occurrence of the same kind is found in the year 872 BCE. More examples are given in Appendix N; they are indicated by –* at the beginning of the line.

Another clue concerning the mysterious phenomenon of a solar eclipse occurring on a 13th can be seen in the fact that 36 years after the Mahābhārata battle another solar eclipse allegedly occurred on a 13th of the fortnight (MBh 16.3(2).16, quoted below). At a first glance, this seems to make a lot of sense because 36 years are two Saros cycles of 18 years each. Eclipses with similar characteristics usually occur after a Saros cycle. Hence, the question arises whether the rare phenomenon was repeated after 18, 36 and 54 years. However, this is not the case. With each Saros cycle, the geographic visibility range of an eclipse shifts by about 113° in a westward direction. Consequently, if a solar eclipse was seen in Kurukṣetra at sunrise, then the solar eclipse 18 years later did not occur at sunrise, at least not in Kurukṣetra, but 113° of longitude further to the west. Nor did the eclipse 36 years after the war occur at sunrise in Kurukṣetra (or Dvārakā). Only the eclipse that occurred 54 years after the war could have been observed near sunrise again, because 3 x 113° = 339° approximately corresponds to a full circle.[161] If the eclipse after 36 years was not seen at sunrise, it cannot have fallen on the 13th of the fortnight. Therefore the theory discussed above apparently does not fit the phenomenon described in the Mahābhārata.

The next question that must be asked is whether the phenomenon could have occurred six months before or after, in an adjacent eclipse season. Again, this is impossible. For, if a waning half-month is short, as would be the case 36 years after the war, then the waning half-month that takes place six months earlier or later would be long, and consequently an eclipse could not occur on a 13th.

Therefore, if the information that 36 years after the war there was a solar eclipse on a 13th is taken seriously, then all the possible explanations for the phenomenon that have been discussed so far cannot be true. Celestial mechanics do not allow it. However, double

[161] E. g., the solar eclipses of 1156 BCE and 1102 BCE were 54 years apart, both visible at sunrise, and possibly dated on the 13th after a lunar eclipse. (See Appendix M, double eclipses marked by +*.)

eclipses with a solar eclipse on the 13th are possible at an interval of 37 years. Within the time range 3500 BCE to 1 BCE, four examples can be found, all of which fall into the second half of the 3rd millennium BCE. Unfortunately, none of them took place in the right time of the year. Because of the uncertainty of Δt it is not known exactly at which geographic longitudes they were observable.[162]

Solar eclipses that occur on the 13th after a full moon and are followed by a lunar eclipse cannot repeat after 36 years either, for the very same reasons. Examples at intervals of 34 to 38 years, have not been found.

*Still, it is interesting that the Mahābhārata mentions a lunar eclipse during twilight, either at dusk or dawn, as well as a solar eclipse at sunrise. Is this a mere coincidence? Should it be concluded that eclipses on the 13th did in fact occur when they took place near sunrise?*

*As has been said, all these considerations do not provide a reliable criterion for the dating of the war. Bad weather conditions can prevent the observation of the full moon. If a 15-day half-month had been assumed by default, eclipses on the 13th could also have come about as a result of incorrect full moon dates.*

A very different explanation for the solar eclipse on the 13th of the fortnight, and generally for eclipses at the wrong time, was proposed by K.L. Daftari.[163] In Daftari's opinion, the text says that *both* eclipses occurred on the 13th of their respective fortnight. In fact it seems that Daftari is right, for the text literally says:

---

[162] The following examples can be extracted from Appendix M:
2 April 2368 BCE / 13 April 2331 BCE (37 years, l = 136-141, z > 2.7)
13 April 2350 BCE / 23 April 2313 BCE (37 years, l = 23-33, z < –2.0)
14 Jan. 2122 BCE / 25 Jan. 2085 BCE (37 years, l = 116-127, z > 2.3)
15 Feb. 2068 BCE / 26 Feb. 2031 BCE (37 years, l= 120-124, z > 2.6)

[163] Daftari, *The Astronomical Method...*, p. 13ff.

चन्द्रसूर्यावुभौ ग्रस्तावेकमासे त्रयोदशीम्

अपर्वणि ग्रहावेतौ प्रजाः संक्षपयिष्यतः

*candrasūryāvubhau grastāvekamāse trayodaśīm*
*aparvaṇi grahāvetau prajāḥ saṃkṣapayiṣyataḥ (29)*

| |
|---|
| Both the Moon and the Sun were eclipsed (swallowed) in one and the same month on the 13th [of the fortnight],<br>on a wrong date: these two eclipses (or: planets)[164] will destroy the creatures. |

All previous solutions discussed so far do not allow that both eclipses occurred on the 13th of their respective half-month. They are based on the fact that the Moon moves considerably faster in one half of its orbit than it does in the other half. As a consequence, a very short fortnight is always followed by a very long one. It is therefore not possible that two successive half-months have the minimum duration of 13.8 days. In reality, the preceding and the following fortnight will be longer than 15 days.

Daftari therefore looks for a different explanation, which he formulates as follows:

> The only acceptable explanation is, that the real *Tithi* was always in advance of, *i.e.*, preceded, the calculated *Tithi*, on account of the excessive length of the lunar month then taken for calculation. The real length of 62 lunar months (= 5 solar years, D.K.) is 1830.8964 days. But if a period larger than this, *i.e.*, 1831 days as in the *Yajur-Vedānga-Jyotisha* or 1830.9375 days as in the *Pitāmaha Siddhānta* (see my *Bhāratīya Jyotisha Śāstra Nirīkshaṇa*, page 75) be taken as the length of 62 lunar months, every calculated *Tithi* would come later than the actual *Tithi*. The interval between the calculated and the actual *Tithi* would increase as the *cycles* advance and the statements given above show that it had accumulated to the extent of about two *Tithis* at the time of the War. Therefore, the statement says that both the eclipses that always happen on the 15th *Tithi* happened on the 13th *Tithi* in the same month.[165]

The required correction of the *tithi* was usually made on the basis of eclipses. The Mahābhārata informs us about it on a later occasion, namely when 36 years later, just before the downfall of Dvārakā and her inhabitants, an eclipse occurred on the 13th:

[164] *grahau*. See footnote 121, p. 220.

[165] Daftari, op. cit., p. 19.

एवं पश्यन्हृषीकेशः संप्राप्तं कालपर्ययम्

त्रयोदश्याममावास्यां तान्दृष्ट्वा प्राब्रवीदिदम्

*evaṃ paśyanhṛṣīkeśaḥ saṃprāptaṃ kālaparyayam*
*trayodaśyāmamāvāsyāṃ tāndṛṣṭvā prābravīdidam (MBh 16.3(2).16)*

When Kṛṣṇa (Hṛṣīkeśa) saw that the time period was completed,
when he saw that the new moon was on the 13th, he said this to them (the Yādavas):

चतुर्दशी पञ्चदशी कृतेयं राहुणा पुनः

तदा च भारते युद्धे प्राप्ता चाद्य क्षयाय नः

*caturdaśī pañcadaśī kṛteyaṃ rāhuṇā punaḥ*
*tadā ca bhārate yuddhe prāptā cādya kṣayāya naḥ (17)*

"This 14th was made the 15th again by Rāhu.
This happened at the time of the Bhārata war, and today again for our downfall."

Daftari explains this as follows:

> This shows that both at the time of the Mahābhārata War and at the time of the destruction of the Yādavas, the 14th *Tithi*, coming on a day on which at the sunrise there was the 13th *Tithi*, was made the 15th by the Rāhu, *i.e.*, by the eclipse and not by any mathematical calculation as suggested by Dixit.[166]

Unfortunately, the calendar then in use is not understood in detail. Hence there is no certainty as to how to calculate the calendar for the year 1198 BCE or a particular other year, nor is it known what kind of problems exactly the calendar makers had to deal with. To reconstruct ancient calendar making through astronomical considerations is also impossible. The incommensurability of the solar and the lunar year leads to numerous problems which each calendar culture solves in their own way. However, Daftari's suggestion being that the counting of *tithis* temporarily becomes discordant and is behind the real position of the Moon, is very plausible.

Another explanation of eclipses on the wrong date is given by the ancient author Varāhamihira in *Bṛhatsaṃhitā* 5.24-27:

[166] Daftari, op. cit., p. 20. Daftari refers to: Shanker Balkrishna Dixit, *Bhāratiya jyotiḥśāstra* (in Marathi), Puna 1931 (Aryabhushan Press).

वेलाहीने पर्वणि गर्भविपत्तिश्च शस्त्रकोपश्च

अतिवेले कुसुमफलक्षयो भयं सस्यनाशश्च

*velāhīne parvaṇi garbhavipattiśca śastrakopaśca*
*ativele kusumaphalakṣayo bhayaṃ sasyanāśaśca (5.24)*

[If an eclipse occurs] a bit before its time, [this means] loss of unborn children and raging of weapons;
[but if it occurs] after its time, destruction of flowers and fruit, fear and destruction of crop.

हीनातिरिक्तकाले फलमुक्तं पूर्वशास्त्रदृष्टत्वात्

स्फुटगणितविदः कालः कथञ्चिदपि नान्यथा भवति

*hīnātiriktakāle phalamuktaṃ pūrvaśāstradṛṣṭatvāt*
*sphuṭagaṇitavidaḥ kālaḥ kathañcidapi nānyathā bhavati (25)*

I have stated the result according to the science of the ancients in case that the correct timing is slightly exceeded or deceeded.
However, for him who knows the correct calculation, the timing will never be different [than the timing of the real event].

यद्येकस्मिन्मासे ग्रहणं रविसोमयोस्तदा क्षितिपाः

स्वबलक्षोभैः संक्षयमायान्त्यतिशस्त्रकोपश्च

*yadyekasminmāse grahaṇaṃ ravisomayostadā kṣitipāḥ*
*svabalakṣobhaiḥ saṃkṣayamāyāntyatiśastrakopaśca (26)*

If an eclipse of the Sun and one of the Moon [occur] within one single month, then kings will
perish through the riot of their own army, and [there will be] raging of weapons.

ग्रस्तावुदितास्तमितौ शारदधान्यावनीश्वरक्षयदौ

सर्वग्रस्तौ दुर्भिक्षमरकदौ पापसन्दृष्टौ

*grastāvuditāstamitau śāradadhānyāvanīśvarakṣayadau*
*sarvagrastau durbhikṣamarakadau pāpasandṛṣṭau (27)*

When both (: the Sun and the Moon) are eclipsed during their rising or setting, they will bring destruction for autumnal harvest and for kings.
When they are totally eclipsed, then they will bring famine and lethal plagues, if they are aspected by evil-doers (: Mars or Saturn).

Here, Varāhamihira might be alluding to the eclipses of the Mahābhārata epic. There is talk of two eclipses within a month, of eclipses at the rising or setting of the eclipsed body, and of eclipses at the wrong time. While eclipses on the 13th are not explicitly mentioned, it is obvious that these are alluded to. Varāhamihira appears to be of the opinion that the eclipses described in the epic fell on the 13th *due to incorrect calculations*. In the case of a solar eclipse on the 13th, a mistake must probably have been made, either with the determination of the previous full moon or with the calendrical calculations. Varāhamihira's explanation thus goes in a similar direction as Daftari's.

The following consideration may be interesting: It has been hypothesized that the new moon on 21st October 1198 BCE, which actually took place in Anurādhā, was predicted and assumed in Jyeṣṭhā. If lunar mansions are counted from Mūla, i. e. from the lunar mansion that follows Jyeṣṭhā, then it is found that the 13th lunar mansion is Rohiṇī. That is where the Kārttika lunar eclipse took place on 4th November, thus not on the 13th day, but *in the 13th lunar mansion*. Normally, the next syzygy should actually take place in the 14th, 15th, or 16th lunar mansion. Of course, the text explicitly requires a *solar* eclipse "on the 13th", not a lunar eclipse. However, as has been illustrated, the astronomical situation was ambiguous and the sequence of the lunar and solar eclipses might have been confounded within the text.

## Two Suns at the End of the Age

Returning to the verse that most likely describes the total eclipse at sunrise:

द्विधाभूत इवादित्य उदये प्रत्यदृश्यत

var. D3: विगतांशुस्तथादित्य उदये प्रत्यदृश्यत

ज्वलन्त्या शिखया भूयो भानुमानुदितो दिवि

*dvidhābhūta ivāditya udaye pratyadṛśyata*
var. D3: *vigatāṃśustathāditya ...*
*jvalantyā śikhayā bhūyo bhānumānudito divi (MBh 6.17.3)*

| |
|---|
| The Sun was seen split in two, as it were, in his rising.<br>*Var.:* Without rays appeared the sun in his rising.<br>With a burning crest (or: flame) rose the shining one again in the sky. |

As has been shown, the "burning crest" (*jvalantī śikhā*) possibly refers to the solar corona. If this interpretation is correct, then what exactly does it mean for the Sun to be "split in two, as it were" in his rising? Could it mean that totality occurred only shortly after sunrise and that for this reason the Sun "appeared twice"? During his first rising, shortly before totality, he appeared as a crescent open upwards to the right. When the eclipse became total, the Sun disappeared again, and shortly thereafter it reappeared as a crescent that was open downwards to the left. Possibly the "splitting in two" of the Sun refers to this. On the day of a total eclipse there are "two Suns", as it were, one before and one after the eclipse.

The following passage speaks of a *second* Sun that occurred at the end of the age and has a kind of "halo" (*pariveṣaḥ*). Although this verse is not taken from the immediate context of the war, it still refers to a phenomenon that occurs at the end of the *yuga*, when the war takes place:

> रूपं सुदर्शनस्यासीदाकाशे पततस्तदा
>
> द्वितीयस्येव सूर्यस्य युगान्ते परिविष्यतः
>
> *rūpaṃ sudarśanasyāsīdākāśe patatastadā*
> *dvitīyasyeva sūryasya yugānte pariviṣyataḥ (MBh 3.23(22).32)*

> The shape of the discus (: the weapon of Kṛṣṇa), as it flew in the sky, was like that of the second sun, having a halo, at the end of the age.

Does this verse refer to a halo in the true astronomical sense, namely in the sense of a ring of light that appears around the Sun under certain atmospheric condition and has a radius of 22°? Such halos, which are caused by ice crystals in the atmosphere, are often accompanied by one or two mock suns that appear to the left and right of the Sun on the ring of light. Then one believes to see either two or even three suns.[167] However, the text mentions only a *second* Sun. There is never talk of *three* Suns at the end of the yuga, there are always two. Therefore it is not certain that a mock sun is intended. Besides it must be noted that a halo always appears around the real Sun, not around mock suns, whereas in the text it is the *second* sun that has a "halo". Moreover, the Sanskrit term for "mock sun" used in ancient texts like Atharvavedapariśiṣṭa, Bṛhatsaṃhitā or Parāśaratantra is *pratisūryaḥ*, whereas the Mahābhārata uses the

[167] Besides the 22° halo, a second halo can rarely appear at a radius of 46°, which can also have two mock suns. If so it is possible to see up to *five* suns.

expression *dvitīyaḥ sūryaḥ*, i. e. a “second sun”. It is therefore difficult to decide whether it is really a mock sun that is intended here.

The term *pariveṣa* could, in principle, also refer to a so-called *atmospheric* “corona”, which has nothing to do with the corona seen during a total solar eclipse but is produced by the diffraction of the sunlight by small water droplets or any kind of aerosols in the atmosphere. However, this phenomenon does not explain the “second sun”.

The quoted verse with the “second sun” is also reminiscent of the “sun split in two with a burning crown”. Hence the question arises whether both verses should be interpreted as referring to the same phenomenon. Do both refer to a halo and a mock sun? Or, do they both describe a total solar eclipse and the solar corona? Could the eclipsed solar disk with the corona be a “second sun” itself? Also what does Kṛṣṇa’s weapon, the discus, which is also mentioned in the halo verse, represent? Could it represent the corona of a total eclipse or a halo or something different?

In principle, it could be even a combination of both. On 21st June 2001, when the author of this work observed a total solar eclipse in Zambia, he saw a double halo in rainbow colours for a few moments during the second diamond ring phase.[168] Strangely this happened although the sky seemed to be very clear. The phenomenon disappeared together with the diamond ring. If the eclipse had taken place during a super-conjunction, then the brighter planets could have possibly been seen for a short moment around the Sun and inside the halo.

Varāhamihira writes:

[168] It is also possible that it was rather an aureole. Unfortunately, this author was too much focused on the diamond ring effect and therefore did not pay much attention to the radius of the rings. He believes, however, that it was a halo effect, because the interior of the ring phenomenon was not lit up, as would be the case with an atmospheric corona.

युद्धानि विजानीयात्परिवेषाभ्यन्तरे द्वयोर्ग्रहयोः

दिवसकृतः शशिनो वा क्षुदवृष्टिभयं त्रिषु प्रोक्तम्

याति चतुर्षु नरेन्द्रः सामात्यपुरोहितो वशं मृत्योः

प्रलयमिव विद्धि जगतः पञ्चादिषु मण्डलस्थेषु

*yuddhāni vijānīyātpariveṣābhyantare dvayorgrahayoḥ*
*divasakṛtaḥ śaśino vā kṣudavṛṣṭibhayaṃ triṣu proktam (BS 34.16)*
*yāti caturṣu narendraḥ sāmātyapurohito vaśaṃ mṛtyoḥ*
*pralayamiva viddhi jagataḥ pañcādiṣu maṇḍalastheṣu (17)*

Battles should be foreknown when two planets stand inside a halo
of the Sun or the Moon. With three [planets], danger of famine and drought is announced.
With four, the king and his minister and priest succumb to death.
With five [planets] that stand inside a halo, know that it is a doomsday (*pralaya*) as it were.

Of course, planets cannot be seen inside a solar halo except during a total solar eclipse. Varāhamihira does not mention this fact. Does he think of it? Or is he talking about an unobservable, but knowable configuration? A similar statement is also found in Kāśyapa, however, he is talking of lunar halos only.[169] The solar eclipse of 21st October 1198 BCE was not total, though. At the southern edge of the Taklamakan Desert it was observable in annular phase. Still, all planets were inside the 22° radius of a solar halo on that day.

Now, a halo around the Sun is a very common phenomenon that probably would not have been associated with the end of the age. Thus the question arises whether the "halo" could be the solar corona that appears during a total solar eclipse. Could the eclipsed Sun with the corona itself be the "second sun"? Could the weapon of Kṛṣṇa, the discus, even represent the corona of a total solar eclipse?

Another issue to be considered here is the following: The dying Bhīṣma is compared to a Sun that has fallen to the earth, has a "shining arc" (*citracāpa-*), and is accompanied by darkness. This can be seen from the following verses, which, however, are taken from different contexts:

[169] Bhat, *Varāhamihira's Bṛhatsaṃhitā*, p. 319.

पश्य शांतनवं कृष्ण शयानं सूर्यवर्चसम्

युगान्त इव कालेन पातितं सूर्यमम्बरात्

*paśya śāṃtanavaṃ kṛṣṇa śayānaṃ sūryavarcasam*
*yugānta iva kālena pātitaṃ sūryamambarāt (MBh 11.23.15)*

> See Bhīṣma, O Kṛṣṇa, who is lying there with the brightness of the Sun, like the Sun that is caused to fall from the sky by the [deity of] time at the end of the age.

चित्रचापमहाज्वालो वीरक्षयमहेन्धनः

युगान्ताग्निसमो भीष्मः परेषां समपद्यत

*citracāpamahājvālo vīrakṣayamahendhanaḥ*
*yugāntāgnisamo bhīṣmaḥ pareṣāṃ samapadyata (MBh 6.114(120).6)*

> To his enemies, Bhīṣma appeared like the fire at the end of the age, that had a shining arc and great flames, that destroyed heroes and had great burning.

खं तमोवृतमासीच्च नासीद्भानुमतः प्रभा

रराास पृथिवी चैव भीष्मे शांतनवे हते

*khaṃ tamovṛtamāsīcca nāsīdbhānumataḥ prabhā*
*rarāsa pṛthivī caiva bhīṣme śāṃtanave hate (MBh 6.115(121).6)*

> The sky was covered with darkness, and there was no light of Sun, and the earth shook, when Bhīṣma, the son of Śaṃtanu, was slain.

Now, Bhīṣma dies on the winter solstice, and symbolically this makes good sense. However, his "fall" occurred over two months earlier. What could that "fall" stand for? Most probably it represents a solar eclipse. The "shining arc" and the dark Sun clearly indicate it.

Doubts about this interpretation of the solar "crest", the "halo", and the "shining arc" as the solar corona could arise from the following passage, which also describes ominous phenomena about the rising and setting Sun:

उभे पूर्वापरे संध्ये नित्यं पश्यामि भारत

उदयास्तमने (-अस्तमये?) सूर्यं कबन्धैः परिवारितम्

*ubhe pūrvāpare saṃdhye nityaṃ paśyāmi bhārata*
*udayāstamane (-astamaye?) sūryaṃ kabandhaiḥ parivāritam (MBh 6.2.20)*

> At both dawn and dusk, O Bhārata, at the rising and setting of the sun, I always see the Sun veiled by shining clouds.

श्वेतलोहितपर्यन्ताः कृष्णग्रीवाः सविद्युतः

त्रिवर्णाः परिघाः संधौ भानुमावारयन्त्युत

*śvetalohitaparyantāḥ kṛṣṇagrīvāḥ savidyutaḥ*
*trivarṇāḥ parighāḥ saṃdhau bhānumāvārayantyuta (21)*

Cloud bars in three colours, with white and red edges and black back sides surround the Sun at dawn and dusk.

These verses apparently mention rays of light and shadow and plays of colours that show up when clouds appear before the Sun near sunset or sunrise. Again, the Sun has a kind of a "crest" or "halo", as it had in the verses quoted previously. This time, however, it is obviously not dealing with a solar corona but with phenomena caused by clouds.

Besides, distant clouds often cause uncertainty regarding the sunset and sunrise. For example the Sun may appear to have set, but then again suddenly re-appear below a cloud layer. So it may be asked: What Kṛṣṇa caused with his yogic power and made Jayadratha believe that the Sun had already set, was that not really an eclipse but a phenomenon caused by clouds? (MBh 7.121(145)) Does the Sun "split in two" refer to this kind of effect, too?

However, the question arises what should be so ominous and inauspicious about this cloud phenomenon that appears almost everyday. It is conceivable that these verses are just an attempt to explain the hard-to-understand tradition of the Sun with the "crest". As total solar eclipses are extremely seldom, the knowledge about their possibility could have been lost over the centuries. For many generations, no human being that lived in the region ever saw a total solar eclipse. Hence, the verses quoted above could in fact also go back to an ancient observation of a total solar eclipse. To a naive observer, the effects of sun rays that are caused by clouds that cover the Sun near the horizon are not too dissimilar to a solar corona. At least, oral descriptions of the two phenomena could not easily be distinguished from each other.

The celestial omens that take place 36 years after the war, shortly before the doom of Dvārakā and the death of Kṛṣṇa also include a Sun "rising without rays" (*viraśmir udaye*), "cloud vessels" (*kabandha-*), and "halos" (*pariveṣa-*):

आदित्यो रजसा राजन्समवच्छन्नमण्डलः

विरश्मिरुदये नित्यं कबन्धैः समदृश्यत

*ādityo rajasā rājansamavacchannamaṇḍalaḥ*
*viraśmirudaye nityaṃ kabandhaiḥ samadṛśyata MBh 16.1.4*

| |
|---|
| The Sun disk was shrouded in haze, O king.<br>He was constantly without rays at sunrise and was seen vesseled in clouds. |

परिवेषाश्च दृश्यन्ते दारुणाश्चन्द्रसूर्ययोः

त्रिवर्णाः श्यामरूक्षान्तास्तथा भस्मारुणप्रभाः

*pariveṣāśca dṛśyante dāruṇāścandrasūryayoḥ*
*trivarṇāḥ śyāmarūkṣāntāstathā bhasmāruṇaprabhāḥ MBh 16.1.5*

| |
|---|
| Terrifying halos were seen around both the Moon and Sun,<br>in three colours with black and harsh edges, with devouring reddish light. |

A little later, a solar eclipse is also mentioned. (MBh 16.3(2).17; quoted on p. 283) Perhaps the text just wants all these phenomena to take place in combination.

Some verses in the passages cited above mention an ominous "Sun split in two, as it were" or a "second sun", and this description was interpreted as a solar eclipse. A "second sun" is mentioned many times in descriptions for the end of the age. However, it does not mean that there are actually two Suns. In other places, as in the verses concerning the dying Bhīṣma, there is talk of only one single Sun at the end of the age.

Another interesting passage mentioning "two Suns" is found in the description of the duel of Arjuna and Karṇa:

रथेन कर्णस्तेजस्वी जगामाभिमुखो रिपून्

युद्धायामर्षताम्राक्षः समाहूय धनंजयम्

*rathena karṇastejasvī jagāmābhimukho ripūn*
*yuddhāyāmarṣatāmrākṣaḥ samāhūya dhanaṃjayam (MBh 8.63(87).2)*

| |
|---|
| Burning [of anger], Karṇa went towards the enemies with his chariot.<br>With eyes that glowed from impatience, he challenged Arjuna for a fight. |

तौ रथौ सूर्यसंकाशौ वैयाघ्रपरिवारणौ

समेतौ ददृशुस्तत्र द्वाविवार्कौ समागतौ

*tau rathau sūryasaṃkāśau vaiyāghraparivāraṇau*
*sametau dadṛśustatra* ***dvāvivārkau samāgatau*** *(3)*

| |
|---|
| As the two chariots, which shone like suns and were covered with tiger [skins],<br>came together, they resembled **two suns that had come together**. |

श्वेताश्वौ पुरुषादित्यावास्थितावरिमर्दनौ

शुशुभाते महात्मानौ चन्द्रादित्यौ यथा दिवि

*śvetāśvau puruṣādityāvāsthitāvarimardanau*
*śuśubhāte mahātmānau* ***candrādityau*** *yathā divi (4)*

| |
|---|
| The two man-suns, [drawn] by white horses and destroyers of their enemies, approaching [each other],<br>shone with their great being (*mahātman-*) like **the Moon and the Sun** in the sky. |

...

इन्द्रवृत्राविव क्रुद्धौ सूर्याचन्द्रमसप्रभौ

महाग्रहाविव क्रूरौ युगान्ते समुपस्थितौ

*indravṛtrāviva kruddhau* ***sūryācandramasa****prabhau*
***mahāgrahāv****iva krūrau* ***yugānte samupasthitau*** *(16)*

| |
|---|
| Like Indra and Vṛtra, who had become angry, they had the splendour of **the Sun and the Moon**,<br>like **the two** dreadful **great planets that appear (or: come together) at the end of the age**. |

It becomes clear that the "two suns" are in fact the Sun and the Moon uniting for a fight with each other. The context also shows that Karṇa plays the part of the Sun. (MBh 8.67(91)) This makes good sense because the Sun god is his father. Moreover, it is Karṇa who dies in this fight. The death of the Sun could stand for a solar eclipse. One may object that this interpretation contradicts the fact that the death of Karṇa takes place at the end of the 17th day, which cannot have been a new moon if the war started on either a new or a full moon. But it should not be expected that all statements of the epic are consistent.

As has been illustrated, Bhīṣma is also compared to the dying Sun at the end of the age (p. 236). And his "fall" during the war is compared to a solar eclipse. From all this it can be concluded that the double Sun says at the end of the age refers to the union of the Sun and the Moon and a total solar eclipse.

And there is another passage that must be studied more closely here. Amongst the omens that indicated the war, there are the following statements:

ग्रहौ ताम्रारुणशिखौ प्रज्वलन्ताविव स्थितौ

सप्तर्षीणामुदाराणां समवच्छाद्य वै प्रभाम्

*grahau tāmrāruṇaśikhau prajvalantāviva sthitau*
*saptarṣīṇāmudārāṇāṃ samavacchādya vai prabhām (MBh 6.3.24)*

The two planets (or: Two planets) with a copper-coloured crest (or: hair tuft) stood there burning, as it were,
and hid the light of the exalted Seven Ṛṣis.

संवत्सरस्थायिनौ च ग्रहौ प्रज्वलितावुभौ

विशाखयोः समीपस्थौ बृहस्पतिशनैश्चरौ

*saṃvatsarasthāyinau ca grahau prajvalitāvubhau*
*viśākhayoḥ samīpasthau bṛhaspatiśanaiścarau (25)*

The two burning planets, Jupiter and Saturn, stay for one year standing in the vicinity of the Viśākhā [stars].

The "Seven Ṛṣis" are usually interpreted as the constellation Ursa Major. They are hidden by "the two planets with a copper-coloured crown". Verse 25 seems to indicate that these two planets are Jupiter and Saturn. However, it is impossible that Jupiter and Saturn "hide" Ursa Major. Only the Moon and the Sun are bright enough to outshine a star and make it invisible. The Seven Ṛṣis are *always* visible under clear night skies – except maybe on a full moon. Very attractive, at a first glance at least, is B. N. Achar's interpretation, that the two objects are comets (Greek *komētēs* = "long-haired star").[170] In fact, the Sanskrit term for a comet's coma is *śikhā*, "hair tuft, crest", just as in the verse under discussion.[171] Although it very rarely occurs that two comets are visible in the sky at the same time, it is not impossible. Also other than planets, comets could in fact appear near the Seven Ṛṣis and outshine them.

However, this could be a false conclusion. To begin with, it must be noted that the Sun is sometimes designated a "planet" (in the *Navagrahastotra*), and the seven planets are also sometimes called "suns" (HV 3.46.11; quoted on p. 121). When Arjuna and Karṇa fight with each other (MBh 8.63(87), quoted above on p. 291f.), the two heroes are compared with

[170] Achar, *Date of the Mahābhārata War* (2014), p. 38.

[171] Varāhamihira, *Bṛhatsaṃhitā* 11.10ff.

– “the two great planets that come together at the end of the age”, (*mahāgrahau yugānte samupasthitau*, 16)

– “the two Suns that have come together”, (*dvāvivārkau samāgatau*, 3)

– “the Sun and the Moon” (*candrādityau yathā divi*, 4; *sūryācandra-masaprabhau,* 16).

It may be concluded that the “two great planets” appearing at the end of the age are synonymous with the “two suns” that also appear at the end of the age, (cf. MBh 3.42(41).11; MBh 3.23(22).32; MBh 8.12(17).51) or with the Sun that rose “split in two, as it were”, while the planets were “flying together”. (MBh 6.17.3)

Moreover, it must be concluded that the two “planets” or “suns” represent the Sun and the Moon shortly before the new moon. Alternately, as has been discussed, the Sun “split in two” also could represent a solar eclipse, and solar eclipses occur on new moons. The “two Suns” fight with each other. So, is the solar eclipse here considered a fight between the Sun and the Moon?

Even the “crest” or “crown” or “hair tuft” (*śikhā*) accompanies the Sun at the end of the *yuga*, as has been seen:

> द्विधाभूत इवादित्य उदये प्रत्यदृश्यत
>
> ज्वलन्त्या शिखया भूयो भानुमानुदितो दिवि
>
> *dvidhābhūta ivāditya udaye pratyadṛśyata*
> *jvalantyā **śikhayā** bhūyo bhānumānudito divi (MBh 6.17.3)*

| |
|---|
| The Sun was seen split in two, as it were, in his rising.<br>With a burning **crest** (or: flame) rose the shining one in the sky. |

It has been suggested that this “crest” or “crown” (*śikhā*) represented the solar corona that appears during a total solar eclipse. Hence the “two planets with the crest” could allude to either a halo or a total solar eclipse and its corona. Sufficient evidence has been found that a solar eclipse took place in the year of the war.

The fact that the two “planets” “hid the light of the seven Ṛṣis” remains problematic, as long as they were not comets in the region of the Seven Ṛṣis. However, it has been shown that the common interpretation of the Seven Ṛṣis as Ursa Major does not always make sense. According to the Purāṇas, the Seven Ṛṣis formed a conjunction in the lunar mansion of Maghā at the beginning of the *kaliyuga*, not long after the great war. (VP 4.24.105ff.) It has also been seen that all interpretation attempts that assume that the Seven Ṛṣis stand for Ursa Major fail miserably. Fixed stars do not move or form conjunctions. It makes a lot more sense to interpret the Seven Ṛṣis as the seven planets. This solution is supported by the fact that according to India's astronomical tradition all the planets formed a conjunction at the beginning of the *kaliyuga*, whereas the Purāṇa text under discussion does not mention any planets at all.[172] There can be little doubt that here the "Seven Ṛṣis" are in fact the seven planets.

It is therefore very likely that the verse MBh 6.3.24 is a distorted description of the super-conjunction, and that this super-conjunction was accompanied by a new moon and even a solar eclipse. The Seven Ṛṣis stand for the planets, and the "the two planets with a copper-coloured crest or hair tuft" for the Sun and the Moon at the time of a solar eclipse. The planets form a conjunction with the Sun and the Moon, they enter their light and become invisible.

What is a bit irritating is that the verses 24 and 25 seem to identify the two planets with Jupiter and Saturn. However, it is conceivable that the oral tradition that this text was based on was not aware anymore of the true identity of the two "planets". The astronomical descriptions in the narrative are often confused, no doubt because the records were corrupted over the centuries.

## Ketu, Dhūmaketu, and Comets

It has been shown that the double sun at the end of the age probably alludes to a solar eclipse. However, there is also evidence that one or two comets could have played part in the "double sun".

Some verses in the Mahābhārata mention an enigmatic celestial object called Dhūmaketu. In Vedic literature, and also in the Mahābhārata, this term can stand for different things. Often it stands for the fire god, Agni (e.g. MBh 1.97.17; 1.216.1; 6.67.3; 7.85.3; 13.143.23).

[172] The version of the Viṣṇu Purāṇa has one verse that mentions planets (VP 4.24.102). However, it is introduced with *atrocyate*, which indicates a quotation, and it does not refer to the *kaliyuga* but to the *kṛtayuga*. It therefore has to be concluded that it is only a gloss.

However, in the following verse, Dhūmaketu seems to stand for the fire of the Sun at the end of the age:

स पाण्डवयुगान्तार्कः कुरूनप्यभ्यतीतपत्

प्रददाह कुरून्सर्वानर्जुनः शस्त्रतेजसा

युगान्ते सर्वभूतानि धूमकेतुरिवोत्थितः

*sa pāṇḍavayugāntārkaḥ kurūnapyabhyatītapat (MBh 7.31(30).44cd)*
*pradadāha kurūnsarvānarjunaḥ śastratejasā*
*yugānte sarvabhūtāni dhūmaketurivotthitaḥ (45)*

This Pāṇḍava, who is the Sun of the end of the age, burned the Kurus.
Arjuna burned all the Kurus with the blaze of his weapons,
like the *Dhūmaketu*, who arises at the end of the age, [burns] all living beings.

Other verses about the Sun at the end of the age are:

पश्य शांतनवं कृष्ण शयानं सूर्यवर्चसम्

युगान्त इव कालेन पातितं सूर्यमम्बरात्

*paśya śāṃtanavaṃ kṛṣṇa śayānaṃ sūryavarcasam*
*yugānta iva kālena pātitaṃ sūryamambarāt (MBh 11.23.15)*

See Bhīṣma, O Kṛṣṇa, who is lying there with the brightness of the Sun, like the Sun that is caused to fall from the sky by the [deity of] time at the end of the age.

चित्रचापमहाज्वालो वीरक्षयमहेन्धनः

युगान्ताग्निसमो भीष्मः परेषां समपद्यत

*citracāpamahājvālo vīrakṣayamahendhanaḥ*
*yugāntāgnisamo bhīṣmaḥ pareṣāṃ samapadyata (MBh 6.114(120).6)*

To his enemies, Bhīṣma appeared like the fire at the end of the age, that had a shining arc and great flames, that destroyed heroes and had great burning.

In MBh 3.3.26 Dhūmaketu also appears as one of the 108 names of the Sun god. Does Dhūmaketu therefore refer to the Sun god also in the following verse, which evidently describes an astronomical configuration?

अभावं हि विशेषेण कुरूणां प्रतिपश्यति

धूमकेतुर्महाघोरः पुष्यमाक्रम्य तिष्ठति

*abhāvaṃ hi viśeṣeṇa kurūṇāṃ pratipaśyati*
*dhūmaketurmahāghoraḥ puṣyamākramya tiṣṭhati (MBh 6.3.12)*

The destruction of the Kurus is particularly obvious.
Dhūmaketu with great terror has gone to Puṣya and is standing there.

Ganguli, however, translates *dhūmaketu* as “comet” here:

> A fierce comet riseth, afflicting the constellation *Pusya*.

In fact, this seems to be more plausible, at least in the current verse. Why would the Sun entering Puṣya be considered terrifying, when this happens once every year? A comet by the name of *dhūmaketu* is also mentioned by Parāśara.[173] In the work of Varāhamihira the term *dhūmaketu* denotes a whole category of comets that cause calamities.[174] In Atharvavedapariśiṣṭa, *dhūmaketu* is the ninth planet besides the Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn, and Rāhu. However, in this list it does not refer to the descending lunar node, but to a “comet”, where no difference seems to be made between different comets. In older Indian astronomy, such as the *Navagrahastotra*, the term *ketu* means “comet”.[175] It was only later that Ketu was assigned the role of the opposition point of Rāhu and interpreted as the descending lunar node. In the Mahābhārata there is no clue that the descending node was already known as Ketu. Rāhu at that time was held responsible for *all* eclipses.

Some authors who have dealt with the astronomical details of the Mahābhārata have identified *dhūmaketu* with the “secondary planet”

---

[173] Iyengar, *Parāśaratantra*, p. 141ff.; idem, “A Profile of Indian Astronomy before the Siddhāntic Period”, p. 12.

[174] Varāhamihira, *Bṛhatsaṃhitā* XI,9.

[175] The Text reads as follows:

अर्धकायं महावीर्यं चन्द्रादित्यविमर्दनम् / सिंहिकागर्भसंभूतं तं राहुं प्रणमाम्यहम्

*ardhakāyaṃ mahāvīryaṃ candrādityavimardanam*
*siṃhikāgarbhasaṃbhūtaṃ taṃ rāhuṃ praṇamāmyaham (8)*

> To him who has half a body, who has great force, who wears down the Moon and the Sun,
> who is born from the womb of Siṃhikā, to this Rāhu I bow.

पलाशपुष्पसंकाशं तारकाग्रहमस्तकम् / रौद्रं रौद्रात्मकं घोरं तं केतुं प्रणमाम्यहम्

*palāśapuṣpasaṃkāśaṃ tārakāgrahamastakam*
*raudraṃ raudrātmakaṃ ghoraṃ taṃ ketuṃ praṇāmyaham (9)*

> To him who resembles the blossom of the Palāśa tree, who has tails (lit. tufts of leaves) with which he seizes stars,
> to the wild one, who is of wild nature, the horrible one, to this Ketu I bow.

The Palāśa tree has reddish petals. In their arrangement, these resemble the tails of a comet, which are often reddish, too. That comets can “seize” stars with their tails, makes good sense. The lunar node, on the other hand, cannot do that.

(*upagraha*) *dhūma*, whose position is obtained by adding 133°20', or 10 lunar mansions, to the position of the Sun. This view, however, is entirely speculative. When the Mahābhārata mentions *dhūmaketu* in astronomical context, then either the doomsday Sun is meant or a spectacular comet.

The following verse, which explicitly mentions some *ketuḥ*, points to a comet, too:

> आदित्यपथगः केतुः पार्थस्यामिततेजसः
>
> दीपयामास तत्सैन्यं पाण्डवस्य महात्मनः
>
> यथा प्रज्वलितः सूर्यो युगान्ते वै वसुंधराम्
>
> *ādityapathagaḥ **ketuḥ** pārthasyāmitatejasaḥ (MBh 7.6(7).17cd)*
> *dīpayāmāsa tatsainyaṃ pāṇḍavasya mahātmanaḥ*
> *yathā prajvalitaḥ sūryo yugānte vai vasuṃdharām (18)*

> The **comet** of the immeasurably resplendent son of Pṛthā, which wanders along the path of the Sun,
> made this army of the Pāṇḍava shine, who is of great character,
> like the burning Sun at the end of the age [makes] the earth [shine].

Spectacular comets appear every few years or decades. It is therefore, quite possible that a comet appeared near the time of the great battle. Unfortunately, astronomy is not able and will never be able to say whether a comet appeared in 1198 BCE or a year nearby, unless of course some historical testimony is yet to be discovered, e. g. on cuneiform tablets. If such a comet was so extremely bright that it was visible even during the day, then it might well have been considered to be a "second sun".

Thus, it must be asked whether the second sun appearing at the end of the age is in reality a comet. The above-cited verses that deal with the second sun, are quite compatible with this interpretation. As are the verses about the death of Bhīṣma, which are quote again below:

> पश्य शांतनवं कृष्ण शयानं सूर्यवर्चसम्
>
> युगान्त इव कालेन पातितं सूर्यमम्बरात्
>
> *paśya śāṃtanavaṃ kṛṣṇa śayānaṃ sūryavarcasam*
> *yugānta iva kālena pātitaṃ sūryamambarāt (MBh 11.23.15)*

> See Bhīṣma, O Kṛṣṇa, who is lying there with the brightness of the Sun, like the Sun that is caused to fall from the sky by the [deity of] time at the end of the age.

चित्रचापमहाज्वालो वीरक्षयमहेन्धनः

युगान्ताग्निसमो भीष्मः परेषां समपद्यत

*citracāpamahājvālo vīrakṣayamahendhanaḥ*
*yugāntāgnisamo bhīṣmaḥ pareṣāṃ samapadyata (MBh 6.114(120).6)*

To his enemies, Bhīṣma appeared like the fire at the end of the age, that had a shining arc and great flames, that destroyed heroes and had great burning.

Is the "multi-coloured arc" not reminiscent of the tail of a comet? However, it could also refer to the solar corona during a total solar eclipse. In MBh 8.63(87).2ff., at least, the description of the battle between Arjuna and Karṇa, the "second Sun" is clearly the Moon approaching its new moon phase. It seems that the epic here mixes up different phenomena that may not have been easy to distinguish for ancient observers. The solar corona is not dissimilar to a comet's tail. Otherwise, it would have to be assumed that different traditions are combined throughout the text.

In analysing the text passage MBh 6.3.24-29, the following verse has been disregarded, which, as already stated, appears in two versions and is difficult to interpret. First the variant preferred by the critical edition (including its sub-variants) will be considered:

कृत्तिकासु ग्रहस्तीव्रो नक्षत्रे प्रथमे ज्वलन्

वपूंष्यपहरन्भासा धूमकेतुरिव स्थितः

(var. तासां) (var. अवस्थितः, उपस्थितः)

*kṛttikāsu grahastīvro nakṣatre prathame jvalan*
*vapūṃṣyapaharanbhāsā dhūmaketuriva sthitaḥ (26)*
(var. *tāsāṃ*) (var. *avasthitaḥ*, *upasthitaḥ*)

A (or: The) strong planet burned in the Kṛttikās, the first lunar mansion, and robbed them their beauty with his light, standing there like [the comet] Dhūmaketu (or: like the Sun).
*(var.:)* and robbed them their beauty, standing there like Dhūmaketu.
*(var.:)* and robbed them their beauty, he, Dhūmaketu, standing there.

At the outset, it is clear that the celestial object mentioned here is similar to a burning fire. It could very well be the comet Dhūmaketu, which was so bright and spectacular, that it outshone the Pleiades. However, the critical edition opts for the variant "*like* Dhūmaketu". If so, it does not seem to be the comet Dhūmaketu, but some other object that stood there "like a fire" (*dhūmaketur iva*). What could this object be?

Other than a bright comet, only the full moon is strong enough to "rob" the Kṛttikās of their light, and the Moon was the only celestial body that passed Kṛttikā during the month of the great conjunction. A near-full moon in Kṛttikā showed up in the night before the Kārttika full moon, i.e. in the night of 3rd/4th November 1198 BCE.

Some manuscripts contain the following text instead of the last verse:

> अशोभिता दिशः सर्वाः पांसुवर्षैः समन्ततः
>
> उत्पातमेघा रौद्राश्च रात्रौ वर्षन्ति शोणितम्
>
> कृत्तिकां पीदयंस्तीक्ष्णैर्नक्षत्रं पृथिवीपते
>
> अभीक्ष्णं वाता वायन्ते धूमकेतुमवस्थिताः
>
> विषमं वेदयन्त्येत आक्रन्दजननं महत्
>
> *aśobhitā diśaḥ sarvāḥ pāṃsuvarṣaiḥ samantataḥ*
> *utpātameghā raudrāśca rātrau varṣanti śoṇitam*
> *kṛttikāṃ pīdayaṃstīkṣṇairnakṣatraṃ pṛthivīpate*
> *abhīkṣṇaṃ vātā vāyante dhūmaketumavasthitāḥ*
> *viṣamaṃ vedayantyeta ākrandajananaṃ mahat (26)*

> All the [four] directions have no splendour, they have dirty rain all-around, unexpected clouds and tempests cause a rain of blood at night.
> They tormented the lunar mansion Kṛttikā with sharp weapons, O lord of the earth.
> Suddenly, winds blew, basing themselves on Dhūmaketu.
> They indicate disaster which will cause great woe.

Only the underlined words have a counterpart in the version quoted further above. The meaning is completely different, however quite interesting.

Here, the word *pīḍayan* is considered to be an imperfect without augment. Otherwise it would be a present participle in nominative case and singular number, but then the grammatical subject would be missing.

Again, it is not certain, what could be the meaning of *dhūmaketu*. Could it be a comet? Did the ancients believe that comets could cause tempests? Possibly. The Sun cannot be meant in any case, because it does not shine during the night.

Another verse, which has been discussed already and which in principle could refer to two comets, is the following:

ग्रहौ ताम्रारुणशिखौ प्रज्वलन्ताविव स्थितौ

सप्तर्षीणामुदाराणां समवच्छाद्य वै प्रभाम्

*grahau tāmrāruṇaśikhau prajvalantāviva sthitau*
*saptarṣīṇāmudārāṇāṃ samavacchādya vai prabhām (MBh 6.3.24)*

> The two planets (or: Two planets) with a copper-coloured crest (or: hair tuft) stood there burning, as it were,
> and hid the light of the exalted Seven Ṛṣis.

The "hair tuft" (*śikhā*, Greek *komē* = Latin *coma*) could indicate a comet's tail. However, this is uncertain, as has been shown. (p. 293ff.) There are good reasons to assume that it refers to the Sun and Moon (or Rāhu) and the solar corona.

Finally, the theories of N. Achar and M. Gupta must be discussed.[176] They believe that at the time of the great war there was a real armada of comets in the sky. While the epic does not expressly mention that there were that many comets (*ketavaḥ*) in the sky, Achar argues as follows: Two verses say that Saturn was in Rohiṇī, but according to another verse, Saturn was in Viśākhā. Since these statements contradict each other, Achar draws the conclusion that the "Saturn" (*śanaiścaraḥ*) which is in Viśākhā is actually a comet. Since some ancient Indian authors considered comets as sons of planets, Achar suggests that it must be a comet of the "Saturn family". In the same way he also regards other planets for which contradictory positions are given in the text. In addition, there are astronomical 12 objects that allegedly cannot be assigned to any planet due to their name or description.

It is obvious that in this way *every* contradiction in planetary positions could be eliminated, and *many different* planetary configurations could be considered to match the text. For example, instead of accepting *śanaiścara* in Rohiṇī as the planet Saturn and *śanaiścara* in Viśākhā as a comet, Achar could also have chosen the reverse solution. However, above all, Achar would have to answer the question why the Mahābhārata does not explicitly mention a

[176] Achar, *Date of the Mahābhārata War* (2014), p. 34ff.; Gupta, "The Date of the Mahābhārata War", p. 50f.

great number of comets (*ketavaḥ*) anywhere. At best, there are clues to a *single* comet that appears as a "second sun". However, as has been shown, that object is described in a way that it could alternatively be explained as a total solar eclipse. Besides that, there are only references to "meteors" (*ulkāḥ*), but that again is a very different phenomenon. Of course, it is not completely impossible that a whole swarm of comets appear in the sky. The comet Shoemaker-Levy 9, which broke apart and collided with Jupiter in the year 1994, is a nice example, although the event was observable only using a telescope. However, since this kind of event is *extremely* rare and the text does not explicitly mention a "swarm of comets", the possibility seems very unlikely.

Moreover, it must be objected that nowhere in ancient Indian literature the names of planets are used to denote comets. Although a comet of Jupiter's family might have been mentioned as a *bṛhaspatiputraḥ* or *bārhaspatyaḥ*, it would certainly never have been called by the name *bṛhaspatiḥ*. When Achar quotes the following verse:

> मघास्वङ्गारको वक्रः श्रवणे च बृहस्पतिः
>
> *maghāsvaṅgārako vakraḥ śravaṇe ca bṛhaspatiḥ*

| [Son of] Mars is retrograde in Maghā, and [son of] Jupiter in Śravaṇa. |
|---|

then this is just implausible.

Last but not least it must be noted, that the 12 names of comets that Achar extracts from the text do *not* appear in Varāhamihira's Bṛhatsaṃhitā, as claimed by Achar.[177]

## Eclipses in 3139 and 3138 BCE

On behalf of public interest some problems will be discussed that those scholars are confronted with who insist that the war must have taken place 36 years before the beginning of the *kaliyuga*, i.e. in 3139 or 3138 BCE.

---

[177] Achar, op. cit., p. 38. Achar refers to Ramakrishna Bhat's translated and commented edition of 1981. Chapter 11 on pp. 121ff. treats comets. Two lists of comets are given on pp. 146ff.

Let the eclipses in the autumn of 3139 BCE be considered first. The solar eclipse of 1st September did not take place in Jyeṣṭhā, as required by the epic, but about one and a half months too early, in the lunar mansion Citrā. The subsequent penumbral lunar eclipse of 15th September, however, occurred in the boundary region of Aśvinī and Bharaṇī. While it could be assigned to the month of Kārttika according to current methods of calendar making, ancient astronomers might have assigned it rather to the month of Āśvina. Another penumbral eclipse had occurred one month earlier already, on 16th August.

If no error in current estimations of ΔT is assumed, then the solar eclipse on 1st September 3139 BCE was observable after sunrise in partial phase (maximum magnitude 50% at 5:53 LMT). The lunar eclipse of 15th September was penumbral with a magnitude of 0.22 and took place in the early afternoon (maximum 13:36 LMT). There are several problems connected with this lunar eclipse:

– A lunar eclipse that occurs in the afternoon is below the horizon and is therefore not observable. This problem can be avoided only by adopting a sufficiently large error in the underlying estimation of ΔT. In the current case, one would have to move the moon's shadow by about 50° in geographic longitude. The estimated probability for an error in ΔT of this amount is approximately 20%. As a consequence, the solar eclipse would have been observable with a magnitude of 75%, not at sunrise, but during the morning.

– A penumbral lunar eclipse with a magnitude less than 0.6 cannot be seen in the night sky. When Sunil Bhattacharjya was contacted regarding this problem, he contacted the American eclipse expert Fred Espenak. Espenak said that a penumbral lunar eclipse of magnitude 0.22 may have been perceived *very subtly*, *if it had occurred in the evening, when the sky was still bright* and not in strong contrast with the lunar disc. (see footnote ??? above on p.¬ ???) In principle, this situation is possible here, but it is still very doubtful that such an extremely subtle eclipse would have been noticed.

Moreover, unlike claims by Bhattacharjya in Internet forums, this lunar eclipse did not take place on the 13th of the month, but clearly on the 14th. This problem has already been resolved on p.¬ ???.

Finally, this solution is not viable because according to the information given in the Mahābhārata, the lunar eclipse *preceded* the solar eclipse, and did not follow it as in the current case.

So, how about the other penumbral lunar eclipse, which had preceded the solar eclipse? It had taken place on the evening of 16th August (21:07 LMT) with a magnitude of 0.20, in a dark sky and therefore invisible. If one wanted to apply the above trick of correcting ΔT and move the eclipse to the early evening and a still bright sky, this is possible, of course. One would have to move the shadow by about 20° in geographic longitude. However, as a result of the same ΔT correction, the solar eclipse would become practically unobservable.

Was the situation any better in the year 3138 BCE? A partial solar eclipse could possibly have been observed on 21st August before sunset. However, this eclipse fell in the wrong month, namely in Bhādrapada or Āśvina, depending on the calendar used. The partial lunar eclipse two weeks earlier took place on 6th August before sunrise and was assigned to the month of Bhādrapada. Otherwise, there is no objection against these two eclipses.

The solar eclipse of 25th February 3138 BCE, which occurred exactly 36 lunar years before the Kaliyuga date, does not fit either. Its shadow was too far in the south and therefore could not be seen from India, no matter how much one wanted to manipulate ΔT. More interesting would have been the annular solar eclipse of 18th March 3140 BCE. There was a small probability of 1% that it could have been observed in Kurukṣetra, but it occurred 38, not 36, years before Kaliyuga. Besides, if it was observable from Kurukṣetra, then the subsequent lunar eclipse of 1st April was *not* visible from the same place.

In better agreement with the Mahābhārata is the eclipse pair of the year 3142 BCE. The partial lunar eclipse of 19th October took place in Rohiṇī and therefore could be assigned to the month of Kārttika. A fortnight later, there was a partial solar eclipse in Mūla, not very far from Jyeṣṭhā. However, here the time distance from Kaliyuga is 39½ years.

The lesson is clear: After datings of the war that are based on the *kaliyuga* date could not do justice to the criterion of the superconjunction, it now has become obvious that they cannot do justice to the criterion of the eclipses either.

# *Planetary Configurations*

## Jupiter and Saturn in Viśākhā

Let us continue with another astronomical description of celestial occurrences immediately preceding the battle:

ग्रहौ ताम्रारुणशिखौ प्रज्वलन्ताविव स्थितौ

सप्तर्षीणामुदाराणां समवच्छाद्य वै प्रभाम्

*grahau tāmrāruṇaśikhau prajvalantāviva sthitau*
*saptarṣīṇāmudārāṇāṃ samavacchādya vai prabhām (MBh 6.3.24)*

| |
|---|
| Two planets with a copper-coloured crown stood there burning, as it were,<br>and hid the light of the exalted Seven Ṛṣis. |

This verse was interpreted as a distorted recollection of the great conjunction, when all planets disappeared in the light of the Sun. (p. 293-295) The text continues:

संवत्सरस्थायिनौ च ग्रहौ प्रज्वलिताावुभौ

विशाखयोः समीपस्थौ बृहस्पतिशनैश्चरौ

*saṃvatsarasthāyinau ca grahau prajvalitāvubhau*
*viśākhayoḥ samīpasthau bṛhaspatiśanaiścarau (25)*

| |
|---|
| The two burning planets, Jupiter and Saturn, stay for one year standing in the vicinity of the Viśākhā [stars]. |

In this verse, it is generally understood that Saturn and Jupiter remained *stationary* in the *nakṣatra* Viśākhā. However, this is astronomically impossible, and it is not exactly what is depicted in the verse. A planetary station is not referred to whatsoever. As Jupiter and Saturn are the two slowest planets, it is quite possible that they spent a year in the vicinity of the star Viśākhā, depending on how the word "vicinity" is to be interpreted. Daftari translates the verse as follows:

| |
|---|
| Both the Jupiter and the Saturn, the planets that stay for a year or years (in one Rāśi or constellation), being effulgent stand near the Viśākhā. |

Indeed, Saturn stays within a *nakṣatra* for about a year, and Jupiter within a zodiac sign (*rāśiḥ*) for about a year.[178]

This verse presents quite a conundrum to the traditional as it is in contradiction to two other passages that seem to locate Saturn in Rohiṇī. In order to avoid this contradiction, some authors assume that the names *Bṛhaspati* and *Śanaiścara* here do not denote Jupiter and Saturn, but are actually names of comets.[179] As has been illustrated, this explanation lacks any common sense, particularly since the same names were used for the planets only a couple of verses prior. This is a feeble attempt to justify any contradictions in the sacred text. In reality, *Bṛhaspati* and *Śanaiścara* are the names usually given for Jupiter and Saturn throughout the Mahābhārata.

According to the verse referenced above, Saturn and Jupiter were in the lunar mansion Viśākhā. This is quite interesting, especially if considering the evidence that the battle occurred during a super-conjunction of all planets. The super-conjunction thus, must have taken place near Viśākhā. And this conclusion is in perfect agreement with the condition that at the time of the super-conjunction a new moon took place in Jyeṣṭhā and a full moon took place that was assigned to the month of Kārttika. Also, it is in complete agreement with the super-conjunction of 1198 BCE. The two planets indeed were in conjunction in Viśākhā during both their heliacal setting and rising in September and October, 1198 BCE. This is exemplary confirmation that the epic was referring to the celestial configuration of that year.

The next verse (MBh 6.3.26) can be found in two versions and is difficult to interpret. It seems hopelessly corrupt. It has been discussed previously on p. 299ff.

After that, the text continues as follows:

---

[178] Daftari, *The Astronomical Method ...*, p. 27.

[179] M. Gupta, "The Date of Mahābhārata War", in: Shastri, A. M. (ed.), *Mahābhārata*, 2004, p. 51; Achar, "Date of the Mahābhārata War based on Simulations using Planetarium Software", p. 18.

त्रिषु पूर्वेषु सर्वेषु नक्षत्रेषु विशां पते

बुधः संपततेऽभीक्ष्णं जनयन्सुमहद्भयम्

*triṣu pūrveṣu sarveṣu nakṣatreṣu viśāṃ pate*
*budhaḥ saṃpatate'bhīkṣṇaṃ janayansumahadbhayam (27)*

Among the three foremost planets (*nakṣatra!*), O ruler of the people, Mercury hastily comes flying (to join them) and produces great danger/ fear.

The verb *sampatate*, which is translated as "he comes flying (to join them)", was also used in verse MBh 6.17.2 where all planets "flew together" (*sampetuḥ*) to form a super-conjunction. The intended meaning could be the following: At the end of October, 1198 BCE, Jupiter, Saturn, and Mercury appeared as the first planets in quick succession in the morning sky, Jupiter on 25th, Mercury and Saturn on the 30th, Venus appeared only on 3rd November, Mars in early December. Mercury formed a very narrow conjunction with Jupiter and Saturn on 4th November, which was also the day of the lunar eclipse of the month of Kārttika. Again, this verse seems to confirm the year of war accepted by this study as it mentions Mercury as the third planet to appear in the morning sky.

Alternatively, the verse could also be translated as follows:

त्रिषु पूर्वेषु सर्वेषु नक्षत्रेषु विशां पते

बुधः संपततेऽभीक्ष्णं जनयन्सुमहद्भयम्

*triṣu pūrveṣu sarveṣu nakṣatreṣu viśāṃ pate*
*budhaḥ saṃpatate'bhīkṣṇaṃ janayansumahadbhayam (27)*

Mercury produces great danger/fear by repeatedly flying together with the three foremost planets (*nakṣatra*!), O ruler of the people.

The third planet that appeared after Jupiter and Saturn was Mercury, the fourth was Venus. Mercury made conjunctions with both Jupiter and Saturn on 30th October, and again on 4th November, and with Venus on 11th November. The conjunction with Mars on 25th/26th November was difficult to observe.

The text continues with the following verses, which have already been discussed in the last chapter:

चतुर्दशीं पञ्चदशीं भूतपूर्वां च षोडशीम्

इमां तु नाभिजानामि अमावास्यां त्रयोदशीम्

*caturdaśīṃ pañcadaśīṃ bhūtapūrvāṃ ca ṣoḍaśīm*
*imāṃ tu nābhijānāmi amāvāsyāṃ trayodaśīm (MBh.6.3.28)*

| |
|---|
| [New moons] on the 14th, 15th or 16th there have been before.<br>But this new moon on the 13th day I do not know. |

चन्द्रसूर्यावुभौ ग्रस्तावेकमासे त्रयोदशीम्

अपर्वणि ग्रहावेतौ प्रजाः संक्षपयिष्यतः

*candrasūryāvubhau grastāvekamāse trayodaśīm*
*aparvaṇi grahāvetau prajāḥ saṃkṣapayiṣyataḥ (29)*

| |
|---|
| Both the Moon and the Sun were eclipsed (swallowed) in one and the same month on the 13th [of the fortnight],<br>on a wrong date: these two eclipses (or: planets)[180] will destroy the creatures. |

In the month the war began, both a solar and a lunar eclipse took place, each of them too early according to the calendrical calculations available at the time. As has been stated, two eclipses within a month also applies to the planetary gathering of the year 1198 BCE. On 21st October, a solar eclipse occurred that was observable from Kurukṣetra, reaching a magnitude of 87%. A fortnight later, on 4th November, a partial lunar eclipse with a magnitude of 70% could be observed, also from Kurukṣetra.

To recapitulate the conclusions until now, the text mentions the following celestial events:

– There was a super-conjunction of all planets.
– Jupiter and Saturn were the first to rise heliacally in Viśākhā
– Mercury was the third one to rise heliacally
– Within a month a solar and a lunar eclipse was observed.
– The lunar eclipse occurred in the twilight.
– The solar eclipse occurred at sunrise.

It is extremely plausible that these observations are referring to the configuration in the year 1198 BCE and the total solar eclipse at sunrise in the year 1187 BCE.[181] Diagrams of the configurations described here, can be found on p. 242-255.

---

[180] *grahau*. See footnote 121, p. 220.

[181] Daftari tries to further substantiate this result citing three other places in the epic where eclipses are mentioned. Unfortunately, these points are disagreeable:→

## Saturn and Jupiter torment Rohiṇī

In a passage that has been examined in the context of the super-conjunction, the following elucidating verse can be found:

रोहिणीं पीडयन्नेष स्थितो राजञ्छनैश्चरः

व्यावृत्तं लक्ष्म सोमस्य भविष्यति महद्भयम्

*rohiṇīṃ pīḍayanneṣa sthito rājañchanaiścaraḥ*
*vyāvṛttaṃ lakṣma somasya bhaviṣyati mahadbhayam (MBh 6.2.32)*

| |
|---|
| Saturn's position tormented Rohiṇī, O king.<br>The [hare] sign of the Moon had disappeared. There will be great danger/fear. |

Here interest lies primarily in the position of Saturn, which affects Rohiṇī in a "tormenting" way. This statement is generally understood to mean that Saturn is located in the *nakṣatra* Rohiṇī. However, if this were Saturn's position during a super-conjunction of

1) After the war, Gāndhārī, the mother of the Kauravas, had cursed Kṛṣṇa because in her opinion he had caused or been conducive to this war between relatives. She had prophesied to him that his own people, the Yādavas, would fight each other and be completely destroyed 36 years later. (MBh 11.25.40-42) This event allegedly also coincided with a "solar eclipse at the wrong time". (MBh 16.3.16-18) For reasons unknown, Daftari reckons these 36 years not from the end of the war, but from the exile of the Pāṇḍavas, which had occurred 13 years earlier. He finds that in 1176 v. BCE there was a partial solar eclipse observable from Dvārakā, followed by a partial lunar eclipse. However, if 36 years are counted from the year of the war, the year 1162 BCE will be found. Unfortunately, there was no solar eclipse in that year, only two lunar eclipses. In the opinion of this study, this is not a serious problem. The evidence for the year 1198 BCE is already very strong. Not all information given in the epic is correct. A partial solar eclipse occurred in 1164 BCE. (Daftari, op. cit., pp. 45ff.) →

2) A "solar eclipse at the wrong time" is also mentioned for the time of the dice game 13 years before the war, which had resulted into the exile of the Pāṇḍavas. Although an observable 30% solar eclipse did occur in 1211 BCE, this does not offer strong enough support for the given eclipse date because partial eclipses occur quite often for a given geographic location. (Daftari, op. cit., pp. 47f.) →

3) In the Harivaṃśa there is a description of the celestial configuration at the time when Kṛṣṇa killed Kaṃsa. Daftari calculates that this must have happened on 10th May 1237 BCE. He even gives the correct positions of the Sun, Mars, and Venus, but errs in that he calculates a solar eclipse for that date. Unfortunately, Daftari had no computer available in 1940, which would have probably helped him to avoid such errors. (Daftari, op. cit., pp. 48ff.)

all the planets, then this super-conjunction would have had to take place in Rohiṇī. Yet, the same text passage mentions a full moon in the month Kārttika (MBh 6.2.23). As this full moon would have had to take place either in Kṛttikā or in Rohiṇī, the Sun would have been about 180° away from Rohiṇī. It can thus be excluded that Saturn and the other planets form a conjunction in Rohiṇī.

Another verse (MBh 5.141.7) where Saturn "torments" Rohiṇī will be studied in the next chapter.

An interesting explanation of planetary "tormenting" is given by P.V. Holay.[182] He interprets the verse in the sense that Rohiṇī (Aldebaran) is standing above the western horizon shortly before sunrise, day after day losing a bit of her altitude and brightness, while Saturn has his heliacal rising and becomes brighter and brighter day by day. When this happens, Saturn may well stand in Viśākhā, as was the case of the super-conjunction of 1198 BCE.

Although Jupiter was standing quite close to Saturn, the text does not mention Jupiter. The reason for this may simply be that at the time of Saturn's heliacal rising on 30th October, Rohiṇī had already become more indistinctive than it was during Jupiter's heliacal rising five days earlier. However, another passage mentions that Jupiter also "tormented" Rohiṇī. On the day of Karna's death, the 12th day of the battle, the text states:

> बृहस्पती रोहिणीं संप्रपीड्य बभूव चन्द्रार्कसमानवर्णः
>
> *bṛhaspatī rohiṇīṃ saṃprapīḍya babhūva candrārkasamānavarṇaḥ (MBh 8.68(94).49cd)*

| |
|---|
| Jupiter tormented Rohiṇī and his colour became similar to the Moon and the Sun. |

This verse could be referring to a heliacal rising of Jupiter, while Rohiṇī was evanescing in the western sky. It is also interesting that there is a text variant using the word *saṃparivārya* ("hiding") rather than *samprapīḍya* ("tormenting"). This can be taken as confirmation that the term "torment" in the astrology of those times indeed meant that a celestial body took away another's light and forced it to set.

---

[182] Holay, V. P., "The Year of Kaurava-Pāṇḍava War", p. 64.

Doubt about this interpretation of the term *pīḍ-*, "to torment", may arise from the following passage, considering Ganguli's translation first:

भाग्यं नक्षत्रमाक्रम्य सूर्यपुत्रेण पीड्यते

शुक्रः प्रोष्ठपदे पूर्वे समारुह्य विशां पते

उत्तरे तु परिक्रम्य सहितः प्रत्युदीक्षते

*bhāgyaṃ nakṣatramākramya sūryaputreṇa pīḍyate*
*śukraḥ proṣṭhapade pūrve samāruhya viśāṃ pate*
*uttare tu parikramya sahitaḥ pratyudīkṣate (MBh 6.3.14)*

> The Sun's offspring (Sani) (= Saturn; D.K.) approaching towards the constellation Bhaga (= Uttarphalgunī; D.K.), afflicteth (*pīd-* = "tormented"; D.K.) it.
> The planet Sukra (= Venus; D.K.), ascending towards Purva Bhadra, shineth brilliantly,
> and wheeling towards the Uttara Bhadra, looketh towards it, having effected a junction (with a smaller planet). (translation by Ganguli[183])

Does Saturn "torment" a lunar mansion simply by the mere fact that it *enters* it? But it seems unnatural that *nakṣatram* should be at the same time the direct object of *ākramya* and the subject of *pīḍyate*. Furthermore, the expression "shineth brillantly" in Ganguli's translation is not given in the Sanskrit text. A better sense might be arrived at and justice done to the grammar using the following translation:

भाग्यं नक्षत्रमाक्रम्य सूर्यपुत्रेण पीड्यते

शुक्रः प्रोष्ठपदे पूर्वे समारुह्य विशां पते

उत्तरे तु परिक्रम्य सहितः प्रत्युदीक्षते

*bhāgyaṃ nakṣatramākramya sūryaputreṇa pīḍyate*
*śukraḥ proṣṭhapade pūrve samāruhya viśāṃ pate*
*uttare tu parikramya sahitaḥ pratyudīkṣate (MBh 6.3.14)*

> Venus, having entered Pūrvabhādrā, O ruler of the people,
> is tormented by Saturn, who has entered the lunar mansion Uttaraphalgunī,
> But after [Venus] has gone round in Uttarabhādrā, she shines forth together [with that *nakṣatra* (? or with the Sun?)].

Following this translation, Venus in Pūrvabhādrā is "tormented" by Saturn, who is roughly in opposition to her in Uttaraphalgunī. She approaches her heliacal setting, becomes retrograde in Uttarabhādrā, and then rises "together", i.e. either together with the same

183 http://www.sacred-texts.com/hin/m06/m06003.htm

*nakṣatra* or together with the Sun, and that means that she rises heliacally. If this interpretation is correct, then Venus' "being tormented" is her heliacal setting. Saturn, who is found in near opposition, is her "tormentor", rising about simultaneously with her setting. However, shortly thereafter she makes her heliacal rising and – as it seems – overcomes the "torture".

Incidentally, this verse is not compatible with the year 1198 BCE, where Venus rose on 3rd November in Anurādhā. The passage which it is taken from will be examined later.

Another verse concerning planetary "torment" reads as follows:

> तेऽपीडयन्भीमसेनं क्रुद्धाः सप्त महारथाः
>
> प्रजासंहरणे राजन्सोमं सप्त ग्रहा इव
>
> *te'pīḍayanbhīmasenaṃ kruddhāḥ sapta mahārathāḥ*
> *prajāsaṃharaṇe rājansomaṃ sapta grahā iva (MBh 7.112(136).22; vgl. 6.96(101).36; HV 3.55.68)*

> These seven angry great warriors tormented Bhīma,
> like the seven planets [torment] the Moon at [the time of] the destruction of the creation.

In this verse, the "torment" could be interpreted as the disappearance of the old moon, which is a kind of "heliacal setting". All the planets, after their heliacal reappearance, are in conjunction with the last crescent of the waning moon above the eastern horizon. The Moon appears for the last time before the new moon. To put it briefly: The planets have appeared, the Moon disappears.

The interpretation of planetary "tormenting" as "the forcing of a celestial body to disappear or set" apparently proves to be good. As well, the statements made by the epic that Saturn and Jupiter are tormenting Rohiṇī are apparently compatible with 1198 BCE as the year of the battle.

## Mars in Jyeṣṭhā/Anurādhā

Shortly after the mention of the new moon in Jyeṣṭhā the celestial configuration at the beginning of the battle is described as follows (MBh 5.141(143)):

प्राजापत्यं हि नक्षत्रं ग्रहस्तीक्ष्णो महाद्युतिः

शनैश्चरः पीडयति पीडयन्प्राणिनोऽधिकम्

*prājāpatyaṃ hi nakṣatraṃ grahastīkṣṇo mahādyutiḥ*
*śanaiścaraḥ pīḍayati pīḍayanprāṇino 'dhikam (MBh 5.141.7)*

Saturn, the stinging planet with great splendour, torments [Rohiṇī], the lunar mansion that is [ruled] by Prajāpati, [at the same time] exceedingly tormenting the living beings.

कृत्वा चाङ्गारको वक्रं ज्येष्ठायां मधुसूदन

अनुराधां प्रार्थयते मैत्रं संशमयन्निव

*kṛtvā cāṅgārako vakraṃ jyeṣṭhāyāṃ madhusūdana*
*anurādhāṃ prārthayate maitraṃ saṃśamayanniva (8)*

And Mars, O Kṛṣṇa, after having made a turn in Jyeṣṭhā,
runs towards Anurādhā in order to end friendships, as it were.

Following the common understanding of planetary "torment" and assuming Saturn was in Rohiṇī, this description is not compatible with a conjunction of all planets. For Saturn in Rohiṇī and Mars in Jyeṣṭhā and Anurādhā are too far apart. As has been shown, only Holay's interpretation of planetary "torment" can help here. He says that Saturn has his heliacal rising in the morning before sunrise, while Rohiṇī is sinking to the horizon in the western sky and loses her light due to what is referred to as atmospheric extinction. It follows that Saturn is located near or in Viśākhā and the Sun is located in Jyeṣṭhā or Anurādhā. This is exactly the configuration during the new moon near Anurādhā/Jyeṣṭhā in 1198 BCE. *Mars in Anurādhā, as mentioned in the text, meets the requirements as well, as this was exactly the position of Mars during the super-conjunction. The year 1198 BCE again suffices extremely well with this criterion.*

Withal, there remains an irreconcilable problem with Mars' retrograde motion. The text clearly states that Mars became retrograde in

Jyeṣṭhā and moved back towards Anurādhā, the preceding lunar mansion. The new moon in Jyeṣṭhā means that the Sun is also in the same vicinity of the sky. Yet for Mars to become stationary and retrograde in Jyeṣṭhā, he must be about 140° away from the Sun. It follows that the Sun would have to be in one of two lunar mansions, namely Aśvinī or Bharaṇī in order for Mars to become stationary. Otherwise, if the Sun stands in Anurādhā or Jyeṣṭhā and Mars is close by, his motion must be direct. One of the two statements – either the new moon in Jyeṣṭhā or Mars stationary retrograde in Jyeṣṭhā – must be false. Either the new moon does not occur in Jyeṣṭhā or Mars is not retrograde in this *nakṣatra*. It need not be explained that for similar reasons, a full moon in Kṛttikā is not compatible with this description as well. Taking all this into account it is clear that *although the position of Mars in Anurādhā fits perfectly with the year 1198 BCE, his alleged retrogression is not possible.*

It could be stated that virtually all authors on the subject accept that the war started either during a new moon in Jyeṣṭhā or during a full moon in the month of Kārttika. Consequently, none of them assume a retrograde Mars in Jyeṣṭhā or Anurādhā during the war. At best, it could be considered that Mars was retrograde in those nakṣatras *earlier* in the same year. Yet in the year 1198 BCE, this was not the case. It may be interesting, however, that Mars became stationary retrograde in Jyeṣṭhā on 30th April 1188 BCE, the year before the spectacular solar eclipse that occurred at sunrise.[184] Maybe it was this celestial event that was noted in relation to the war.

In any case, the alleged retrogression of Mars is not a serious problem for the favoured year 1198 BCE. The error is clearly in the text which asserts what is astronomically impossible. It is very possible that a retrograde Mars wrongly got into the text. In fact, retrograde Mars often appears in accounts of inauspicious celestial omens.[185] It seems that the retrogression of Mars was a literary topos that was regularly used in poetic descriptions of disastrous celestial configurations.

---

[184] The last time that Mars had become retrograde in Jyeṣṭhā was on 20 March 1220 BCE.

[185] MBh 8.14.1; 6.3.13; HV 2.23.25; 2.116.66.

Daftari's solution that in this verse *aṅgārakaḥ* could denote Venus rather than Mars is quite alluring, as only Venus can be retrograde near the Sun.[186] In fact, Venus became retrograde during the superconjunction on 8th October, 6° after the star Jyeṣṭhā (Antares), and direct again on 18th November near the star Anurādhā (Dschubba). It is very unlikely that *aṅgārakaḥ* denotes Venus, because in the verses MBh 6.3.13-14, which will be discussed later, *śukraḥ* and *aṅgārakaḥ* occur next to each other and are located in different *nakṣatras*. Since Venus has to be *śukraḥ* and all the other planets are already mentioned in the context, the only remaining candidate for *aṅgārakaḥ* is Mars. Still, it is not impossible that in the verse under discussion Venus was confounded with Mars.

Unfortunately, the next verse is also problematic:

नूनं महद्भयं कृष्ण कुरूणां समुपस्थितम्

विशेषेण हि वार्ष्णेय चित्रां पीडयते ग्रहः

*nūnaṃ mahadbhayaṃ kṛṣṇa kurūṇāṃ samupasthitam*
*viśeṣeṇa hi vārṣṇeya citrāṃ pīḍayate grahaḥ (9)*

Now, O Kṛṣṇa, great danger emerged for the Kurus,
for, O son of Vṛṣṇi, a planet exceedingly torments the [*nakṣatra*] Citrā.

This statement is inconsistent with a planetary gathering near a Jyeṣṭhā new moon or a Kārttika full moon, no matter whether Holay's interpretation of planetary "torment" is accepted or its common understanding as a conjunction. However, it is very strange that the verse apparently does not know *which planet it was* that tormented Citrā. All other verses that have been discussed referred to the planets by their name. Thus the question arises whether the author of this verse knows what he is talking about at all and whether the verse is authentic whatsoever. There may be no other option but to disregard it.

The following verse continues without problem:

सोमस्य लक्ष्म व्यावृत्तं राहुरर्कमुपेष्यति

दिवश्चोल्काः पतन्त्येताः सनिर्घाताः सकम्पनाः

*somasya lakṣma vyāvṛttaṃ rāhurarkamupeṣyati*
*divaścolkāḥ patantyetāḥ sanirghātāḥ sakampanāḥ (10)*

The [hare] sign of the moon has disappeared. Rāhu is approaching the Sun.
These meteors fall from the sky with noise and earthquake.

[186] Daftari, *The Astronomical Method ...*, p. 60.

If Rāhu, the lunar node, approaches the Sun, then a solar eclipse or a lunar eclipse, or both, are likely to occur.

Considering all this it may be concluded that the passage under examination, although not without problems, is still in agreement with 1198 BCE as the year of war.

## Alternative Approaches I

To obdurate it can be demanded that Mars must have been retrograde in Jyeṣṭhā/Anurādhā and that another planet "tormented" Citrā. However, this would only cause new problems, and considerably more difficult ones.

If it can be accepted that Mars was retrograde, it has to be dismissed that a new moon was occurring in Jyeṣṭhā or a Kārttika full moon occurred at the same time. As has been stated, at the moment of Mars' first station, the Sun must have been situated in Aśvinī or Bharaṇī. If Rāhu approached the Sun, then the lunar eclipse had to take place in Citrā, Svāti, or Viśākhā, and the following solar eclipse in Bharaṇī or Kṛttikā.

What planet could then be "tormenting" Citrā? According to the contemporary interpretation of "tormenting", the said planet would have to occupy Citrā. If the Sun was in Aśvinī or Bharaṇī, it could only be Jupiter, because Mercury's and Venus' maximum elongations are too small for them to fall into Citrā. Rāhu is out of the question, because according to the subsequent verse he must have been "approaching" the Sun. Other than Jupiter, only Ketu or the Moon or the lunar eclipse could be connoted. The latter must have taken place in Citrā or one of the two subsequent lunar mansions. Otherwise, could it be referring to the fast-moving Moon? If Ketu is taken into consideration, it is important to reiterate, that Ketu did not yet represent the descending lunar node in Mahābhārata, but a comet.

A different solution is found if Holay's definition of planetary "torment" is chosen. As the Sun was in Aśvinī or Bharaṇī, a planet in Revatī, possibly Mercury, Venus, or Jupiter, could have been heliacally rising and "tormenting" the star Citrā which was sinking in the western horizon at the same time. Alternately it could have been the last crescent of the old moon. Rāhu, at least, must be ruled out as he is said to be approaching the Sun in the subsequent verse. What solution can be given for Saturn "tormenting" Rohiṇī? With the given position of the Sun, he could not heliacally rise in Viśākhā. Could he have been "tormenting" Rohiṇī in a different way? He could have made his evening rising (acronychal rising) in Viśākhā and forced Rohiṇī, who was in opposition, to heliacally set.

Using the conventional understanding of "tormenting", the following configuration results:

– Saturn in Rohiṇī
– Mars becomes retrograde in Jyeṣṭhā (Anurādhā)
– Sun in Aśvinī or Bharaṇī
– a lunar and a solar eclipse,
  however not in the month of Kārttika!
– either Jupiter or the lunar eclipse in Citrā

This configuration is potentially historical. The period from 3500 BCE to the year 0 was scored by computer and only one suitable date that fits the conditions adequately well has been found, being 11th April, 415 BCE. The conditions for Mars and Saturn are satisfied. There was a solar eclipse, but invisible from India, because it occurred shortly after midnight. Jupiter stood near Citrā in Svāti. The 20% lunar eclipse of 26th March took place in Citrā, but was also not observable from India.

If the station of Mars in Jyeṣṭhā is taken into consideration with a new moon in Jyeṣṭhā (or a Kārttika full moon), the condition that the station of Mars occurred around the same date must be dismissed, permitting that it did occur in the course of the same year. It will be assumed then, that the solar eclipse took place during the Jyeṣṭhā new moon. The planet which occupied Citrā cannot be determined, however, at least not before a suitable date from the other information can be found. The following configuration results:

– Saturn in Rohiṇī
– retrograde Mars in Jyeṣṭhā (Anurādhā) in the same year
– new moon in Jyeṣṭhā and/or Kārttika full moon,
  Rāhu causes a lunar and a solar eclipse
– an unidentified planet in Citrā

A real configuration that satisfies these conditions cannot be found in the period from 3500 BCE to the year 0.

If Holay's understanding of planetary "tormenting", the following configuration is arrived at:

– retrograde Mars in Jyeṣṭhā (Anurādhā)
– Sun in Aśvinī or Bharaṇī
– Saturn in acronychal rising in Viśākhā "torments" Rohiṇī, who is heliacally setting
– Jupiter, Mercury, or Venus, heliacally rise in Revatī and "torments" Citrā at her acronychal setting (morning setting)
– Rāhu causes a lunar and a solar eclipse

This configuration cannot be found within the specified period. If the eclipse conditions are dismissed, several dates can be found.

Some authors who tried to date the great war based on this text passage started out primarily from the statement that within two weeks both a lunar and solar eclipses occurred. However, eclipses with their apocalyptic connotations are not really the most credible element in this text. They might have been invented by the author to intensify the apocalyptic atmosphere. Saturn "tormenting" Rohiṇī or retrograde Mars in Jyeṣṭhā / Anurādhā are much more likely to be accurate. Unfortunately, however, these two statements are incompatible with other statements throughout the text.

R.N. Iyengar dates the configuration to the year 1478 BCE.[187] He ignores the evidences for a super-conjunction. Instead he chooses the following approach: He considers it plausible that in the year of the war a solar and a lunar eclipse occurred within 15 days, both observable from Kurukṣetra. Moreover he accepts the information that Saturn was in the vicinity of Aldebaran (Rohiṇī). He first lists all years that fulfil these two conditions. Then he states that according to the epic, another solar eclipse happened 36 years after the war, when Kṛṣṇa's city Dvārakā was about to be swallowed by the ocean. Furthermore, it is stated that a solar eclipse also happened 13 years before the war, when the Pāṇḍavas were banned from their kingdom. Using this information, Iyengar further reduces the number of possible years of war. Finally, he finds that out of all the remaining years, only the year 1478 BCE fits with the condition that Mars was in Anurādhā and Jyeṣṭhā, and he concludes that the verses under discussion refer to the waning half-moon in the month

---

[187] Iyengar, "Internal Consistency of Eclipses and Planetary Positions in Mahābhārata", p. 97ff.

of Kārttika, which occurred on the 20 September 1478 BCE. The nameless planet in the lunar mansion Citrā he identifies as Mercury.

While the configuration of this day might be closest to the conditions set by Iyengar himself, they do not fit the text particularly well, considering the following points:

– Iyengar ignores all passages that indicate that the war took place during a super-conjunction.

– The eclipses in the year of war proposed by him did not occur in the month of Kārttika but five months too early in the region of Ārdrā und Punarvasu: the lunar eclipse on 16th May (total) and the solar eclipse on 1st June (partial, 37%). Iyengar is well aware of this situation, but he believes that the verse concerning the Kārttika full moon does not necessarily indicate a lunar eclipse and that the eclipses could have taken place in a different month. Still, it can be objected that the text gives us the impression that the eclipses occurred just before the great battle, which took place near a Kārttika full moon in October or November.

– The sojourn of Mars in Anurādhā and Jyeṣṭhā, which is mentioned in the immediate context of the eclipses did not take place during the time of the eclipses but in September and October, shortly before the battle.

– Mars was not retrograde, but in direct motion. Retrograde phases of Mars occurred in 1479 BCE in Āśleṣā and Puṣya as well as in 1477 BCE in Uttara- and Pūrvaphalgunī. Iyengar believes that the retrogression of Mars mentioned by the text is “inaccurate” or “poetic fancy”. In fact, he might be right in this because retrograde Mars was a common topos in descriptions of inauspicious celestial omens. However, if so, then the information on Mars is not a strong criterion for the dating of the war.

– Saturn was not in Rohiṇī in 1478 BCE, as claimed by Iyengar, but in Aśvinī and Bharaṇī. This is proven even by the sky map that Iyengar himself gives for 20th September. Saturn reached Rohiṇī only two years later.

– Mercury was not in Citrā on 20th September, but in exact conjunction with the star Hasta. This is also proven by the sky map provided by Iyengar.

Considering all these critical points, it seems Iyengar's solution is unacceptable. Of course, it is impossible to do full justice to the text, considering all its problems and contradictions. It seems that Iyengar is too "generous" when deciding whether or not the conditions set by himself are fulfilled.[188]

Completely untenable, are the solutions given by Raghavan and Achar, who date the battle to the year 3067 BCE, based on the same textual evidence and assuming a double eclipse.[189] The solar eclipse on 14th October 3067 BCE took place after sunset and was not observable from Kuruksetra.[190] The small uncertainty in the lunar ephemeris cannot help this eclipse either.[191] The two lunar eclipses on 29th September and 28th October were only penumbral with magnitudes of 0.10 and 0.27, and therefore not perceivable to the human eye. A minimum magnitude of 0.6 is required for penumbral eclipses to be perceivable.[192] As well, the condition for Mars is not properly met. *It is not true* that in that year Mars made a turn in Jyeṣṭhā (Antares) and moved towards Anurādhā in retrograde motion, as the text demands. Mars already became retrograde in February of the same year, *before* reaching Anurādhā, in the lunar mansion Viśākhā.[193] Saturn however was indeed located in Rohiṇī.

---

[188] The same "generosity" also manifests itself where Iyengar tries to explain why the epic in one place locates Saturn in Rohiṇī and in another place in conjunction with Jupiter in Viśākhā. He believes that the latter position does not refer to the year of the war but to the beginning of the exile of the Pāṇḍavas, i.e. to the solar eclipse date of 19th March 1493 BCE, and was erroneously moved to a wrong place in the epic. However, Jupiter was not in conjunction with Saturn, as it should have been, but far away from Viśākhā in the region of Mūla.

[189] Achar, *Reclaiming the Chronology of Bharatam*; Raghavan, *The date of the Mahabharata and the Kali Yugadhi*.

[190] See this author's explanations on p. 268, foot note 145.

[191] See this author's explanations on p. 268, foot note 146.

[192] http://eclipse.gsfc.nasa.gov/LEcat5/figure.html

[193] On 29th January 2013, in a public discussion by e-mail, Achar explained his acceptance of such an ill-placed Mars as follows: "Next step was to look for those years in which Mars was retrograde between Jyeshtha and Anuuraadha. ... So it was necessary to look for Mars in opposition at a point in between Jyeshtha and Anuuraadha. This was found to be too restrictive. It was felt that a range from Vishakha to Muula should be considered for Mars rather than just Anuuraadha-Jyeshtha alone. The choice was based on the analogy of the Moon, for the Full Moon is also an 'opposition' and Kartika Pornima is not just full moon at Kartika

Finally, all the eclipses that took place 36 years after the war announcing the downfall of the Yādavas – in October and November 3031 BCE according to Raghavan and Achar – were locally invisible.[194]

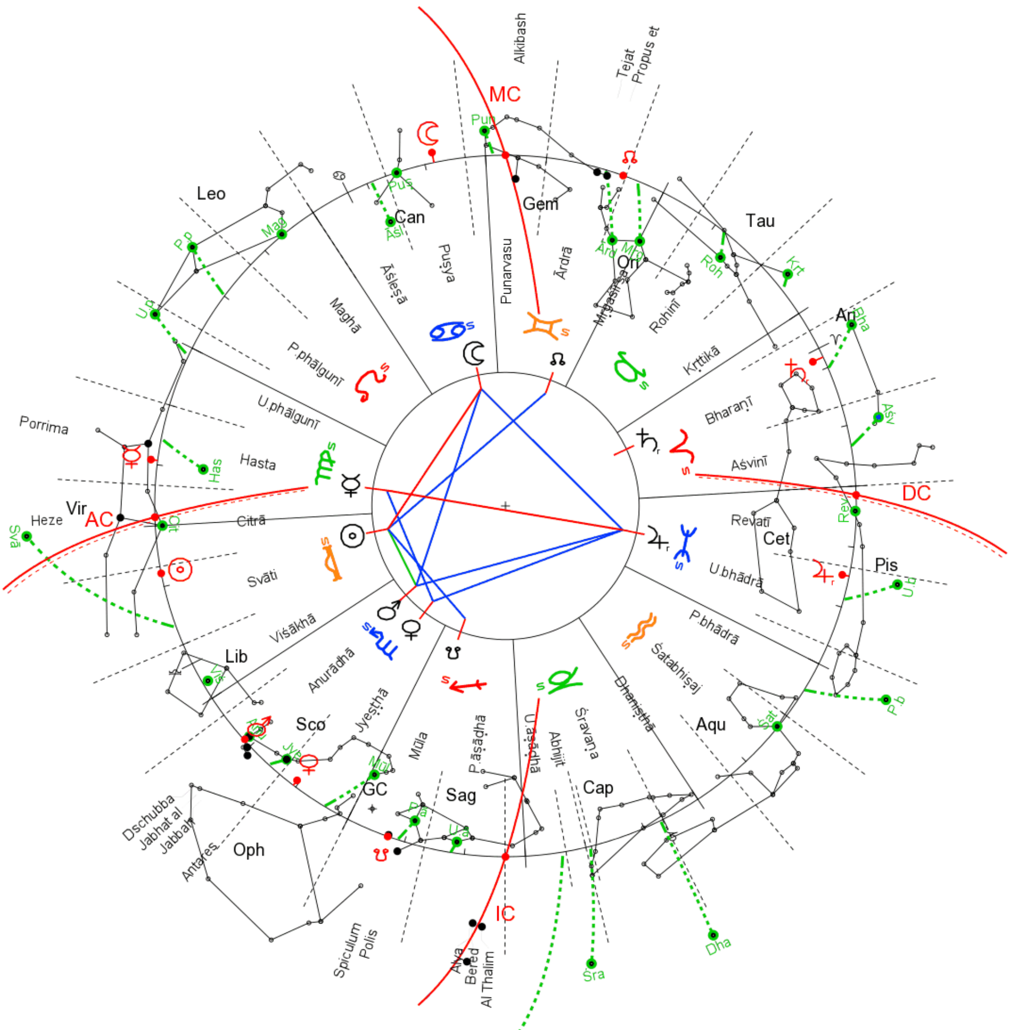
To sum it up, all the solutions discussed above are a lot more problematic and a lot less agreeable with the text than the solution outlined in this work. The only points that have been dismissed so far are the retrogression of Mars and the unidentified planet that "torments" Citrā. Everything else seems to fit very well.

---

alone, but can occur in a range from Bharani to Rohini." Now, while it may have been difficult to determine the date of full moon exactly and tell the lunar mention in which it occurred, the position of Mars could be observed directly. As the two stars Jyeṣṭhā and Anurādhā are only about 7° from each other in ecliptic longitude, the position of Mars is very well-defined. Mars in Viśākhā just does not fit the text.

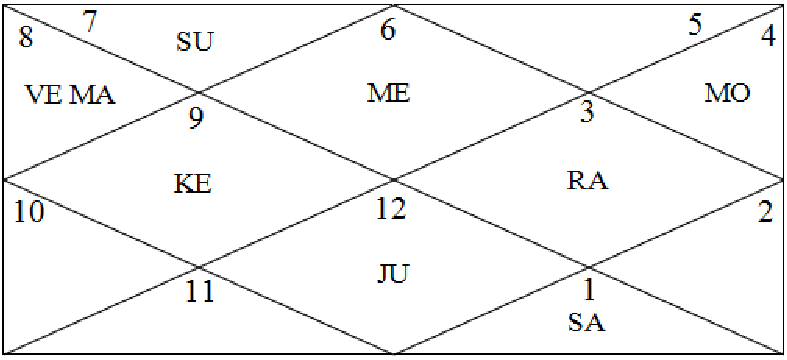
In his publication of 2014, Achar does not do justice to the verse either. According to him, the text requires a "retrograde motion of aṅgāraka (= Mars, DK) just before reaching jyeṣṭhā". (Achar, *Date of the Mahabharata War* (2014), p. 40) But this is a wrong interpretation. The text says that Mars "became retrograde" (*vakraṃ kṛtvā*) "in *jyeṣṭhā*" (*jyeṣṭhāyām*, a locative) and "ran towards Anurādhā" (*anurādhāṃ prārthayate*). Exactly this did *not* happen in the year 3067 BCE. Mars became retrograde in Viśākhā at 1°01' sidereal Scorpio (Lahiri).

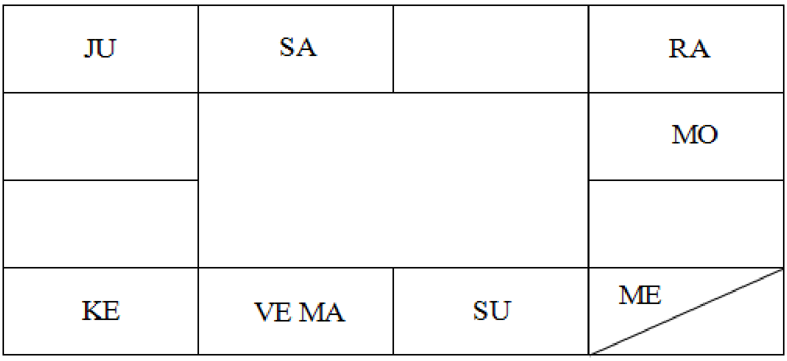
[194] The lunar eclipses on 20th October and 19th November 3031 BCE were both penumbral and had magnitudes of 0.11 and 0.27, far below the minimum value required for visibility to the human eye (0.6). The solar eclipse on 5th November could have been visible from Kurukṣetra, if ΔT were corrected in a suitable way. However, there is no correction value that would make visible *both* the solar eclipse of 3067 BCE *as well as* the one of 3031 BCE.




Configuration on 20th September 1478 BCE, the approximate date of the war in the opinion of R. N. Iyengar. It is the "best possible" solution if it is assumed that a solar eclipse occurred not only during the war but also 13-15 years before and 36 years after it. Moreover, Iyengar requires Saturn near Rohiṇī, Mars between Anurādhā and Jyeṣṭhā, and some other planet in Citrā. However, in the above graphic, Saturn and Mercury are clearly in the wrong lunar mansion.

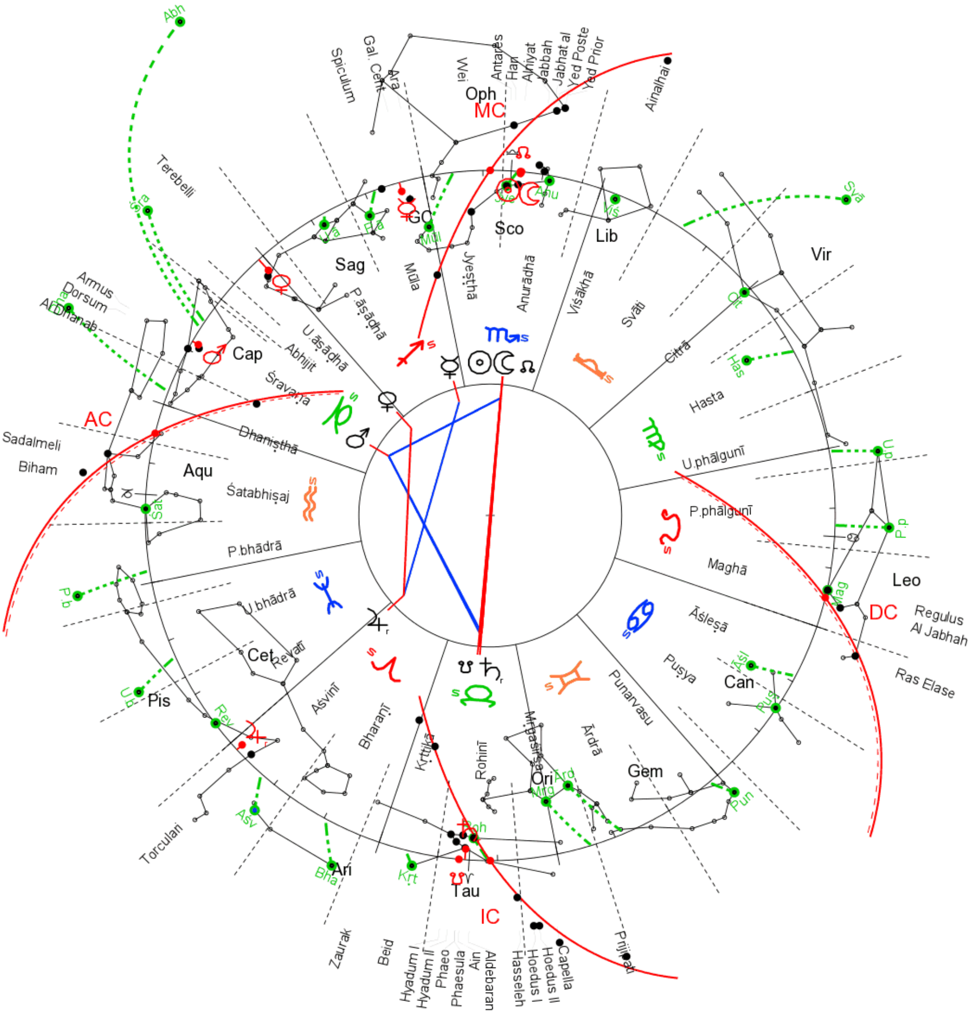
Iyengar ignores the super-conjunction. Besides, he believes that the eclipses need not have taken place in the month of Kārttika.




War Configuration (RN Iyengar)
20 Sep 1478 BCE (-1477) jul., 5:00 LMT, Kurukshetra 76e51,29n59
JD (UT)=1181845.4948611, JD (ET)=1181845.8945835, delta_t=34536.0 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 335°40'41" (True Citra)
Sidereal time: 4:00:58 (60°14'31")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 178°32'08" | Kan/Vir 28°32'08" | Cit | | |
| Sun | 187°47'10" | Tul/Lib 7°47'10" | Sva | 2 | -0°00'01" |
| Moon | 98°28'15" | Kar/Can 8°28'15" | Pus | 11 | 2°37'30" |
| Mercury | 169°15'29" | Kan/Vir 19°15'29" | Has | 1 | 1°44'20" |
| Venus | 229°29'50" | Vrk/Sco 19°29'50" | Jye | 3 | -1°37'24" |
| Mars | 218°33'20" | Vrk/Sco 8°33'20" | Anu | 3 | -0°15'40" |
| Jupiter | 345°10'38" | Min/Pis 15°10'38" | UBh | 7 | -1°48'57" |
| Saturn | 21°51'17" | Mes/Ari 21°51'17" | Bha | 8 | -2°54'09" |
| Rahu | 67°06'28" | Mit/Gem 7°06'28" | Ard | 10 | |
| Ketu | 247°06'28" | Dha/Sag 7°06'28" | Mul | 4 | |

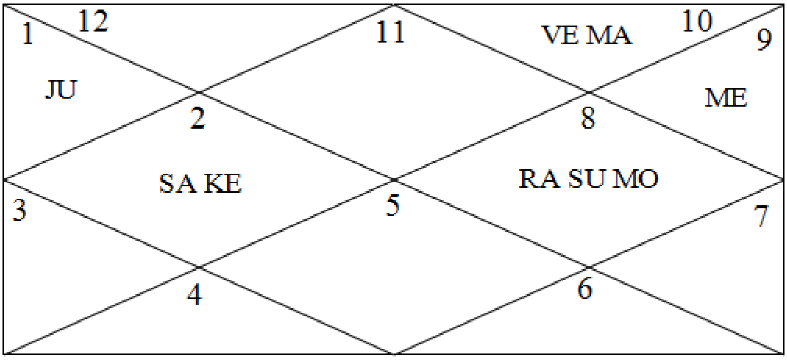


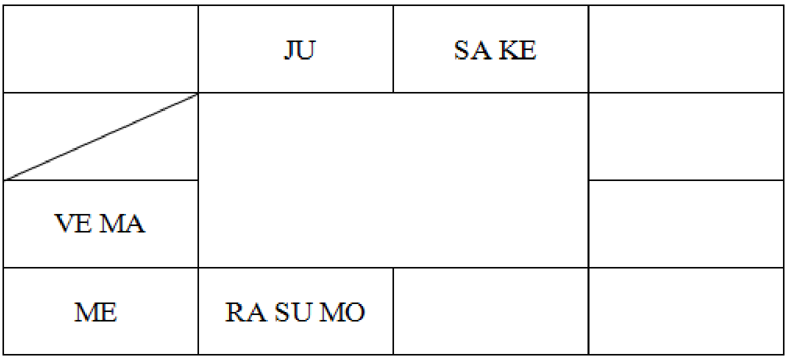

Solar eclipse near Jyeṣṭhā (Antares) of 14th October 3067 BCE, in the war year proposed by Achar and Raghavan. The above calculation was made assuming an error in current estimations of ΔT that would have made the eclipse visible in Kurukṣetra with a magnitude of 10%. The assumed error corresponds to an offset in geographic longitude of 86°. The probability for this assumption, and thus for the visibility of the eclipse in Kurukṣetra, is only 1%.

Saturn was in Rohiṇī, as intended by the authors. However, Mars did not become stationary in Jyeṣṭhā or Anurādhā in this year, as required by the text, but already became retrograde in February in Viśākhā.

The lunar eclipses on 29th September and 28th October were both penumbral and with magnitudes < 0.3 not perceptible to the human eye.

All evidence that points to a super-conjunction has been ignored.




Solar Eclipse 3067 BCE (BN Achar)
14 Oct 3067 BCE (-3066) jul., 12:53 UT, Kurukshetra (longitude adjusted instead of Delta T correction) 8w58,29n59
JD (UT)=601488.0368056, JD (ET)=601488.9151909, delta_t=75892.5 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 313°53'05" (True Citra)
Sidereal time: 12:10:19 (182°34'38")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 305°08'06" | Kum/Aqu 5°08'06" | Dha | | |
| Sun | 223°42'56" | Vrk/Sco 13°42'56" | Anu | 10 | -0°00'04" |
| Moon | 223°39'22" | Vrk/Sco 13°39'22" | Anu | 10 | -0°29'18" |
| Mercury | 244°00'32" | Dha/Sag 4°00'32" | Mul | 11 | -2°23'41" |
| Venus | 270°53'16" | Mak/Cap 0°53'16" | UAs | 12 | -3°48'02" |
| Mars | 288°24'12" | Mak/Cap 18°24'12" | Sra | 12 | -1°46'35" |
| Jupiter | 1°28'58" | Mes/Ari 1°28'58" | Asv | 3 | -1°52'40" |
| Saturn | 44°31'43" | Vrb/Tau 14°31'43" | Roh | 4 | -2°47'46" |
| Rahu | 223°31'54" | Vrk/Sco 13°31'54" | Anu | 10 | |
| Ketu | 43°31'54" | Vrb/Tau 13°31'54" | Roh | 4 | |

## Another celestial configuration

Another description of the celestial configuration at the beginning of the battle, which is incompatible with all previous descriptions, begins as follows:

> अभीक्ष्णं कम्पते भूमिरर्कं राहुस्तथाग्रसत्
>
> श्वेतो ग्रहस्तथा चित्रां समतिक्रम्य तिष्ठति
>
> *abhīkṣṇaṃ kampate bhūmirarkaṃ rāhustathāgrasat*
> *śveto grahastathā citrāṃ samatikramya tiṣṭhati (MBh 6.3.11)*

> The earth shakes again and again. Rāhu swallowed the Sun.
> The white Planet (or: a white planet) just entered Citrā and is standing there.

The first line tells us of a solar eclipse in the lunar node (Rāhu). The second line is difficult. The following solutions are possible:

1. The "white planet" has "entered" (*samatikramya*) Citrā and is "standing" (*tiṣṭhati*) there or makes a "station" (*tiṣṭhati*) and becomes retrograde.

2. The "white planet" has "crossed" or "gone beyond" (*samatikramya*) Citrā and is now "standing" (*tiṣṭhati*) in the subsequent lunar mansion Svāti or makes a "station" (*tiṣṭhati*) there and becomes retrograde. If the planet is retrograde, it will be standing in the lunar mansion preceding Citrā, i.e. in Hasta.[195]

This work prefers solution 1, because it is simpler and does not involve an unmentioned *nakṣatra*, also because of the parallel expression *ākramya tiṣṭhati* in the following verse. Besides, the correct term for "station" is *vakraṃ kṛ-* (see below, verse 13). It is therefore doubtful that *tiṣṭhati* meant a planetary station.

What planet could be meant by the "white planet"? According to the dictionaries, the term *śveto grahaḥ* either denotes Venus or a comet. As has been seen, comets are popular stopgaps, but give no valuable information because in the remote past it is unknown

[195] According to the commentator Nīlakaṇṭha, the "white planet" is Ketu. It has crossed Citrā and stands at the beginning of Svāti. This interpretation is apparently inspired by verse 16. (*śveto grahaḥ ketuḥ citrāmatikrāmati svātyādau vartate*). However, this is astronomically impossible, since Ketu is always in retrograde movement. After crossing Citrā, he can only be in Hasta.

when comets occurred. Not even for the comet Halley is it known. Venus is out of the question here because verse 14 mentions her in Uttarabhādrā. A text variant ($G_3$) gives *budho* instead of *śveto*. However, it cannot mean Mercury either because Citra is too far away from Uttarabhādrā, where Venus was located. The maximum allowable distance between Venus and Mercury is about 75°. Previously this study has assumed Jupiter in Citrā. However, verse 13 (see below) states that Jupiter was in Śravaṇa. Mars was in Maghā, according to verse 14. Could the "white planet" be referring to Saturn? It is doubtful because he, the "son of the Sun" (*sūryaputraḥ*) mentioned in verse 14, was located in Pūrvaphalgunī. The Moon falls out of consideration, because during an eclipse, the Moon must be in conjunction with the Sun. The only remaining candidates would be Rāhu and Ketu (as descending lunar node); and since these two cannot change direction, they must be ruled out, if *tiṣṭhati* is considered to mean "station". The only remaining candidate for the "white planet" that could have a station is a comet.

To associate Rāhu and Ketu (as the descending lunar node) with the colour "white" does not seem very convincing because they are responsible for *eclipses*. However, the solar corona is a bright appearance that could have been ascribed to the lunar nodes. As will be demonstrated the Sun must be in the area of Revatī as per the information given later regarding Mars and Venus. It is also known that Rāhu swallowed the Sun, so he must be close to the Sun. These facts are indeed compatible with the positioning of Ketu in Citrā (see solution 1, above) or Hasta (solution 2; the lunar nodes are always retrograde), because Ketu is in opposition to the Sun and Rāhu. Verse 16, however, states that the "hard planet" is between Citrā and Svāti. If that verse is also referring to Ketu, the only possible position for Ketu would be Citra. Nīlakaṇṭha also believes that Ketu is intended here.[196] However, it must not be forgotten that

---

[196] However, his argumentation is astronomically wrong:

कार्तिक्याः परं हि संग्रामारम्भः। तत्र तुलास्थमर्कं रहुरुपैति। तदा एव श्वेतो ग्रहः केतुश्चित्रामतिक्रामति स्वात्यादौ वर्तते। नित्यं समसप्तकस्थौ राहुकेतू इदानीमेकराशिगतौ महानिष्टसूचकाविति भावः।

*kārtikyāḥ paraṃ hi saṃgrāmārambhaḥ. tatra tulāsthamarkaṃ rahurupaiti. tadā eva śveto grahaḥ ketuścitrāmatikrāmati, svātyādau vartate. nityaṃ samasaptakasthau rāhuketū idānīmekarāśigatau mahāniṣṭasūcakāviti bhāvaḥ.*

Ketu in the Mahābhārata does not represent the southern lunar node but a comet.

Basically, it has to be noted again *that the passage is so vague that it seems its author had no real knowledge about the astronomical configuration during the war.*

The text continues:

अभावं हि विशेषेण कुरूणां प्रतिपश्यति

धूमकेतुर्महाघोरः पुष्यमाक्रम्य तिष्ठति

*abhāvaṃ hi viśeṣeṇa kurūṇāṃ pratipaśyati*
*dhūmaketurmahāghoraḥ puṣyamākramya tiṣṭhati (12)*

| |
|---|
| One sees very clearly the destruction of the Kurus.<br>[The comet] Dhūmaketu with great terror is standing near Puṣya. |

The question is, what was *dhūmaketuḥ*. In the translation it is rendered as denoting a comet, although it could be something else. The word literally means "the smoke-shaped one" or "who has smoke as his sign". It has already been illustrated that in principle, it could denote the fire god, the Sun god, or a comet, but certainly not the southern lunar node. However, in the above verse, it cannot be referring to the Sun as he has to be positioned near Revatī to meet other criteria. (See the following verse 13) Nor can *dhūma-ketu* in Puṣya be referring to Ketu if he is the "white planet" in Citrā in verse 11, no matter whether he is a comet or the descending node. Besides, as will be illustrated, the Sun was swallowed by Rāhu in the region of Aśvinī und Kṛttikā, therefore it can be ruled out that Ketu as the opposite point of Rāhu could stand in Puṣya.

---

| |
|---|
| For, the beginning of the battle is after the [full moon night] of the month of Kārttika. Then Rāhu approaches the Sun which is located in Libra. At the same time the white planet, [i.e.] Ketu, leaves Citrā and is located at the beginning of Svāti. Rāhu and Ketu, always in opposition to each other, have entered one and the same zodiac sign at that time and indicate great evil. |

However, it is astronomically impossible that Ketu stands in at the beginning of Svāti after crossing Citrā, because the lunar nodes are always in retrograde motion. Also, the idea that Rāhu and Ketu could stand in the same zodiac sign is astronomically absurd.

सेनयोरशिवं घोरं करिष्यति महाग्रहः

मघास्वङ्गारको वक्रः श्रवणे च बृहस्पतिः

*senayoraśivaṃ ghoraṃ kariṣyati mahāgrahaḥ*
*maghāsvaṅgārako vakraḥ śravaṇe ca bṛhaspatiḥ (13)*

The (or: A) great planet will cause dreadful calamity for the two armies. Mars is moving backward in Maghā, and Jupiter [moves backward (? or: is ?)] in Śravaṇa.

The "great planet" in verse 13 is either the comet (?) mentioned in 12 (*dhūmaketuḥ*) or it could refer to any other planet, which unfortunately can not be identified.

Mars was stationary in Maghā, "and Jupiter in Śravaṇa". Would the statement about Jupiter mean that he became *stationary* in Śravaṇa simultaneous to Mars becoming stationary? Alternately could it mean that Jupiter was simply *located* in Śravaṇa? If Mars was in Maghā and Jupiter at the beginning of Śravaṇa – or, as can be learned in verse 17, in Abhijit, which overlaps Śravaṇa – then their maximum angular distance would be 213°. Unfortunately, it is not quite plausible that both planets are stationary at such angular distance. The elongation of Mars stationed in Maghā would have been about 130°, the elongation of Jupiter stationed in Śravaṇa about 117°. If the two values are added together, the result will be 247°. This is clearly too much. Stated another way: With Mars stationary in Maghā the Sun would be found in Revatī or Aśvinī, but with Jupiter stationary in Śravaṇa/Abhijit, the Sun would be found in Kṛttikā. Thus it can be ruled out that Mars became stationary in Maghā and Jupiter in Śravaṇa at the same time. Therefore, it can be concluded that only Mars was stationary. One could object that further below in verse 17 Jupiter is said to make two stations in Śravaṇa. However, as this verse mentions *two* stations, it obviously describes his motion over a period of several months.

It is important to note that the stations of the planets played an important role in ancient planetary theories, such as in Mesopotamia. By using the stations, the approximate position of a planet could be calculated. Babylonian horoscopes therefore not only listed the current positions of the planets but also planetary stations that have occurred near the date in question. For the interpretation of the verse under discussion, it should be considered that the stations of Mars in

Maghā and the two stations of Jupiter in Śravaṇa may have occurred not exactly at the time of the battle, but perhaps within a few months. It might have to be concluded that the Sun was somewhere between Revatī and Kṛttikā, the two lunar mansions where he would have had to be for the two planets to become stationary.

भाग्यं नक्षत्रमाक्रम्य सूर्यपुत्रेण पीड्यते

शुक्रः प्रोष्ठपदे पूर्वे समारुह्य विशां पते

उत्तरे तु परिक्रम्य सहितः प्रत्युदीक्षते

*bhāgyaṃ nakṣatramākramya sūryaputreṇa pīḍyate*
*śukraḥ proṣṭhapade pūrve samāruhya viśāṃ pate*
*uttare tu parikramya sahitaḥ pratyudīkṣate (MBh 6.3.14)*

Venus, having entered Pūrvabhādrā, O ruler of the people,
is tormented by Saturn, who has entered the lunar mansion Uttaraphalgunī,
But after [Venus] has gone round in Uttarabhādrā, she shines forth together [with that *nakṣatra* (? or with the Sun?)].

This verse has been interpreted to mean Venus was "tormented" in Pūrvabhādrā, almost in opposition to Saturn, who was in Uttaraphalgunī, therefore, she was approaching her heliacal setting, became retrograde in Uttarabhādrā and then rose "together" with the Sun – i.e. rose heliacally. (p. 311f.)

Saturn was thus in Uttaraphalgunī, and Venus in the range of Pūrvabhādrā and Uttarabhādrā. The text seems to indicate a loop of Venus followed by her heliacal rising: Venus "shines forth together" with the Sun. If Venus appeared in Uttarabhādrā, the Sun could have been in Revatī. The station of Mars in Maghā could also suggest the Sun to be in Revatī, because it requires an elongation of about 130°. Yet again, it must be taken into consideration, as with the stations of Mars and Jupiter, that this event might have occurred just *close to, not exactly at* the beginning of the battle. The heliacal rising of Venus might have occurred around the time Mars took station, with Mars however taking station more than a month before that of Jupiter.

श्यामो ग्रहः प्रज्वलितः सधूमः सहपावकः

ऐन्द्रं तेजस्वि नक्षत्रं ज्येष्ठामाक्रम्य तिष्ठति

*śyāmo grahaḥ prajvalitaḥ sadhūmaḥ sahapāvakaḥ*
*aindraṃ tejasvi nakṣatraṃ jyeṣṭhāmākramya tiṣṭhati (15)*

The (or: A) dark planet burns with smoke and fire.
He has entered Indra's fiery *nakṣatra* Jyeṣṭhā and stands [there].

The "dark planet" (*śyāmo grahaḥ*) in Jyeṣṭhā remains a mystery. The only remaining planet whose position remains unaccounted for is Mercury. However, the *nakṣatra* Jyeṣṭhā, where it was found, was unfortunately too far away from the Sun, because Mercury's maximum elongation is only 29°. The verse is a bit reminiscent of the new moon and the solar eclipse in Jyeṣṭhā that has already been accounted for. Perhaps the verse was inserted later, by someone who did not exactly understand the configuration described.

> ध्रुवः प्रज्वलितो घोरमपसव्यं प्रवर्तते
>
> (var. ins. रोहिणीं पीडयत्येवमुभौ च शशिभास्करौ)
>
> चित्रास्वात्यन्तरे चैव धिष्ठितः परुषो ग्रहः
>
> *dhruvaḥ prajvalito ghoramapasavyaṃ pravartate*
> (var. ins. *rohiṇīṃ pīḍayatyevamubhau ca śaśibhāskarau*)
> *citrāsvātyantare caiva dhiṣṭhitaḥ paruṣo grahaḥ (16)*

> Dhruva (Ursa Major) is burning and makes a dreadful circumambulation to the right.
> (*var. ins.* He torments Rohiṇī and the Moon and the Sun.)
> The (or: A) hard planet is standing between Citrā and Svāti.

Dhruva, the celestial north pole, has been ignored because it does not contribute anything to the dating of the planetary configuration. The second half seems to mention the "white planet" of verse 11 again. It has been commented already (p. 326ff.).

> वक्रानुवक्रं कृत्वा च श्रवणे पावकप्रभः
>
> ब्रह्मराशिं समावृत्य लोहिताङ्गो व्यवस्थितः
>
> *vakrānuvakraṃ kṛtvā ca śravaṇe pāvakaprabhaḥ*
> *brahmarāśiṃ samāvṛtya lohitāṅgo vyavasthitaḥ (17)*

> After [Jupiter], who glows like fire, had made his first and second station in Śravaṇa, and after he had returned to (or: circled around?) Brahmarāśi (= Abhijit), he stood [there] with red limbs.

The planet "with red limbs" can hardly be Mars, which, according to verse 13 was in Maghā. It could only be Jupiter, which according to the same verse, was located in Śravaṇa. The text clearly mentions two stations, both of which occur in Śravaṇa.

The configuration above is presumably as follows:

- – Saturn was in Pūrva- or Uttaraphalgunī
- – Jupiter was in Śravaṇa (where it makes two stations)
- – Mars was in Maghā (where it makes a station)
- – Rāhu, the lunar node, was near the Sun, favouring eclipses
- – Ketu (a comet?) was in Citrā or Hasta
- – the Sun was eclipsed by the Moon in Revatī
- – Venus was in Pūrva- or Uttarabhādrā (where it rose heliacally)

This configuration is realistic, and again, a historical date can be found that reasonably, although not perfectly, fulfils the listed conditions. In December 673 BCE, Mars became retrograde in Maghā, while Saturn was in Pūrvaphalgunī. Jupiter became direct in April 672 BCE near Śravaṇa. Venus made her heliacal rising in March in Revatī and approached to Uttarabhādrā in retrograde motion before she became direct again. A solar eclipse occurred on 13th February, at night, however not observable from India. The lunar eclipse in the evening of 27th February was visible. The solar eclipse did not take place in Revatī or Uttarabhādrā, but already in Pūrvabhādrā; and Ketu was in Uttaraphalgunī, near Hasta.

The text thus seems to describe a real astronomical observation. However, if so, it is unknown for what reasons it was imbedded in the epic. It is very unlikely that it is the date of the Mahābhārata battle, because it is far too late.

What can be concluded from all this? In this chapter, a description of a celestial configuration that allegedly took place at the beginning of the Mahābhārata battle has been examined. This description is completely in contradiction with all other descriptions which have been discussed in the preceding chapters. However, it is interesting that those other descriptions were remarkably consistent, indicating that the battle coincided with a great conjunction of all planets that can be dated to the year 1198 BCE. The passage discussed in the current chapter is not only incompatible with that year, a plausible date for the war cannot be derived from it. It obviously is not authentic, as it contains no real tradition going back to the era of the great battle. What makes this passage particularly suspicious is the fact that it mentions nameless planets. It seems the author of these verses did not know exactly what he was talking about.

## Alternative Approaches II

A similar attempt to interpret and date the verses discussed above, was undertaken by O. G. Sreenadh.[197] His solution differs from that accepted by this study basically in one point: In verse 15 he chooses a text variant with "white planet" (*śveto grahaḥ*) instead of "dark planet" (*śyāmo grahaḥ*). He interprets this "white planet", which is located in Jyeṣṭhā, as Ketu. As a consequence, he places Rāhu, the Sun and the Moon in opposition to it in Rohiṇī. Unfortunately, placing the "white planet" in Jyeṣṭhā conflicts with the other "white planet" (*śveto grahaḥ*) mentioned in verse 11, which was said to be located in Citrā. Sreenadh tries to solve this problem by interpreting the planet as the *upagrahaḥ* ("secondary planet") *dhūmaḥ*, which in his opinion appears in the subsequent verse 12 under the name *dhūmaketuḥ*. That the text places it in Puṣya instead of Citrā, he considers to be erroneous. This solution is not very convincing. Also it has the problem that the resulting position of the Sun would be in Rohiṇī, which is in conflict with other information given within the text. Venus in Pūrvabhādrā would have an elongation of at least 66°, while in reality her maximum elongation possible is only 47°. Mars retrograde in Maghā with an elongation not greater than 93° is not consistent with the Sun in Rohiṇī either. In reality the elongation required would be at least 130°. As a result, Venus and Mars are the weakest points in Sreenadh's dating of this configuration to 26th April, 436 BCE. Venus was in Bharaṇī, and she did not make a loop near the Bhādrā *nakṣatras* that year. Mars was in direct motion. It is true, however, that he became retrograde in the *nakṣatra* Maghā. Sreenadh is well aware of these shortcomings, yet has chosen to believe that the compatibility between the text and the configuration in 436 BCE is surprisingly accurate.[198]

[197] Sreenadh, O. G., "A Planetary position given in the Mahabharata".

[198] http://groups.yahoo.com/group/ancient_indian_astrology/message/55236

Another attempt was made by A. Sharan.[199] In his brief Internet article he opines that the war took place from 1st to 18th November 2156 BCE. His criteria are:

> There was a Kartik Purnima (full moon of the month of Kārttika; D. K.) on Oct, 7/8, 2156 BCE which had descriptions of planetary configuration such as (a) Rahu was attacking the Sun thereby implying that it was an eclipse season, but not an actual eclipse, (b) Mars in Magha, (c) Jupiter in Shravana, (d) Saturn in Rohini, and (e) Venus in Purva Bhadrapadapar.

However, in the verses under examination, Saturn is not in Rohiṇī, but in Uttaraphalgunī. Moreover, it must be noted that Sharan does not mention the other text passage, where Mars was in Jyeṣṭhā / Anurādhā and Jupiter and Saturn were in Viśākhā. His solution is therefore based on an arbitrary selection of astronomical information given within the text, a selection of which he does not provide any explanation for, making it simply random.

When the planetary positions are examined, it turns out that Mars and Jupiter were correct and that the lunar node also approached the Sun (or the other way round). However, Saturn was in Aśvinī, and Venus in Mūla. Sharan himself concedes that these placements are incorrect. Still, he believes that his date fits better than the solutions offered by Achar and Iyengar. Moreover, it must be criticised that the Kārttika full moon was not a lunar eclipse, and the solar eclipse on 22nd October was not visible from Kurukṣetra. While Sharan is aware of this problem, he believes that the passage under discussion is not referring to a solar eclipse but only a close approach by Rāhu to the Sun, whereas the eclipses mentioned in the epic took place earlier – apparently during the previous eclipse season, six months earlier. Whether that is the idea presented in the text, may be doubted.

For the sake of clarity, this investigation considers each description of the astronomical configurations individually. Although other authors look at the information given in the narrative wholly, mixing up many details. Given that much of the information is contradictory, e. g. Mars could not be in Maghā and in Jyeṣṭhā or Anurādhā at the same time, such authors are forced to either choose one

[199] Sharan, A. M., "The Mahabharata War in 2156 BCE is Ancient Indian History".

selection from the information outlined in the text, or to assume that the astronomical occurrences took place at different times. Two approaches as such were undertaken by V. N. Sharma.[200]

Sharma mainly relies on the *planetary configurations* mentioned in the epic. In his view, the eclipses are the least credible events, because they are a literary commonplace in texts to do with fierce battles. The numerous contradictions between the planetary configurations described in the epic lead him to assume that the text was formed on the basis of *several* different configurations that happened on *several different* dates close in time to the battle and were erroneously mixed up in the extant text. Sharma therefore proceeds as follows: He first lists all statements made by the epic concerning positions of the planets. Then he states that, of all these statements, the one concerning Jupiter and Saturn in Viśākhā is the most reliable, whereas the retrogression of Mars is rather unreliable because it seems to be stereotypical. Saturn in Rohiṇī he interprets as ambiguous; either it is Rohiṇī herself, or it could also refer to the "other Rohiṇī", i.e. Jyeṣṭhā. Sharma therefore searches for all dates on which Jupiter and Saturn made a conjunction near Viśākhā and checks whether the following two or three years contain two or three dates on which the other statements of the epic are met. Proceeding like this, he finds two time ranges that seem to fit: from 1495 to 1492 BCE and from 2111 to 2109 BCE. However, the latter he considers less probable, for historical reasons. Sharma's second attempt, where he chooses a slightly different approach, leads him to the year 3022 BCE as the year of the battle. Historical considerations apparently play no role in this.

This study does not take on the arduous task of comparing in detail the dates found by Sharma with the information given within the text. However, in the time range from 1495 to 1492 BCE, it can be criticised that the "most reliable" configuration, viz. Jupiter and Saturn in Viśākhā is not given. At the time of the conjunction on 17th March 1495 BCE the two planets were not in Viśākhā, but between Hasta and Citrā. When Jupiter reached the star Viśākhā (i Librae) on 17th December, he was already 17° ahead of Saturn; at

---

[200] Sharma, V. N., "Model of Planetary Configurations in the Mahābhārata: An Exercise in Archaeoastronomy" (1986); idem, "On Astronomical References in the Mahābhārata" (2003?).

his second conjunction with the star on 1st April 1494 BCE, he was at 21°, and at the third conjunction on 11th August, 19° ahead of Saturn. The time range from 2111 to 2109 BCE is more suitable. The conjunction of the two planets on 10th January 2111 BCE, indeed took place in Viśākhā. Besides, there was a partial solar eclipse near the star Jyeṣṭhā on 24th October 2110 BCE and a total lunar eclipse on 7th November, however not in Kṛttikā or Rohiṇī, as required in the month of Kārttika, but in Mṛgaśīrṣa. In the years after 1495 BCE, eclipses took place during the wrong time of the year.

The third solution provided by Sharma, which he developed in his second attempt and according to which the war would have taken place in the year 3022 BCE, is based on the following configurations: Three years before the war, in October and November 3025 BCE, there was a Jupiter-Saturn conjunction in Viśākhā, accompanied by retrograde Mars in Maghā (not noted by Sharma). In the year of the war itself, in September, Mars went through Jyeṣṭhā (although not retrograde); Saturn was in Jyeṣṭhā, hence "torturing" the "other Rohiṇī"; and Jupiter was in Śravaṇa. The new moon of the war, which took place in the lunar mansion of Indra, is assumed to be in Viśākhā, not in Jyeṣṭhā, Viśākhā being the other *nakṣatra* ruled by Indra.[201] It is dated to 27th September 3022 BCE. However, a partial solar eclipse (82%), which could be seen from Kurukṣetra, occurred only a year later on 15th October 3021 BCE, however not in Viśākhā but in Jyeṣṭhā (not noticed by Sharma). A fortnight later, on 29th October, a partial lunar eclipse (71%) was observable in Rohiṇī. In this regard, Sharma succeeds in trying to meet a large amount of the astronomical clues given in the epic – even more than he noticed himself, albeit over a period of several years.

It has not been confirmed whether this is really the best solution that can be found through Sharma's approach. However, what could be criticised is the fact that the different astronomical statements are treated completely out of context. No consistent interpretation is given, e. g., for the passage that was examined in this chapter. Instead, it has been assumed that the elements of the different configurations were wildly jumbled in the extant version of the epic.

[201] However, according to MBh 6.3.15 Jyeṣṭhā is the lunar mansion of Indra.

But can this be accepted? The resulting dates derived through an approach as such, regrettably, could be nothing but accidental.

## Duels and Conjunctions of Planets

An interesting passage of astronomical importance is found in the description of Śalya's attack on the Pāṇḍavas:

व्यदृश्यत तदा शल्यो युधिष्ठिरसमीपतः

रणे चन्द्रमसोऽभ्याशे शनैश्चर इव ग्रहः

*vyadṛśyata tadā śalyo yudhiṣṭhirasamīpataḥ*
*raṇe candramaso 'bhyāśe śanaiścara iva grahaḥ (MBh 9.15(16).10)*

| |
|---|
| Then Śalya was seen near Yudhiṣṭhira<br>in battle, like the planet Saturn near the Moon. |

पीडयित्वा तु राजानं शरैराशीविषोपमैः

अभ्यधावत्पुनर्भीमं शरवर्षैरवाकिरत्

*pīḍayitvā tu rājānaṃ śarairāśīviṣopamaiḥ*
*abhyadhāvatpunarbhīmaṃ śaravarṣairavākirat (11)*

| |
|---|
| After tormenting the king with his arrows that were like poisonous snakes,<br>he hurried towards Bhīma and showered him with a rain of arrows. |

तस्य तल्लाघवं दृष्ट्वा तथैव च कृतास्त्रताम्

अपूजयन्ननीकानि परेषां तावकानि च

*tasya tallāghavaṃ dṛṣṭvā tathaiva ca kṛtāstratām*
*apūjayannanīkāni pareṣāṃ tāvakāni ca (12)*

| |
|---|
| When they saw his swiftness and skill with weapons,<br>the armies of the enemies and your own ones applauded him. |

Verse 10, compares the attacking Śalya with Saturn and Yudhiṣṭhira with the Moon. Shortly thereafter Śalya moves on and attacks the next Pāṇḍava, namely Bhīma. After which he brings the other Pāṇḍavas into distress. This description is very strange. Why is *Saturn* mentioned of all planets? Saturn is the most inconspicuous planet, aside from Mercury, and can easily be confused with a fixed star. Why does the text not choose the much more spectacular Moon-Venus conjunction? Does it indicate that these verses contain reminiscences of real astronomical observations?

It is also strange that the slow Saturn (Śalya) unleashes such dynamism, while the Moon (Yudhiṣṭhira) appears almost stationary. Saturn then soars past Yudhiṣṭhira and attacks Bhīma. One gets the impression that the text confuses the roles of the actors. It would make much more sense to assume that *the Moon is the aggressor and attacks the planets that have recently appeared in the morning sky and are now standing in a line like a pearl necklace*.

Studying the sky map for 17th November 1198 BCE, just before sunrise (cf. p. 344f.), it can be seen that Saturn is the foremost of the five planets, and that the Moon is manoeuvring towards the row of planets. This seems to further confirm this book's chosen date for the war.

Yudhiṣṭhira, the eldest and leader of the Pāṇḍavas, must therefore represent Saturn, the first of the planets in the row. Yudhiṣṭhira is the son of Yama, the god of death, and the planet Saturn has been associated with death. Yudhiṣṭhira's title *dharmarāja*, "King of the *dharma*", also fits Saturn. Even in the epic, Saturn, the "son of the Sun", is associated with death, time and *dharma* (MBh 12.192 (199).32).

If Yudhiṣṭhira does represent Saturn, then it seems that Bhīma, the second Pāṇḍava and the son of the wind god, must be identified with Jupiter, who stands immediately behind Saturn. Is it possible for each of the Pāṇḍavas to represent one of the five planets? Unfortunately, this is difficult. The text often compares fighting heroes with planets, and not only the Pāṇḍavas, as shall be seen. It also seems inadvisable to attempt to assign the planets to the Pāṇḍavas using their Hellenistic interpretation. Although the Hellenistic interpretation of Saturn is in agreement with the statements made above, the epic generally does not show any influence of Hellenistic astrology. For example, the zodiac signs are never mentioned in the Mahābhārata. In the next chapter the question as to whether the five Pāṇḍavas could accurately portray the five planets will be examined closer.

Another interesting passage is found in the description of the duel of Arjuna with Aśvatthāmā:

अथ संशप्तकांस्त्यक्त्वा पाण्डवो द्रौणिमभ्ययात्

अपाङ्क्तेयमिव त्यक्त्वा दाता पाङ्क्तेयमर्थिनम्

*atha saṃśaptakāṃstyaktvā pāṇḍavo drauṇimabhyayāt*
*apāṅkteyamiva tyaktvā dātā pāṅkteyamarthinam (MBh 8.12(17).47)*

Then the Pāṇḍava (Arjuna) left behind the Saṃśaptakas and went to the son of Droṇa (Asvatthāmā),
like a charity donor who leaves behind one of unequal rank and [goes] to one of equal rank who has money.

ततः समभवद्युद्धं शुक्राङ्गिरसवर्चसोः

नक्षत्रमभितो व्योम्नि शुक्राङ्गिरसयोरिव

*tataḥ samabhavadyuddhaṃ śukrāṅgirasavarcasoḥ*
*nakṣatramabhito vyomni śukrāṅgirasayoriva (48)*

Then occurred the battle of the light forces of Venus and Jupiter,
like [the battle] in the sky of Venus and Jupiter round about a star (or: *nakṣatra*).

संतापयन्तावन्योन्यं दीप्तैः शरगभस्तिभिः

लोकत्रासकरावास्तां विमार्गस्थौ ग्रहाविव

*saṃtāpayantāvanyonyaṃ dīptaiḥ śaragabhastibhiḥ*
*lokatrāsakarāvāstāṃ vimārgasthau grahāviva (49)*

Firing up each other with glowing arrow rays,
they made the world tremble like two planets that were on the wrong track.

ततोऽविध्यद्भ्रुवोर्मध्ये नाराचेनार्जुनो भृशम्

स तेन विबभौ द्रौणिरूर्ध्वरश्मिर्यथा रविः

*tato 'vidhyadbhruvormadhye nārācenārjuno bhṛśam*
*sa tena vibabhau drauṇirūrdhvaraśmiryathā raviḥ (50)*

Then Arjuna pierced [him] violently with an arrow in the middle of the eyebrows.
As a result of this [arrow] the son of Droṇa shone like the Sun with rays going upward.

अथ कृष्णौ शरशतैरश्वत्थाम्नार्दितौ भृशम्

सरश्मिजालनिकरौ युगान्तार्काविवासतुः

*atha kṛṣṇau śaraśatairaśvatthāmnārditau bhṛśam*
*saraśmijālanikarau yugāntārkāvivāsatuḥ (51)*

The two Kṛṣṇas (i.e. Kṛṣṇa and Arjuna), violently shaken by Aśvatthāmā with hundreds of arrows,
were like the two suns at the end of the age with numerous nets of rays.

The duel of the two heroes is compared to a conjunction of Venus and Jupiter. Venus approached Jupiter within 2°16’ on 22nd/23th November. Moreover, the text mentions the two Suns that rise at the end of the age and, as has been seen, might represent the union of the Sun and the Moon and a solar eclipse. Although the solar eclipse had actually occurred a month earlier, it was a new moon just two days prior on 20th November. The fact that the Sun is mentioned in connection with the planetary battle of Jupiter and Venus indicates that the two planets were visible in the morning before sunrise. In any case, this passage is compatible with the war in 1198 BCE.

Another passage with information about the celestial configuration during the war reads as follows:

समुत्सृज्याथ शैनेयो गौतमं रथिनां वरम्

अभ्यद्रवद्रणे द्रौणिं राहुः खे शशिनं यथा

*samutsṛjyātha śaineyo gautamaṃ rathināṃ varam*
*abhyadravadraṇe drauṇiṃ rāhuḥ khe śaśinaṃ yathā (MBh 6.97(102). 42)*

| |
|---|
| Then Sātyaki left behind Gautama, the best among the chariot warriors, and rushed towards the son of Droṇa (Aśvatthāmā) in the battle, like Rāhu [rushes] to the Moon in the sky. |

पुनश्चैनं शरैर्घोरैश्छादयामास भारत

निदाघान्ते महाराज यथा मेघो दिवाकरम्

*punaścainaṃ śarairghoraiśchādayāmāsa bhārata*
*nidāghānte mahārāja yathā megho divākaram (49)*

| |
|---|
| [Aśvatthāmā] again covered him with terrible arrows, O Bhārata,<br>like a cloud [covers] the Sun at the end of the summer, O great king. |

सात्यकिश्च महाराज शरजालं निहत्य तत्

द्रौणिमभ्यपतत्तूर्णं शरजालैरनेकधा

*sātyakiśca mahārāja śarajālaṃ nihatya tat*
*drauṇimabhyapatattūrṇaṃ śarajālairanekadhā (50)*

| |
|---|
| And Sātyaki, O great king, beat back this net of arrows.<br>and hurriedly flew to the son of Droṇa with nets of arrows in several ways. |

तापयामास च द्रौणिं शैनेयः परवीरहा

विमुक्तो मेघजालेन यथैव तपनस्तथा

*tāpayāmāsa ca drauṇiṃ śaineyaḥ paravīrahā*
*vimukto meghajālena yathaiva tapanastathā (51)*

And Sātyaki, the slayer of hostile heroes, fired up the son of Droṇa,
just like the Sun after getting rid of a net of clouds.

शराणां च सहस्रेण पुनरेनं समुद्यतम्

सात्यकिश्छादयामास ननाद च महाबलः

*śarāṇāṃ ca sahasreṇa punarenaṃ samudyatam*
*sātyakiśchādayāmāsa nanāda ca mahābalaḥ (52)*

And Sātyaki, on his part, covered him with a thousand of arrows,
who presented himself [without protection], and he roared with great power.

दृष्ट्वा पुत्रं तथा ग्रस्तं राहुणेव निशाकरम्

अभ्यद्रवत शैनेयं भारद्वाजः प्रतापवान्

*dṛṣṭvā putraṃ tathā grastaṃ rāhuṇeva niśākaram*
*abhyadravata śaineyaṃ bhāradvājaḥ pratāpavān (53)*

When he saw his son like this, like the Moon seized by Rāhu,
Droṇa rushed violently against Sātyaki.

विव्याध च पृषत्केन सुतीक्ष्णेन महामृधे

परीप्सन्स्वसुतं राजन्वार्ष्णेयेनाभितापितम्

*vivyādha ca pṛṣatkena sutīkṣṇena mahāmṛdhe*
*parīpsansvasutaṃ rājanvārṣṇeyenābhitāpitam (54)*

And he pierced [him] with a very sharp arrow in the great battle,
in order to reach his son, O king, whom the son of Vṛṣṇi was firing up.

सात्यकिस्तु रणे जित्वा गुरुपुत्रं महारथम्

द्रोणं विव्याध विंशत्या सर्वपारशवैः शरैः

*sātyakistu raṇe jitvā guruputraṃ mahāratham*
*droṇaṃ vivyādha viṃśatyā sarvapāraśavaiḥ śaraiḥ (55)*

Sātyaki, on his part, having defeated in fight the son of the guru, the great chariot warrior,
pierced Droṇa with twenty arrows entirely [made of] iron.

तदन्तरममेयात्मा कौन्तेयः श्वेतवाहनः

अभ्यद्रवद्रणे क्रुद्धो द्रोणं प्रति महारथः

*tadantaramameyātmā kaunteyaḥ śvetavāhanaḥ*
*abhyadravadraṇe kruddho droṇaṃ prati mahārathaḥ (56)*

Meanwhile, the son of Kuntī, of immense nature and with a shining chariot, rushed against Droṇa enraged in battle, the great chariot warrior.

ततो द्रोणश्च पार्थश्च समेयातां महामृधे

यथा बुधश्च शुक्रश्च महाराज नभस्तले

*tato droṇaśca pārthaśca sameyātāṃ mahāmṛdhe*
*yathā budhaśca śukraśca mahārāja nabhastale (57)*

Then Droṇa and the son of Pṛthā (Arjuna) came together in the great battle, like Mercury and Venus in the sky, O great king.

According to this text, Rāhu seizes the Moon at the end of summer, and subsequently a planetary battle ensues between Mercury and Venus. This description is also compatible with the year of war being 1198 BCE. A Mercury-Venus conjunction that was observable took place on 11th November, and a lunar eclipse had occurred a week earlier on 4th November.

Now the epic several times mentions conjunctions of pairs of planets. It is worthwhile to examine *which* conjunctions are mentioned and which ones actually occurred in 1198 BCE after the heliacal rising of the planets.

– MBh 6.3.25, 27 and 28: *Saturn and Jupiter are in Viśākhā rising heliacally in conjunction with Mercury, while the Moon is full.* (quoted on p. 305-308) This configuration corresponds to 3rd and 4th November 1198 BCE (see fig. on p. 248f.). It could be observed by the naked eye.

– MBh 6.43(45).36-38: Bāhlīka and Dhṛṣṭaketu fight with each other and are compared to a conjunction of *Mercury and Mars*. This conjunction occurred twice, on 25th October and on 25th November, although only the latter could be observed by naked eye.

– MBh 6.43(45).52-54: Drupada and Jayadratha fight with each other and resemble a conjunction of *Venus and Mars*. This conjunction occurred on 4th November. However, Mars was so faint that he could not be observed.

– MBh 6.97(102).57: Droṇa and Arjuna fight with each other and resemble a conjunction of *Mercury and Venus*. This conjunction occurred on 11th November.

– MBh 6.100(105).20: Abhimanyu and Citrasena fight with each other and are compared to a conjunction of *Mercury and Saturn*.[202] This conjunction occurred on 3rd and 4th November.

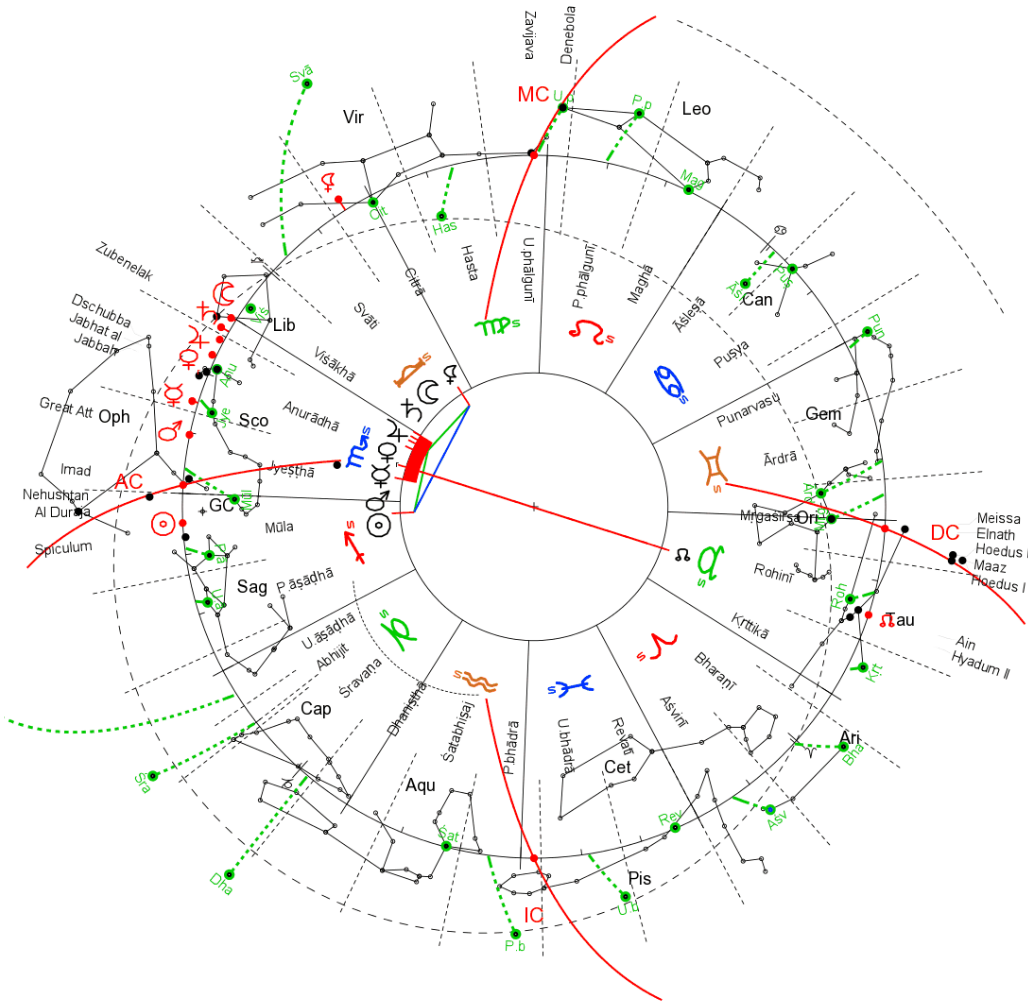
– MBh 7.60(84).19-21: Arjuna, who is accompanied by Kṛṣṇa as his charioteer, fights with Jayadratha. It is said that Arjuna fights "like the Moon destroys the darkness [of the night] together with Mercury and Venus" (*sahito budhaśukrābhyāṃ tamo nighnanyathā śaśī*). This description seems to accommodate 18th November on which the Moon was betwixt Mercury and Venus. (vide fig. on p. 250f.) Since Mars was still invisible, it was Venus, the Moon, and Mercury that rose last before sunrise and "drove away the darkness of the night".

– MBh 7.143.30: Duḥśāsana and Prativindhya fight with each other and are compared to *Mercury and Venus*. This was the conjunction of 11th November.

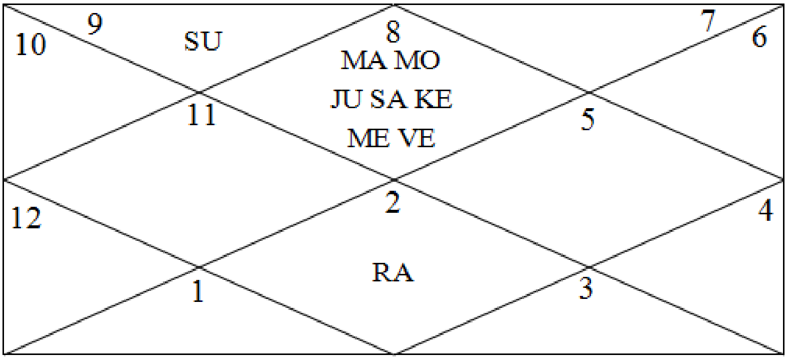
– MBh 8.12(17).46-51: Arjuna fights with Aśvatthāmā, and the duel is compared to a conjunction of *Venus and Jupiter*. Venus approached Jupiter until a minimum distance of 2°16' on 22th/23th November, and then withdrew again.

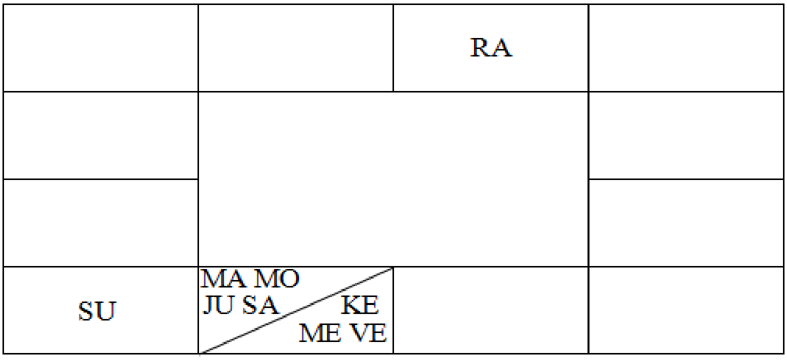
What is interesting about this list is the fact that *all conjunctions of two planets that actually took place also appear in the text, while all those conjunctions that did not take place do not appear in the text*. There were no conjunctions of Venus and Saturn, Mars and Jupiter, or Mars and Saturn, and the text does not mention them. All other conjunctions are mentioned in the text, and they did take place in actuality. Could this be coincidence? If not, then this looks like a further confirmation for the year 1198 BCE.

[202] Ganguli wrongly translates "Venus and Saturn". There is no such variant in the critical edition, only the variant *budhaniśākarau*, i.e. "Mercury and the Moon".



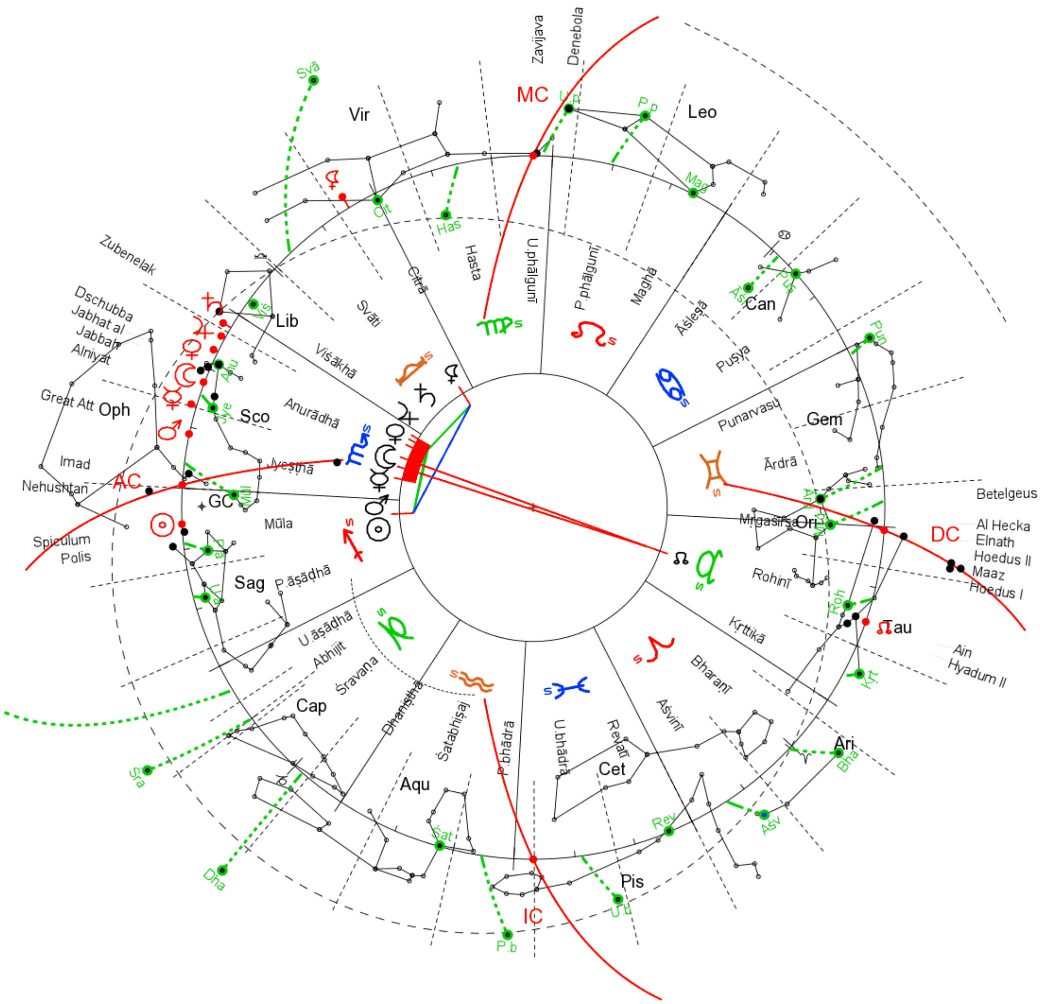
Morning of 17th November, 1198 BCE (MBh 9.15(16).10-12): The Moon (Śalya) attacks the five planets (Pāṇḍavas), first Saturn (Yudhiṣṭhira), then Jupiter (Bhīma) and the others.



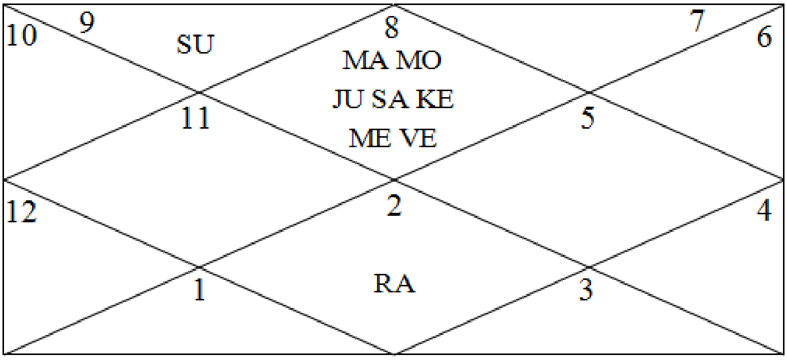



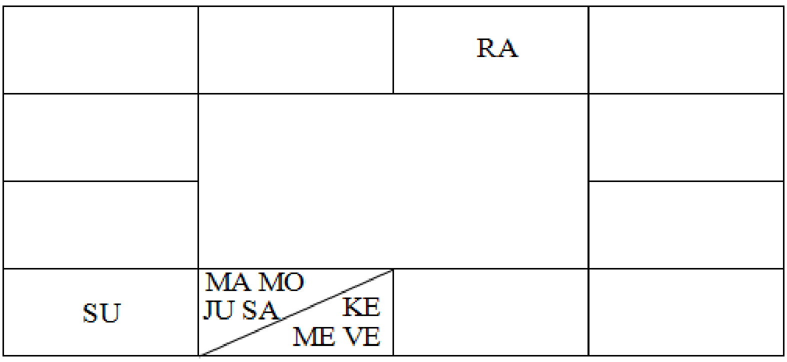

Shalya Attacks the Pandavas (Moon-Saturn Conjunction)
17 Nov 1198 BCE (-1197) jul., 6:00 LMT, Kurukshetra 76e51,29n59
JD (UT)=1284173.5365278, JD (ET)=1284173.8711375, delta_t=28910.3 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 339°32'14" (True Citra)
Sidereal time: 8:57:58 (134°29'23")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 238°48'52" | Vrk/Sco 28°48'52" | Jye | | |
| Sun | 244°48'52" | Dha/Sag 4°48'52" | Mul | 2 | -0°00'00" |
| Moon | 210°59'14" | Vrk/Sco 0°59'14" | Vis | 1 | 1°11'30" |
| Mercury | 224°57'50" | Vrk/Sco 14°57'50" | Anu | 1 | 1°33'54" |
| Venus | 216°52'24" | Vrk/Sco 6°52'24" | Anu | 1 | 1°03'36" |
| Mars | 230°20'49" | Vrk/Sco 20°20'49" | Jye | 1 | 0°05'24" |
| Jupiter | 214°08'17" | Vrk/Sco 4°08'17" | Anu | 1 | 1°06'47" |
| Saturn | 212°17'45" | Vrk/Sco 2°17'45" | Vis | 1 | 2°20'03" |
| Rahu | 44°14'09" | Vrb/Tau 14°14'09" | Roh | 7 | |
| Ketu | 224°14'09" | Vrk/Sco 14°14'09" | Anu | 1 | |




Morning of 18th November 1198 BCE (MBh 7.60(84).19-21), day of the fight of Arjuna (and Kṛṣṇa) with Jayadratha: The “Moon along with Mercury and Venus destroys the darkness [of the night]”. Since Mars was still invisible, it were Venus, the Moon, and Mercury that rose last before sunrise and “destroyed away the darkness of the night”.




Arjuna and Jayadratha (Moon-Mercury-Venus Conjunction)
18 Nov 1198 BCE (-1197) jul., 6:00 LMT, Kurukshetra 76e51,29n59
JD (UT)=1284174.5365278, JD (ET)=1284174.8711369, delta_t=28910.2 sec
Swiss Ephemeris 2.02, using JPL Ephemeris DE431
Ayanamsha: 339°32'14" (True Citra)
Sidereal time: 9:01:54 (135°28'31")

| | Longitude | Rashi/Zodiac | Naksh | Bhava | Latitude |
|---|---|---|---|---|---|
| Asc. | 239°38'57" | Vrk/Sco 29°38'57" | Jye | | |
| Sun | 245°50'11" | Dha/Sag 5°50'11" | Mul | 2 | -0°00'00" |
| Moon | 223°10'24" | Vrk/Sco 13°10'24" | Anu | 1 | 0°04'42" |
| Mercury | 226°18'46" | Vrk/Sco 16°18'46" | Anu | 1 | 1°26'44" |
| Venus | 216°52'41" | Vrk/Sco 6°52'41" | Anu | 1 | 1°15'13" |
| Mars | 231°05'22" | Vrk/Sco 21°05'22" | Jye | 1 | 0°04'44" |
| Jupiter | 214°20'43" | Vrk/Sco 4°20'43" | Anu | 1 | 1°06'49" |
| Saturn | 212°24'01" | Vrk/Sco 2°24'01" | Vis | 1 | 2°20'09" |
| Rahu | 44°10'58" | Vrb/Tau 14°10'58" | Roh | 7 | |
| Ketu | 224°10'58" | Vrk/Sco 14°10'58" | Anu | 1 | |

## Do the five Pāṇḍavas stand for the five planets?

The suspicion that the five Pāṇḍavas represent the five planets Mercury, Venus, Mars, Jupiter and Saturn has been previously suggested. The following verse has given rise to this consideration:

ते वृताः समरे पञ्च गजानीकेन भारत

अशोभन्त नरव्याघ्रा ग्रहा व्याप्ता घनैरिव

*te vṛtāḥ samare pañca gajānīkena bhārata*
*aśobhanta naravyāghrā grahā vyāptā ghanairiva (MBh 9.24(25).24)*

| |
|---|
| When in battle these five [Pāṇḍavas] were surrounded by the elephant battle line, O Bhārata,<br>they shone beautifully, the men-tigers, like the planets when they are surrounded by clouds. |

Another verse that supports this presumption, which however is not contained in the critical edition, is the following:

ध्वजं तु कुरुराजस्य पाण्डवस्य महौजसः

दृष्टवानस्मि सौवर्णं सोमं ग्रहगणान्वितम्

*dhvajaṃ tu kururājasya pāṇḍavasya mahaujasaḥ*
*dṛṣṭavānasmi sauvarṇaṃ somaṃ grahagaṇānvitam (MBh 7.23.85)*[203]

| |
|---|
| The standard of the Kuru king, the Pāṇḍu son of great force,<br>I saw it like a golden Moon followed by the host of the planets. |

The banner is compared to the old moon, and the planets that follow it most probably represent the five Pāṇḍavas. Another verse that links the Pāṇḍavas with the planets, is found in the episode where all the Pāṇḍavas one after the other come to a lake, drink its water without the permission of its guardian spirit and keel over dead immediately. Then Yudhiṣṭhira comes to the lake and sees his dead brothers:

स ददर्श हतान्भ्रातॄँल्लोकपालानिव च्युतान्

युगान्ते समनुप्राप्ते शक्रप्रतिमगौरवान्

*sa dadarśa hatānbhrātṝṁllokapālāniva cyutān*
*yugānte samanuprāpte śakrapratimagauravān (MBh 3.297(311).1)*

| |
|---|
| He saw his brothers killed, like the lords of the world (i. e. the planets?), fallen [from the sky], when the end of the age has arrived, the ones who shine like Indra. |

[203] Taken from the edition by Krishnacharya and Vyasacharya.

It appears that the Mahābhārata War is not only an earthly, but also a heavenly war. The warriors, their banners, weapons and chariots are often described as "bright" or "shining" and compared to celestial bodies. When two warriors shoot hundreds or thousands or even millions of arrows at each other within just a moment, and when these arrows even hit the opponent without lethality it obviously does not resemble an earthly battle, but rather spectacular events in the sky. What seems to play an important part, among other things, are the bright and dark rays that appear when the Sun is near the horizon and covered by clouds.

Can it be said which Pāṇḍava represents which planet? Unfortunately, this is difficult. There is no source in the epic that gives precise details about such correlations. It has also been seen that the epic often compares fighting heroes with planets, not only the Pāṇḍavas, but also several other heroes. (p. 337ff.) Should it be concluded that a connection between the five Pāṇḍavas and the five planets does not really exist and that the verses quoted above are nothing but mere comparisons? Or, could the Pāṇḍavas originally have been identified with the planets, and this information was forgotten over time? It is obvious, at least, that the epic in its extant form is no longer consistent with the Pāṇḍavas being a planetary effigy.

Is it still possible to assign a planet to each Pāṇḍava, on the basis of their fathers? Since their earthly father Pāṇḍu did not beget any children, they were begotten by the gods. The fathers of the five brothers were:

| | |
|---|---|
| Yudhiṣṭhira | Yama, the god of death |
| Bhīma | Vāyu, the wind god |
| Arjuna | Indra, the weather god and king of the gods |
| Nakula und Sahadeva | the Aśvins, the Nāsatyas/Indian Dioscuri |

Ānandatīrtha believes, that the aforementioned gods incarnated themselves as these heroes, while they had intercourse with Pāṇḍu's women Kuntī and Mādrī.[204]

Unfortunately, these names of gods are not used as names of planets in the Mahābhārata. The older Vedic texts, such as the Ṛgveda, the Brāhmaṇas and the Āraṇyakas, never mention the

[204] Ānandatīrtha (Madhva), *Mahābhāratatātparyanirṇaya*, 12.33; 54; 98; 125.

planets unambiguously, so that there is no certainty as to what their names were in those days and whether they were known and observed at all.[205] Moreover, through this research, an exact list of these five gods, viz. Yama, Vāyu, Indra, and the Aśvins has not been found anywhere else in Vedic literature. Where they are mentioned together, they are always accompanied by non- planetary gods like Agni, Kubera, Mitra, Varuṇa, etc., so that they seem to be unrelated to the planets. A correlation of planets and gods is not found before Brahmāṇḍapurāṇa 1.2.24.47ff. There, Saturn corresponds to Yama, Jupiter to Bṛhaspati, Mars to Skanda, Venus to Śukra, and Mercury to Nārāyaṇa. Out of these names, the epic only uses Bṛhaspati for Jupiter and Śukra for Venus. Saturn is called Śanaiścara, Mars Aṅgāraka, and Mercury Budha. Thus Yama-Saturn is the only god that can be immediately identified as the father of one of the Pāṇḍavas, viz. of Yudhiṣṭhira. Saturn is associated with death, time, and *dharma* in the epic (MBh 12.192 (199).32). Yudhiṣṭhira also has the title *dharmarājā*, "King of Dharma", which seems to accord well with the planet Saturn.

Could the divine fathers of the remaining Pāṇḍavas also be assigned to planets? Indra, the king of the gods, who plays the part of Jupiter Pluvius in the Vedic religion, could be identified with the planet Jupiter. The Aśvins could represent the "twin planets" Venus and Mercury, which are similar to each other in behaviour as they are inner planets. Hence Vayu remains for Mars. Making Arjuna then represent Jupiter, Bhīma, Mars, and Nakula and Sahadeva for Mercury and Venus.

However, while these specific assignments are uncertain, the basic assumption that the five Pāṇḍavas could originally have represented the five planets remains quite plausible. The heroes of the epic are often described as "bright" and "brilliant" and compared to celestial bodies, including planets, the Moon, and the Sun (see quotations on p. 337 and 339ff.). Even where heroes are compared

---

[205] Of course there are passages that mention the gods that were later linked with planets. However, there is no place in the Ṛgveda or in the Brāhmaṇas where, e.g., Bṛhaspati is mentioned in a way that makes it obvious that the planet is meant. The situation appears to be similar as in ancient Greece, where, e.g., the god Zeus was linked with the planet Jupiter only from the 4th century BCE on, although the name of Zeus already appears several centuries before that.

to the Sun, there could actually be a planet behind it, because the planets are themselves often allegorised to suns. As in the following verse from the Harivaṃśa, which refers to the configuration at the end of an age and obviously describes a conjunction of all planets with the crescent of the old moon:

सप्त धूमनिभा घोराः सूर्या दिवि समुत्थिताः

सोमस्य गगनस्थस्य ग्रहाः तिष्ठन्ति शृङ्गगाः

*sapta dhūmanibhā ghorāḥ sūryā divi samutthitāḥ |*
*somasya gaganasthasya grahāḥ tiṣṭhanti śṛṅgagāḥ HV 3.46.11*

| |
|---|
| Seven horrible, smoke-like suns arose in the sky.<br>The planets stand moving towards the horns of the moon god, who stands in the firmament. |

Other places where planets shine like suns read as follows:

वामे च दक्षिणे चैव स्थितौ शुक्रबृहस्पती

शनैश्चरो लोहिताङ्गो लोहितार्कसमद्युतिः

*vāme ca dakṣiṇe caiva sthitau śukrabṛhaspatī |*
*śanaiścaro lohitāṅgo lohitārkasamadyutiḥ HV 3.46.12*

| |
|---|
| Left and right stand Venus and Jupiter,<br>Saturn and Mars, who shines like a red Sun. |

बृहस्पती रोहिणीं संप्रपीड्य बभूव चन्द्रार्कसमानवर्णः

*bṛhaspatī rohiṇīṃ saṃprapīḍya babhūva candrārkasamānavarṇaḥ (MBh 8.68(94).49cd)*

| |
|---|
| Jupiter tormented Rohiṇī and his colour became similar to the Moon and the Sun. |

Once king Drupada, the father of Draupadī, has a vision and sees the true nature of the five Pāṇḍavas. These are actually four former Indras (kings of the gods) and the current Indra. In order to learn humility, they had to incarnate. These Indras are described as "sun rays" or "solar lights" (*sūryabhāsaḥ*; MBh 1.189(199).19) and as "fire- and sun-coloured like Indra" (*śakraprakhyān pāvakāditya-varṇān*, 37). Incidentally, the incarnation of the five Indras is also symbolised by the fact that they are trapped for a time inside a mountain. From an astronomical point of view, the question arises if this entry into the mountain could represent the heliacal setting of the five planets and therefore for a super-conjunction of all planets.

Assuming that the five Pāṇḍavas represent the five planets, then what might the consequences be? First, the question arises, who could stand for the Sun and the Moon. A likely candidate for the Sun is Karṇa, who is actually an elder brother of the Pāṇḍavas. Kuntī, the mother of the Pāṇḍavas, had conceived him from the Sun god, Sūrya, when she was still a virgin and unmarried. As she was ashamed of the illegitimate child, she put him into a basket and placed him into a river, entrusting he would be brought to safety or to his future foster parents.

Who then could allegorise the Moon? As the Pāṇḍavas and Karṇa have no other siblings, Draupadī might play this part, the common wife of the Pāṇḍavas. When Drupada in his vision sees the Pāṇḍavas as "fire- and sun-coloured" (*pāvakādityavarṇāḥ*) Indras, he also sees Draupadī as the "moon- and fire-like" (*somavahnipra-kāśā*, or: "looking like the fire of the Moon") goddess Lakṣmī. Draupadī as the Moon would fit very nicely because within one month the Moon becomes conjunct with all of the five planets. The image of the five Pāṇḍavas and their common wife could also symbolise the five planets rising heliacally in conjunction with the crescent of the old moon. Karṇa, who also represents the Sun, has a connection with Draupadī. He had charmed her before Arjuna but had been rejected. Later, he took revenge, by calling her a whore in public, thus humiliating her because of her five husbands.

Other than Karṇa and Draupadī, there are two other candidates who are in close relation with the Pāṇḍavas which could represent the Sun and the Moon: Kṛṣṇa and his older brother Balarāma. Kṛṣṇa is often compared to the Sun:

सा यत्र रोहिणी देवी वसुदेवसुखावहा

तत्र तं बालसूर्याभं कृष्णं गूढं न्यवेशयत्

*sā yatra rohiṇī devī vasudevasukhāvahā*
*tatra taṃ bālasūryābhaṃ kṛṣṇaṃ gūḍhaṃ nyaveśayat* || *HV 49(2.5).30*

| |
|---|
| Where Rohiṇī was, the goddess, who brought happiness to Vasudeva,<br>there he brought secretly this Kṛṣṇa, who resembled the new-born sun. |

In the Viṣṇupurāṇa, the following verse can be found:

ततोऽखिलजगत्पद्मबोधायाच्युतभानुना

देवकीपूर्वसन्ध्यायामाविर्भूतं महात्मना

*tato'khilajagatpadmabodhāyācyutabhānunā*
*devakīpūrvasandhyāyāmāvirbhūtaṃ mahātmanā (VP 5.3.2)*

Then, in order to awaken the lotus of the whole world, the Kṛṣṇa sun (*acyuta* sun) appeared, the Great Self, in the Devakī dawn.

Balarāma could represent the Moon, as in the Harivaṃśa:

संकर्षणात्तु गर्भस्य स तु संकर्षणो युवा

भविष्यत्यग्रजो भ्राता मम शीतांशुदर्शनः

*saṃkarṣaṇāttu garbhasya sa tu saṃkarṣaṇo yuvā |*
*bhaviṣyatyagrajo bhrātā mama śītāṃśudarśanaḥ || HV 47.32*

Because of the pulling out (*saṃkarṣaṇa-*) of the embryo, this child will be [called] Saṃkarṣaṇa.
He will be my elder brother, who resembles the cold-rayed [Moon].

Incidentally, it is interesting to note that Balarāma does not participate in the war, but goes on a pilgrimage. The Moon, too, does not really participate in the planetary gathering. He joins the planets only briefly, but then moves on, in the opposite direction. The planets disappear in the west and reappear to the east again; the Moon does the opposite.

The question whether Kṛṣṇa and Balarāma represent the Sun and the Moon or whether it is rather Karna and Draupadī need not be decided unambiguously. Depending on the context, both views can be quite valid. Myths are highly variable, they constantly develop, change their shape, form different variants, which are later reconnected again with each other.

There are other indications that the five Pāṇḍavas represent the five planets. Thirteen years before the war, the Pāṇḍavas and their rivals, the Kauravas, met for a game of dice which the Pāṇḍavas had lost. As a result, they had to go into exile for 13 years. Moreover, it had been imposed on them that they would have to spend the 13th year in disguise, so that nobody could recognise them or know where they were. If they fail, they would lose their rights to the kingdom forever. Could these statements contain some astronomical truth? Could the years represent months, so that the real time span intended would be a year of 12 month plus a leap month? This would again fit the year 1198 BCE. As has been illustrated, there were two full moons at the end of this year, which could be considered Kārttika full moons, the second of which was 13 months after the Kārttika full moon of the preceding year. If in fact there was a leap month inserted in this year, then the super-conjunction and the concealment of the five planets would have occurred in the leap month. It was the 13th month, in which the planets entered into the sunlight and became combust.

There are even more legends about the five Pāṇḍavas that could allude to the heliacal setting of the five planets. The Kauravas built a house out of highly flammable material and entertained the Pāṇḍavas therein with the intention of burning them alive. However, the Pāṇḍavas were warned and had an underground passage dug leading them to freedom. Thus, they were able to escape the assassination. Upon first consideration, this tale does not seem to contain astronomical allusions. Though it could allude to the fact that the five planets immerged into the earth during the "burning" of the horizon and became invisible. The red-coloured evening and morning sky, into which the planets disappear and from which they reappear, is often compared to fire:

ततो मुहूर्ताद्भगवान्सहस्रांशुर्दिवाकरः

दहन्वनमिवैकान्ते प्रतीच्यां प्रत्यदृश्यत

*tato muhūrtādbhagavānsahasrāṃśurdivākaraḥ*
*dahanvanamivaikānte pratīcyāṃ pratyadṛśyata (MBh 12.52.26)*

| |
|---|
| Shortly thereafter, the Lord, the thousand-rayed day-maker (: the Sun), was seen setting in the west, burning the forest in one place, as it were. |

उभे संध्ये प्रकाशेते दिशां दाहसमन्विते

आसीद्रुधिरवर्षं च अस्थिवर्षं च भारत

*ubhe saṃdhye prakāśete diśāṃ dāhasamanvite*
*āsīdrudhiravarṣaṃ ca asthivarṣaṃ ca bhārata (MBh 6.2.30)*

| |
|---|
| Both twilights glowed accompanied by the burning of the [four] directions.<br>And there was a rain of blood and a shower of bone, O Bhārata. |

→

अलक्ष्यः प्रभया हीनः पौर्णमासीं च कार्त्तिकीम्

चन्द्रोऽभूदग्निवर्णश्च समवर्णे नभस्तले

*alakṣyaḥ prabhayā hīnaḥ paurṇamāsīṃ ca kārttikīm*
*candro'bhūdagnivarṇaśca samavarṇe nabhastale (MBh 6.2.23)*

The Moon lost his [hare] sign and became devoid of light on the full moon of the month of Kārttika (or: in the *nakṣatra* Kṛttikā), and fiery in colour at the firmament, which was of the same colour.

The last verse, has been interpreted as a lunar eclipse just after sunset, because the sky was fiery in colour.

The first of the above-cited verses, in which the Sun "burns" the forest while setting, is reminiscent of the legend of the burning of the Khāṇḍava Forest. In this story, Arjuna wages war against his father Indra, and defends the fire god Agni against Indra's rain showers. During this struggle, the planets also fall down to the earth:

समुत्पाट्य तु पाणिभ्यां मन्दराच्छिखरं महत्

सद्रुमं व्यसृजच्छक्रो जिघांसुः पाण्डुनन्दनम्

*samutpāṭya tu pāṇibhyāṃ mandarācchikharaṃ mahat*
*sadrumaṃ vyasṛjacchakro jighāṃsuḥ pāṇḍunandanam (MBh 1.218 (229).47)*

Indra tore out the great peak from [Mount] Mandara with his hands and hurled it, with all its trees, trying to kill the son of Pāṇḍu.

ततोऽर्जुनो वेगवद्भिर्ज्वलिताग्रैरजिह्मगैः

बाणैर्विध्वंसयामास गिरेः शृङ्गं सहस्रधा

*tato 'rjuno vegavadbhirjvalitāgrairajihmagaiḥ*
*bāṇairvidhvaṃsayāmāsa gireḥ śṛṅgaṃ sahasradhā (48)*

Then Arjuna [took] powerful, straight arrows
with burning heads and dashed the horn of the mountain into a thousand pieces.

गिरेर्विशीर्यमाणस्य तस्य रूपं तदा बभौ

सार्कचन्द्रग्रहस्येव नभसः प्रविशीर्यतः

*girerviśīryamāṇasya tasya rūpaṃ tadā babhau*
*sārkacandragrahasyeva nabhasaḥ praviśīryataḥ (49)*

Then the shape of the splintered mountain shone
like [the shape] of the sky, which is splintered into the Sun, the Moon, and the planets,

तेनावाक्पतता दावे शैलेन महता भृशम्

भूय एव हतास्तत्र प्राणिनः खाण्डवालयाः

*tenāvākpatatā dāve śailena mahatā bhṛśam*
*bhūya eva hatāstatra prāṇinaḥ khāṇḍavālayāḥ (50)*

When this great mountain violently crashed into the forest fire,
more creatures were killed that lived in Khāṇḍava [Forest].

Ganguli translates as follows:

The fragments of that mountain, in falling through the skies, looked as if the sun and the moon and the planets, displaced from their positions fell down on earth.

The collapse of the splintered mountain into the burning forest therefore represents the heliacal setting of the planets in the "burning" of the afterglow.

Coming back to the following description from Bhīṣmaparva:

एकादशैताः श्रीजुष्टा वाहिन्यस्तव भारत

पाण्डवानां तथा सप्त महापुरुषपालिताः

*ekādaśaitāḥ śrījuṣṭā vāhinyastava bhārata*
*pāṇḍavānāṃ tathā sapta mahāpuruṣapālitāḥ (MBh 6.16.44)*

This, O Bhārata, are **your eleven glorious armies**,
**and the seven [armies] of the Pāṇḍavas** are also commanded (protected) by great men.

उन्मत्तमकरावर्तौ महाग्राहसमाकुलौ

युगान्ते समुपेतौ द्वौ दृश्येते सागराविव

*unmattamakarāvartau mahāgrāhasamākulau*
*yugānte samupetau dvau dṛśyete sāgarāviva (MBh 6.16.45)*

The two armies resemble two oceans that flow together at the end of the age,
that are churned up by wild sea monsters, and abound with huge crocodiles.

... (*two verses*) ...

मघाविषयगः सोमस्तद्दिनं प्रत्यपद्यत

दीप्यमानाश्च संपेतुर्दिवि सप्त महाग्रहाः

*maghāviṣayagaḥ somastaddinaṃ pratyapadyata*
*dīpyamānāśca saṃpeturdivi sapta mahāgrahāḥ (MBh 6.17.2)*

On that day, the Moon god (Soma) entered the region of Maghā.
**The seven great planets burned in the sky and flew together.**

द्विधाभूत इवादित्य उदये प्रत्यदृश्यत

ज्वलन्त्या शिखया भूयो भानुमानुदितो दिवि

*dvidhābhūta ivāditya udaye pratyadṛśyata*
*jvalantyā śikhayā bhūyo bhānumānudito divi (3)*

| |
|---|
| The Sun was seen split in two, as it were, in his rising.<br>With a burning crown the shining one rose in the sky. |

This super-conjunction is apparently associated with the clash of the seven Pāṇḍavas armies with the eleven armies of the Kauravas. After the above considerations, it is very likely that the seven armies of the Pāṇḍavas represent the five planets plus the Sun and the Moon. But then, what could the 11 armies of the Kauravas represent? Could they serve as the 11 days during which the planets were invisible in the year 1198 BCE, when they came together to the super-conjunction? Is the Mahābhārata War to be interpreted as the manifestation on earth of the super-conjunction in the sky?

Several places there is mention of 18 armies (7 + 11) in the epic that participated in the battle, and of 18 days that the battle lasted:

अष्टादश समाजग्मुरक्षौहिण्यो युयुत्सया

तन्महद्दारुणं युद्धमहान्यष्टादशाभवत्

*aṣṭādaśa samājagmurakṣauhiṇyo yuyutsayā*
*tanmahaddāruṇaṃ yuddhamahānyaṣṭādaśābhavat (MBh 1.2.23c-e)*

| |
|---|
| Eighteen armies came together in pugnaciousness.<br>This great cruel battle lasted eighteen days. |

Could the 18-day duration of the battle represent the number of armies? Maybe this could be justified as follows: The planets were invisible for eleven days. During five of the days, the five planets made their heliacal rising. Two additional days could account for the solar and lunar eclipse. Unfortunately, this explanation is merely speculative, due to lack of evidence.

# *Bhīṣma's Death*

## How Many Days from the Battle to Bhīṣma's Death?

Attempts have also been made to date the Mahābhārata war using astronomical information given in the story of the death of Bhīṣma. Is this really possible?

Upon closer inspection, unfortunately, the situation is again very complicated. Let us first look back to the beginning of the battle! After a failed attempt to mediate between the warring parties, Kṛṣṇa gave his companions the following advice:

सप्तमाच्चापि दिवसादमावास्या भविष्यति

संग्रामं योजयेत्तत्र तां ह्याहुः शक्रदेवताम्

*saptamāccāpi divasādamāvāsyā bhaviṣyati*
*saṃgrāmaṃ yojayettatra tāṃ hyāhuḥ śakradevatām (MBh 5.140(142).18)*

| |
|---|
| After the seventh day will be the new moon.<br>Then one has to harness battle, for that [new moon], they say, has Indra as its [presiding] deity. |

The *nakṣatra* ruled by Indra is identified with Jyeṣṭhā, whose main star is Antares. This information plays a key role in the approaches of most authors who try to date the war on the basis of Bhīṣma's death circumstances. However, it has been illustrated that other text passages indicate that the war began on a full moon in the month of Kārttika. This full moon was accompanied by a lunar eclipse, as is evident from the following verse:

अलक्ष्यः प्रभया हीनः पौर्णमासीं च कार्त्तिकीम्

चन्द्रोऽभूदग्निवर्णश्च समवर्णे नभस्तले

*alakṣyaḥ prabhayā hīnaḥ paurṇamāsīṃ ca kārttikīm*
*candro'bhūdagnivarṇaśca samavarṇe nabhastale (MBh 6.2.23)*

| |
|---|
| The Moon lost his [hare] sign and became devoid of light on the full moon of the month of Kārttika (or: in the *nakṣatra* Kṛttikā), and fiery in colour at the firmament, which was of the same colour. |

As has been illustrated, the beginning of the war on a Kārttika full moon is supported by the events of the 14th night of the war and by Balarāma's calendrical remark after his return from his pilgrimage.

Bhīṣma is lethally wounded on the 10th day of the battle (MBh 6. 113(119) .96-105). In the moment he falls, he notices that the Sun is on his way south, from the summer solstice to the winter solstice. According to a Vedic doctrine, this is an unfavourable time to die if one strives for spiritual liberation. Bhīṣma decides to use his yogic powers to retain his breath of life until the winter solstice:

एवं विभो तव पिता शरैर्विशकलीकृतः

शिताग्रैः फल्गुनेनाजौ प्राक्शिराः प्रापतद्रथात्

किंचिच्छेषे दिनकरे पुत्राणां तव पश्यताम्

*evaṃ vibho tava pitā śarairviśakalīkṛtaḥ*
*śitāgraiḥ phalgunenājau prākśirāḥ prāpatadrathāt*
*kiṃcicchеṣe dinakare putrāṇāṃ tava paśyatām (MBh 6.114(120).81)*

| |
|---|
| Like this, your mighty father was broken into pieces by the sharp-pointed arrows by Arjuna in the battle, and he fell from the car with his head in eastward direction (or: headfirst),<br>shortly before sunset, while your sons saw it. |

... पतन्स ददृशे चापि खर्वितं च दिवाकरम्

*... patansa dadṛśe cāpi kharvitaṃ ca divākaram (86)*

| |
|---|
| Even as he fell, he saw that the Sun was defective. |

संज्ञां चैवालभद्वीरः कालं संचिन्त्य भारत

अन्तरिक्षे च शुश्राव दिव्यां वाचं समन्ततः

*saṃjñāṃ caivālabhadvīraḥ kālaṃ saṃcintya bhārata*
*antarikṣe ca śuśrāva divyāṃ vācaṃ samantataḥ (87)*

| |
|---|
| His consciousness he held fast, the hero, considering the [unfavourable] time, O Bhārata.<br>And in the air he heard a heavenly voice from all sides: |

कथं महात्मा गाङ्गेयः सर्वशस्त्रभृतां वरः

कालं कर्ता नरव्याघ्रः संप्राप्ते दक्षिणायने

*kathaṃ mahātmā gāṅgeyaḥ sarvaśastrabhṛtāṃ varaḥ*
*kālaṃ kartā naravyāghraḥ saṃprāpte dakṣiṇāyane (88)*

| |
|---|
| "How [can it be that this] great being, the son of Gaṅgā, the best of all weapon bearers,<br>the man-tiger, chooses [his death] time after the southward path [of the Sun] has been reached?" |

स्थितोऽस्मीति च गाङ्गेयस्तच्छ्रुत्वा वाक्यमब्रवीत्

धारयामास च प्राणान्पतितोऽपि हि भूतले

उत्तरायणमन्विच्छन्भीष्मः कुरुपितामहः

*sthito'smīti ca gāṅgeyastacchrutvā vākyamabravīt*
*dhārayāmāsa ca prāṇānpatito'pi hi bhūtale*
*uttarāyaṇamanvicchanbhīṣmaḥ kurupitāmahaḥ (89)*

When the son of Gaṅgā heard this, he spoke the word: "I am staying!", held fast his vital forces, [although] he had already fallen to the earth, and waited for the northward path [of the Sun], Bhīṣma, the grandfather of the Kurus.

Based on a text passage that will be studied later, it is usually assumed that the winter solstice took place only 58 days after Bhīṣma's fall. However, the verses quoted here do not really accord with this assumption. The expression *saṃprāpte dakṣiṇāyane* actually gives the impression *that the summer solstice had occurred on the very day or shortly before the day on which Bhīṣma fell*, so that it would have taken 182 days until the winter solstice. Thus, this text passage is in obvious contradiction with the information that the war began on a new moon in Jyeṣṭhā or a Kārttika full moon, because these must have occurred far away from the summer solstice.

Also interesting is the statement that Bhīṣma himself determines the time of the year *in the very moment he is falling to the ground*. The fact that he had to look (*dadṛśe*) at the Sun in order to determine the half-year or *ayana* indicates that there was some uncertainty about it, that the Sun was in transition, near the summer solstice and was about to begin his southward course. If Bhīṣma had fallen 58 days before the winter solstice, he would have known without any astronomical observations that he was about to die in the wrong half of the year.

What method of observation did Bhīṣma use? The text states that a "small remainder of the solar disk" (*kiṃciccheṣe dinakare*) was still visible when Bhīṣma fell, and that it was exactly in that moment that he saw the Sun was "defective" (*kharvitaḥ*). So, did Bhīṣma see the sunset and notice that the sun had stopped wandering to the north? One could argue that such an observation was not possible with day precision even using an observatory. However, as the heroes of our epic often use superhuman powers and abilities this is perhaps not a serious problem. In any case, the text states that Bhīṣma fell with his head towards the east. When he fell on his back, he could have seen the western horizon and the sunset.

Alternatively, it would also have been possible to infer the time of the year from the stars that were visible shortly after sunset. This observation would have been more realistic on the battlefield, although not necessarily more accurate. However, as has been shown, the text is actually talking of an observation of the setting Sun.

The text continues as follows:

तस्य तन्मतमाज्ञाय गङ्गा हिमवतः सुता

महर्षीन्हंसरूपेण प्रेषयामास तत्र वै

*tasya tanmatamājñāya gaṅgā himavataḥ sutā*
*maharṣīnhaṃsarūpeṇa preṣayāmāsa tatra vai (90)*

When Gaṅgā, the daughter of Himavat, learned of this his intention, she sent the Great Ṛṣis there in the form of swans.

ततः संपातिनो हंसास्त्वरिता मानसौकसः

आजग्मुः सहिता द्रष्टुं भीष्मं कुरुपितामहम्

यत्र शेते नरश्रेष्ठः शरतल्पे पितामहः

*tataḥ saṃpātino haṃsāstvaritā mānasaukasaḥ*
*ājagmuḥ sahitā draṣṭuṃ bhīṣmaṃ kurupitāmaham*
*yatra śete naraśreṣṭhaḥ śaratalpe pitāmahaḥ (91)*

Then the swans quickly flew together, who live in the [holy lake] Mānasa ("consisting of thought"),
they went there together to see Bhīṣma, the grandfather of the Kurus,
where he was lying, the best of men, on [his] bed of arrows, the grandfather.

ते तु भीष्मं समासाद्य मुनयो हंसरूपिणः

अपश्यञ्छरतल्पस्थं भीष्मं कुरुपितामहम्

*te tu bhīṣmaṃ samāsādya munayo haṃsarūpiṇaḥ*
*apaśyañcharatalpasthaṃ bhīṣmaṃ kurupitāmaham (92)*

After they had come together to Bhīṣma, the ascetics in the form of swans, they saw Bhīṣma, the grandfather of the Kurus, lying on his bed of arrows.

ते तं दृष्ट्वा महात्मानं कृत्वा चापि प्रदक्षिणम्

गाङ्गेयं भरतश्रेष्ठं दक्षिणेन च भास्करम्

*te taṃ dṛṣṭvā mahātmānaṃ kṛtvā cāpi pradakṣiṇam*
*gāṅgeyaṃ bharataśreṣṭhaṃ dakṣiṇena ca bhāskaram (93)*

When they had seen this great being and made a circumambulation about the son of Gaṅgā, the best of the Bhāratas, [keeping] the Sun on their right hand side,

इतरेतरमामन्त्र्य प्राहुस्तत्र मनीषिणः

भीष्म एव महात्मा सन्संस्थाता दक्षिणायने

*itaretaramāmantrya prāhustatra manīṣiṇaḥ*
*bhīṣma eva mahātmā sansaṃsthātā dakṣiṇāyane (94)*

the wise ones spoke to each other:
"Bhīṣma, as he is a great being, will stay alive during the southward path [of the sun]."

इत्युक्त्वा प्रस्थितान्हंसान्दक्षिणामभितो दिशम्

संप्रेक्ष्य वै महाबुद्धिश्चिन्तयित्वा च भारत

*ityuktvā prasthitānhaṃsān dakṣiṇāmabhito diśam*
*saṃprekṣya vai mahābuddhiścintayitvā ca bhārata (95)*

After the swans had thus spoken, O Bhārata, [Bhīṣma] with great insight watched
them circumambulating to the right (or south), and he pondered.

तानब्रवीच्छांतनवो नाहं गन्ता कथंचन

दक्षिणावृत्त आदित्ये एतन्मे मनसि स्थितम्

*tānabravīcchāṃtanavo nāhaṃ gantā kathaṃcana*
*dakṣiṇāvṛtta āditye etanme manasi sthitam (96)*

And the son of Śaṃtanu said to them: "*I* shall not go [away from this world], by no means,
as long as the sun moves south. This is standing firm in my mind.

गमिष्यामि स्वकं स्थानमासीद्यन्मे पुरातनम्

उदगावृत्त आदित्ये हंसाः सत्यं ब्रवीमि वः

*gamiṣyāmi svakaṃ sthānamāsīdyanme purātanam*
*udagāvṛtta āditye haṃsāḥ satyaṃ bravīmi vaḥ (97)*

I shall go to my true residence that was mine in old times,
when the Sun turns to the north. O swans, I tell you the truth.

धारयिष्याम्यहं प्राणानुत्तरायणकाङ्क्षया

अइश्वर्यभूतः प्राणानामुत्सर्गे नियतो ह्यहम्

तस्मात्प्राणान्धारयिष्ये मुमूर्षुरुदगायने

*dhārayiṣyāmyahaṃ prāṇānuttarāyaṇakāṅkṣayā*
*aiśvaryabhūtaḥ prāṇānāmutsarge niyato hyaham*
*tasmātprāṇāndhārayiṣye mumūrṣurudagāyane (98)*

I shall hold back [my] life forces waiting for the northward path,
for, I have control over the release of the life forces, and I am restrained.
Therefore, I shall hold back the life forces and shall die only during the northward path.

What do the Seven Ṛṣis stand for in this text? It is usually assumed that they are the stars of the constellation Ursa Major, the Big Dipper. So did Bhīṣma determine the time of the year from the view of the Big Dipper shortly after sunset? Could this interpretation be reconciled with the other clues given in the text? The "circumambulation" does not fit, because if one looks to the north, the "circumambulating" stars seem to have the celestial pole on *their left hand side* as they move around it. A "circumambulation" is a respectful going around a person or a sacred object, having that object or person on one's right hand side. A circumambulation in the opposite direction would be a sign of disrespect. At best, one might speculate that from the perspective of Bhīṣma, if he lied on his back with his head to the north, it would appear to him like a correct circumambulation. However, the text states, that he fell with his head in eastward direction (MBh 6.114(120).81, *prākśirāḥ prāpatad rathāt*). The word *prasthā-*, which is used in verse 95 and is translated as "to set out", would then preferably be translated as "to rise". So, the stars of Ursa Major would have transited their lower culmination and begun to rise, and indeed *to the right*; however, as has been said, in a circumambulation in the wrong direction.

Now the Seven Ṛṣis also appeared at the beginning of the war, and there it was found that it made more sense to interpret them as the seven planets. (MBh 6.3.24, see p. 293-295.) Here again, the question can be asked whether the text could describe a conjunction of the seven planets. The "flying together" (*sampātinaḥ*) of the seven swans around Bhīṣma in verse 91 is strongly reminiscent of the "flying together" (*sampetuḥ*) of the seven planets, which occurred at the beginning of the war:

दीप्यमानाश्च संपेतुर्दिवि सप्त महाग्रहाः
*dīpyamānāśca saṃpeturdivi sapta mahāgrahāḥ* (MBh 6.17.2)

The seven great planets burned in the sky and flew together.

Bhīṣma fell as early as on the 10th day of the battle. A super-conjunction can last for several weeks. Hence, if the war began during a super-conjunction, then Bhīṣma could still have fallen during the same conjunction. Besides, it must be kept in mind that the stars of Ursa Major cannot "fly together", whereas the planets can do that very well.

In verse 93, the Ṛṣis make a respectful circumambulation around Bhīṣma, and apparently at the same time around the Sun. Bhīṣma is compared to the sun god in other places, too.[206] The fact that he

[206] Bhīṣma in his incomparable fighting force is like the Sun that burns so bright and hot that one can not look at him (MBh 6.45(49).57f.):

मध्यंदिने यथादित्यं तपन्तमिव तेजसा

न शेकुः पाण्डवेयस्य योधा भीष्मं निरीक्षितुम्

*madhyaṃdine yathādityaṃ tapantamiva tejasā*
*na śekuḥ pāṇḍaveyasya yodhā bhīṣmaṃ nirīkṣitum*

Like the Sun burns bright and strongly at midday,
the warriors of the son of the Pāṇḍava could not look at Bhīṣma.

वीक्षां चक्रुः समन्तात्ते पाण्डवा भयपीडिताः

त्रातारं नाध्यगच्छन्त गावः शीतार्दिता इव

*vīkṣāṃ cakruḥ samantātte pāṇḍavā bhayapīḍitāḥ*
*trātāraṃ nādhyagacchanta gāvaḥ śītārditā iva*

And so, the Pāṇḍavas all around, tormented by fear, looked out,
but did not find a rescuer, like cattle which are plagued by cold.

Or MBh 12.47(48).4:

विकीर्णांशुरिवादित्यो भीष्मः शरशतैश्चितः

शिश्ये परमया लक्ष्म्या वृतो ब्राह्मणसत्तमैः

*vikīrṇāṃśurivāditye bhīṣmaḥ śaraśataiścitaḥ*
*śiśye paramayā lakṣmyā vṛto brāhmaṇasattamaiḥ*

Bhīṣma, who [was studded] with hundreds of arrows like the Sun is studded with rays,
lay there in utmost beauty, surrounded by the best of the Brahmins.

Here again, the question arises: If Bhīṣma is the Sun, then are the Brahmins the planets that gathered to form a super-conjunction?

"falls" just at sunset is probably not a coincidence either. After visiting Bhīṣma, the Ṛṣis set out "to the right" (95). Although *dakṣiṇāṃ diśam* could also mean "to the south", in the context of a "circumambulation" (*pradakṣiṇam*), the translation "to the right" seems more attractive. On the other hand, this does not make a big difference, because the observed motion of the rising planets in the eastern morning sky is both "to the right" and "to the south". As has been stated, a "circumambulation" is a respectful going around a person or a sacred object, having that object or person on one's right hand side. The direction of a circumambulation is the same as the direction of the motion of the stars, not only the daily motion due to the earth rotation but also the motion of the planets relative to the Sun. When the planets rise heliacally in the morning sky after their conjunction with the Sun, they pass the Sun from left to right.

Also interesting is the mention of Gaṅgā. It is she who ordered the Seven Ṛṣis to go to Bhīṣma. At the time when the planets appeared strung like pearls on a chain in the morning sky in 1198 BCE, on the morning of the last crescent on 19th November, the Sun was in the middle of the Milky Way, the heavenly Ganges. *Thus, this episode of the epic provides further confirmation that the battle was considered to have taken place during a super-conjunction of all planets in this particular region of the sky.*

After the battle, the Pāṇḍavas decide to wait and be in mourning for a month before entering Hastināpura. For, at the beginning of Śāntiparva (MBh 12) the following verse is found:

तत्र ते सुमहात्मानो न्यवसन्कुरुनन्दनाः

शौचं निवर्तयिष्यन्तो मासमेकं बहिः पुरात्

*tatra te sumahātmāno nyavasankurunandanāḥ*
*śaucaṃ nivartayiṣyanto māsamekaṃ bahiḥ purāt (MBh 12.1.2)*

Then the generous Kuru sons settled down,
to spend the [period of] mourning for a month outside the city.

After the mourning period, the Pāṇḍavas enter the city. They are triumphantly welcomed, and Yudhiṣṭhira is crowned king. (MBh 12.38ff.) The new king distributes estates and offices, enacts laws, and performs the funeral rites. (MBh 12.42ff.) One gets the impression that it takes Yudhiṣṭhira just two days to do all this. On the next morning, Kṛṣṇa advises Yudhiṣṭhira to set out to Bhīṣma, who is still lying on his bed of arrows in Kurukṣetra, in order to learn from him all things that a king ought to know. Kṛṣṇa himself and the other Pāṇḍavas accompany him. When they arrive, they find Bhīṣma in deep meditation and in silent inner communication with Kṛṣṇa. Kṛṣṇa says to him:

> पञ्चाशतं षट्च कुरुप्रवीर शेषं दिनानां तव जीवितस्य
>
> ततः शुभैः कर्मफलोदयैस्त्वं समेष्यसे भीष्म विमुच्य देहम्
>
> *pañcāśataṃ ṣaṭca kurupravīra śeṣaṃ dinānāṃ tava jīvitasya*
> *tataḥ śubhaiḥ karmaphalodayaistvaṃ sameṣyase bhīṣma vimucya deham*
> *(MBh 12.51.14)*

> A residual of fifty-six days, O best hero of Kurus, remains for you to live. Then you will find the rising of the splendid fruits of [your] deeds, Bhīṣma, after you will have left your body.

Before Kṛṣṇa says these words, there was a mourning period of one month plus one or two days for the enthronement of Yudhiṣṭhira and the reorganisation of the empire. However, this would mean that Bhīṣma spent considerably more time on his bed of arrows than the 68 days assumed by most authors. As Bhīṣma fell on the 10th day of the battle, the total number of days he spent on his bed of arrows must be calculated as follows: the remaining 8 days of the battle, then one month of mourning outside the city, then at least two days for Yudhiṣṭhira's enthronement, and finally the 56 days predicted by Kṛṣṇa, which comes to a total of at least 96 days.

Perhaps the number of days is even larger, because it is unknown whether the month of mourning is to be reckoned just as 30 days or starting from the next new or full moon after the end of the battle. If the latter and if the battle began on a new or full moon and ended after 18 days, then 12 days would have to be added to complete the month. The total number of days between Bhīṣma's fall and his death would then amount to 108.

In any case, it is obvious that these conclusions are in contradiction with the passage discussed further above, where it seems to state that Bhīṣma fell on the summer solstice. If Bhīṣma was to die on the winter solstice, but fell 96 or 108 days before that, then he cannot have fallen on the summer solstice.

After this conversation between Kṛṣṇa and Bhīṣma, it is mentioned that the Moon rises after sunset:

ततो मुहूर्ताद्भगवान्सहस्रांशुर्दिवाकरः

दहन्वनमिवैकान्ते प्रतीच्यां प्रत्यदृश्यत

*tato muhūrtādbhagavānsahasrāṃśurdivākaraḥ*
*dahanvanamivaikānte pratīcyāṃ pratyadṛśyata (MBh 12.52.26)*

| |
|---|
| Shortly thereafter, the Lord, the thousand-rayed day-maker (: the Sun), was seen setting in the west, burning the forest in one place, as it were. |

...

ततः पुरस्ताद्भगवान्निशाकरः समुत्थितस्तामभिहर्षयंश्चमूम्

दिवाकरापीतरसास्तथौषधीः पुनः स्वकेनैव गुणेन योजयन्

*tataḥ purastādbhagavān niśākaraḥ samutthitastāmabhiharṣayaṃścamūm*
*divākarāpītarasāstathauṣadhīḥ punaḥ svakenaiva guṇena yojayan (33)*

| |
|---|
| Then rose in the east the exalted one, the night-maker (i.e. the Moon) and delighted this army<br>and provided the herbs, whose juice the Sun had drunk up, with his (or: their) force (*guṇa-*) again. |

The Sun and the Moon are in opposition, and therefore it follows that the preceding conversation between Kṛṣṇa and Bhīṣma took place near a full moon. As the moon rises *after* sunset, the full moon must have occurred just on the same day or the day before. This means that the 56 days are to be counted from a full moon. Since 59 days are two months, Kṛṣṇa prophesies Bhīṣma's death for a date three days before a full moon. This would correspond to 11th or 12th of the bright fortnight.

According to the above calculations, Bhīṣma spent at least 96 or 108 days on his "bed of arrows". As he fell on the 10th day of the war, the war must have begun at least 105 or 117 days before the winter solstice. Furthermore, it has been found that the war started either with a new moon in Jyeṣṭhā or a full moon of the month Kārttika. On the other hand, it has been found that Bhīṣma must have died 3 days before a full moon. Reckoning from a new moon, this phase of the Moon occurs after about 12, 42, 71, 101, and 130 days, counting from a full moon after about 27, 57, 86, 116, and 145 days.

From this information, the number of days from the beginning of the battle until the death of Bhīṣma can be calculated again. Kṛṣṇa and Bhīṣma talk with each other 56 days before Bhīṣma's death on a full moon evening. This full moon was preceded by Yudhiṣṭhira's enthronisation and the month of mourning. Thus at least 32 days have to be added to the 56 days. However, if the month of mourning was a full calendar month, then it must have ended either 15 or 30 days earlier, depending on whether a new moon calendar or a full moon calendar was in use. Thus what has to be added to the 56 days is possibly not only 32 days but instead either 45 (1½ months) or 59 days (2 months). Hence, from the beginning of the month of mourning until the death of Bhīṣma, there are either 88 or 101 or 115 days, depending on the parameters chosen.

If 88 days are assumed, to be counted from the end of the war, then the 18 days of the war have to be added, making a total of 106 days. However, when Bhīṣma died 3 days before a full moon and the war began on a full moon, then the total number of days must have been 115. Alternatively, if the battle began on a new moon, it must have been 130 days.

On the other hand, if the month of mourning is reckoned as a calendar month, then a full month has to be added to the 101 or 115 days. Taking into account the correct length of a lunar month for the whole period of time, we arrive at either 130 or 145 days.

Hence there must have been either 115 or 130 or 145 days between the beginning of the battle and the death of Bhīṣma. Unfortunately, all these solutions are unrealistic. Bhīṣma allegedly died on the winter solstice. However, if a new moon occurred 130 days earlier near Jyeṣṭhā-Antares, then the distance between this star and the winter solstice must have been sufficiently great. This was the case about 6000 BCE plus or minus a thousand years, which is too early to be a plausible date for the war. A comparable date is found if 145 days are reckoned from the last Kārttika *full moon* and assume that the subsequent new moon took place near Jyeṣṭhā-Antares. On the other hand, if 115 days are counted from the last Kārttika full moon until the winter solstice, then the resulting year of the war is 3900 BCE, which is too early, too.

Perhaps, one could consider the above description of events as incorrect and only accept the mentioned lunar phases: The Jyeṣṭhā new moon at the beginning of the battle could have occurred 71 days before the death of Bhīṣma, which occurred three days before the full moon on the winter solstice. Alternatively, if the war began on a Kārttika full moon, Bhīṣma could have died 86 days later. In the latter case, after all, there would still be time for a 20-day mourning period. In both cases, the year of the war would fall in the period 1700 BCE plus or minus 1000 years.

Later the epic describes, how Bhīṣma, lying on his "bed of arrows" teaches Yudhiṣṭhira in all things that a king needs to know. Then Yudhiṣṭhira notes, 50 days after his arrival in Hastināpura that the winter solstice has come:

उषित्वा शर्वरीः श्रीमान्पञ्चाशन्नगरोत्तमे

समयं कौरवाग्र्यस्य सस्मार पुरुषर्षभः

*uṣitvā śarvarīḥ śrīmānpañcāśannagarottame*
*samayaṃ kauravāgryasya sasmāra puruṣarṣabhaḥ (MBh 13.153(176).5)*

| |
|---|
| After the splendid one (Yudhiṣṭhira) had resided 50 nights in the capital, he recalled, the best of men, that the time [had come] for the eldest of the Kurus. |

स निर्ययौ गजपुराद्याजकैः परिवारितः

दृष्ट्वा निवृत्तमादित्यं प्रवृत्तं चोत्तरायणम्

*sa niryayau gajapurādyājakaiḥ parivāritaḥ*
*dṛṣṭvā nivṛttamādityaṃ pravṛttaṃ cottarāyaṇam (6)*

| |
|---|
| He set out from the elephant city, surrounded by sacrificial priests,<br>after seeing that the Sun had turned around and had turned to the northward path. |

When Yudhiṣṭhira arrives at Bhīṣma's bed, Bhīṣma says:

दिष्ट्या प्राप्तोऽसि कौन्तेय सहामात्यो युधिष्ठिर

परिवृत्तो हि भगवान्सहस्रांशुर्दिवाकरः

*diṣṭyā prāpto'si kaunteya sahāmātyo yudhiṣṭhira*
*parivṛtto hi bhagavānsahasrāṃśurdivākaraḥ (MBh 13.153(167).26)*

| |
|---|
| "How good that you came, son of Kuntī, Yudhiṣṭhira, together with [your] ministers!<br>For the exalted one, the thousand-rayed day-maker has turned around. |

अष्टपञ्चाशतं रात्र्यः शयानस्याद्य मे गताः

शरेषु निशिताग्रेषु यथा वर्षशतं तथा

*aṣṭapañcāśataṃ rātryaḥ śayānasyādya me gatāḥ*
*śareṣu niśitāgreṣu yathā varṣaśataṃ tathā (27)*

| |
|---|
| Fifty-eight nights have passed, while I was lying<br>on pointed arrows – they (: the nights) were like a hundred years. |

माघोऽयं समनुप्राप्तो मासः पुण्यो युधिष्ठिर

त्रिभागशेषः पक्षोऽयं शुक्लो भवितुमर्हति

*mągho'yaṃ samanuprāpto māsaḥ puṇyo yudhiṣṭhira*
*tribhāgaśeṣaḥ pakṣo'yaṃ śuklo bhavitumarhati (28)*

| |
|---|
| The holy month of Māgha has come, Yudhiṣṭhira,<br>three quarters are still left. This might be the bright fortnight." |

This is a very interesting and accurate statement. Since the fall of Bhīṣma on the 10th day of the battle, 58 days have passed, and it is the day of the winter solstice. However, as Yudhiṣṭhira has spent 50 nights in Hastināpura, it seems to follow that he had entered the city immediately after the war, and not mourned outside the city for a month before entering the city, as was said in the beginning of the Śāntiparva (MBh 12). Besides, the statements made in these verses are in contradiction with the passage discussed further above, where Kṛṣṇa predicts that Bhīṣma would have to lie on his bed of arrows for another 56 days. This prediction took place *after* Yudhiṣṭhira's enthronement in Hastināpura, but in the verses just quoted, Yudhiṣṭhira says that he has been in Hastināpura for only 50 days.

The statement that it is the month of Māgha and the bright (waxing) fortnight causes additional problems. From the verses quoted above, it follows that Bhīṣma died 67 days after the beginning of the war. However, if this should be the bright fortnight, then the war would have begun on a new moon, not on a full moon. However, as has been seen, there is some evidence in favour of a full moon as the first day of the battle. The situation is as follows: A bright fortnight 67 days after the beginning of the war is compatible with a new moon near Jyeṣṭhā at the beginning of the war. However, a Jyeṣṭhā new moon at the beginning of the war is not compatible with the rising of the crescent moon in the morning after the 14th night of battle. Nor is it compatible with Balarāma's return from his pilgrimage on the last day of the battle with the Moon in Śravaṇa. Rather, these two facts are compatible with a beginning of the battle on a Kārttika full moon, as is indicated in another passage in Bhīṣmaparva. This, in turn, is incompatible with the death of Bhīṣma on the 67th day, when the moon was waxing. Unfortunately, these inconsistencies cannot be avoided.

Sengupta and others suspect that the statement "This ought to be the light half of the month" is to be interpreted as mere wishful thinking that unfortunately was not in agreement with reality.[207] The Bhagavadgītā teaches that in order to achieve immortality, one has to die during the "bright half of the year", i.e. after the winter solstice, and in the bright half of the month, i.e. after new moon during the waxing moon (BhG 8.24f.). Sengupta's translation of the verse is as follows:

> माघोऽयं समनुप्राप्तो मासः पुण्यो युधिष्ठिर
>
> त्रिभागशेषः पक्षोऽयं शुक्लो भवितुमर्हति
>
> *māgho'yaṃ samanuprāpto māsaḥ puṇyo yudhiṣṭhira*
> *tribhāgaśeṣaḥ pakṣo'yaṃ śuklo bhavitumarhati (28)*

> O Yudhiṣṭhira, the lunar month of Māgha is now fully on and its three-fourths are over. This ought to be the light half of the month (but it is not, D.K.).

However, the words *māgho'yaṃ samanuprāpto* seem to indicate that the month has just begun. Besides, Sengupta's understanding of the verse in the sense of a "pious wish not materialised" seems unnatural. It rather seems that Bhīṣma mentions the real date of the day and that it is the bright half of the month. It is also obvious that Bhīṣma will gain spiritual liberation (MBh 12.47(46).16). Thus he would have to die in the bright fortnight.

Problems are also caused by the fact that the bright half of the month of Māgha is described as *tribhāgaśeṣaḥ*. Unfortunately, this expression is too ambiguous. The following translations are possible or have been proposed by different authors:

1. Ganguli translates the verse as follows:

> This is, again, the lighted fortnight and *a fourth part of it* ought by this be *over*.

How can *tribhāgaśeṣaḥ* be translated as "a fourth part of it (is) over"? Ganguli understood the expression in the sense that "three quarters [of the fortnight] are left over" and that consequently one quarter of the fortnight has already passed. However, what would be a quarter of a fortnight? How are 15 days divided by four?

[207] Sengupta, *Ancient Indian Chronology*, p. 8.

VG Aiyer supposes

> that the winter solstice then occurred ... on the fourth or the fifth lunar day in the month of Magha after Amavasya, the new moon.

It is unlikely, however, that such an ill-defined date be intended. Moreover, this interpretation cannot be reconciled with the statement that the war began during a new moon (let alone a full moon). As Bhīṣma fell on the 10th day of the war and continued to live for 58 days until the winter solstice, this must be the 68th day, counted from the beginning of the war. If days are reckoned from a new moon, there is a new moon again on the 60th day, because two lunar months amount to 59 days. The 68th day, reckoned from a new moon, would have to be the 8th day after the new moon, i.e. the 8th day of the bright fortnight (*śuklapakṣāṣṭamī*). (Reckoning from a full moon, the death of Bhīṣma would result in the dark fortnight, which does not seem to be acceptable.)

2. SB Roy interprets *tribhāgaśeṣaḥ* as "on the third day" after a new moon:

> Bhīṣma said it ought to be Māgha Śukla Tritīya...[208]

However, this interpretation is problematic, too. The use of *-śeśa-* is more likely to indicate that a *tribhāga-* is *left over*, whatever may be the meaning of this word. Moreover, this solution is not consistent with the new moon on the first day of the battle either. Even if the first day of the war fell on a full moon, as is assumed by Roy, one does not arrive at the third day of the fortnight. Roy himself correctly notes that, counted from a full moon, it should in fact be the 8th day of the dark fortnight.

3. From a grammatical point of view, it would be more correct to translate it in the sense that the bright fortnight "has three parts left over". The three parts left over could be three *tithis*, equivalent to about three days, so that it would refer to the 12th day of the fortnight. This solution would again not be compatible with a new moon 68 or 69 days earlier. However, it *would agree* with Kṛṣṇa's prophecy on a full moon night saying that Bhīṣma would stay alive for a remaining 56 days (see p. 366), because 56 days after full moon, it takes another three days until full moon. There are "3 days of a bright fortnight left over".

[208] op. cit. p. 83.

4. It would also be grammatically correct to interpret *tribhāgaśeṣaḥ* in such a way that the bright fortnight "has a third left", i. e. about 5 days. Then the expression would refer to the 10th day of the fortnight. But again, this would not be consistent with the statement that the war began on a new moon.

5. Venkatachelam follows the commentary of Nīlakaṇṭha, who believes that the term *tribhāgaśeṣaḥ* means that "three quarters of the month are still missing", i.e. that a quarter of the *month* has passed and it is the 8th day of the bright fortnight.[209] Apparently he takes *tribhāgaśeṣaḥ* as an attribute to *māsaḥ* ("month") in the first half of the verse, not to *pakṣo'yaṃ śuklaḥ* ("bright fortnight"). This solution is unattractive insofar as *tribhāgaśeṣaḥ*, which is found in the second half of the verse, would preferably be taken as an attribute to ("bright fortnight"). Still, Venkatachelam's solution is not impossible, and it has the advantage that it is consistent with the premise that the war began on a new moon.

6. Sengupta understands the verse to mean that "three quarters of the month have passed", and he assumes that the month begins on new moon, that Bhīṣma dies in the dark fortnight, and that he just *wishes* it would be the bright fortnight. However, as has been stated, the words *māgho'yam samanuprāpto* seem to indicate that the month has begun only recently. Also, a compound ending with -*śeṣa*- should rather be analysed in the way proposed by Venkatachelam, i. e. in the sense that "three quarters or parts are left over".

Venkatachelam points out that "the 8th day of the bright fortnight" is confirmed in the text quoted below. Besides, the text confirms that Bhīṣma dies immediately after the Sun has reached the solstice.

शरतल्पे शयानस्तु भरतानां पितामहः

कथमुत्सृष्टवान्देहं कं च योगमधारयत्

*śaratalpe śayānastu bharatānāṃ pitāmahaḥ*
*kathamutsṛṣṭavāndehaṃ kaṃ ca yogamadhārayat (MBh 12.47(48).1)*

| |
|---|
| [Janamejaya said:] "How did the grandfather of the Bhāratas, lying on the bed of arrows,<br>leave the body and what [kind of] yoga did he adhere to?" |

[209] Venkatachelam, *The Plot in Indian Chronology*, p. 175f.

शृणुष्वावहितो राजञ्छुचिर्भूत्वा समाहितः

भीष्मस्य कुरुशार्दूल देहोत्सर्गं महात्मनः

*śṛṇuṣvāvahito rājañchucirbhūtvā samāhitaḥ*
*bhīṣmasya kuruśārdūla dehotsargaṃ mahātmanaḥ (2)*

[Vaiśampāyana said:] "Listen attentively, O king, with a pure and concentrated [mind],
o tiger of the Kurus, how Bhīṣma, the great being, left the body.

निवृत्तमात्रे त्वयन उत्तरे वै दिवाकरे

समावेशयदात्मानमात्मन्येव समाहितः

*nivṛttamātre tvayana uttare vai divākare*
*samāveśayadātmānamātmanyeva samāhitaḥ (3)*

As soon as the Sun had turned to the northward path,
[Bhīṣma] concentrated and made [his] self enter [his] self.

[var. (not included in the critical edition):

[प्रवृत्तमात्रे त्वयनमुत्तरेण दिवाकरे

[शुक्लपक्षस्य चाष्टम्यां माघमासस्य पार्थिव

[*pravṛttamātre tvayanamuttareṇa divākare*
[*śuklapakṣasya cāṣṭamyāṃ māghamāsasya pārthiva*

As soon as the Sun had turned to the northward path,
on the eighth day of the bright fortnight of the month of Māgha, O lord of the earth,

[प्राजापत्ये च नक्षत्रे मध्यं प्राप्ते दिवाकरे

[समावेशयदात्मानमात्मन्येव समाहितः]

[*prājāpatye ca nakṣatre madhyaṃ prāpte divākare*
[*samāveśayadātmānamātmanyeva samāhitaḥ]*

[just] as [the Moon rose] in the lunar mansion of Prajāpati (= Rohiṇī) and the Sun reached the middle [of the sky],
[Bhīṣma] concentrated and made [his] self enter [his] self.

विकीर्णांशुरिवादित्यो भीष्मः शरशतैश्चितः

शिश्ये परमया लक्ष्म्या वृतो ब्राह्मणसत्तमैः

*vikīrṇāṃśurivādityo bhīṣmaḥ śaraśataiścitaḥ*
*śiśye paramayā lakṣmyā vṛto brāhmaṇasattamaiḥ (4)*

Bhīṣma, who [was studded] with hundreds of arrows like the Sun is studded with rays,
lay there in utmost beauty, surrounded by the best of the Brahmins.

However, exactly the two most important lines are not included in the critical edition of the text, namely the ones that date the death of Bhīṣma to the 8th day of the bright fortnight and locate the Moon in Rohiṇī. Thus, unfortunately, the text cannot be trusted. The two lines were probably interpolated as a support of the theory that the war started on the new moon and that Bhīṣma was lethally wounded on the 10th day of battle and died 58 nights later.

Also interesting are the following verses:

एते हि देवा वसवो विमानान्यास्थाय सर्वे ज्वलिताग्निकल्पाः

अन्तर्हितास्त्वां प्रतिपालयन्ति काष्ठां प्रपद्यन्तमुदक्पतंगम्

*ete hi devā vasavo vimānānyāsthāya sarve jvalitāgnikalpāḥ*
*antarhitāstvāṃ pratipālayanti kāṣṭhāṃ prapadyantamudakpataṃgam (15)*

| |
|---|
| For, these gods [and] Vasus have all mounted their celestial chariots like burning fires;<br>hidden, they are waiting for you when you set out flying to the north. |

व्यावृत्तमात्रे भगवत्युदीचीं सूर्ये दिशं कालवशात्प्रपन्ने

गन्तासि लोकान्पुरुषप्रवीर नावर्तते यानुपलभ्य विद्वान्

*vyāvṛttamātre bhagavatyudīcīṃ sūrye diśaṃ kālavaśātprapanne*
*gantāsi lokānpuruṣapravīra nāvartate yānupalabhya vidvān (16)*

| |
|---|
| As soon as the exalted one, the Sun god, has turned around and set out in northerly direction, [following] the command of Time,<br>o greatest hero, you will go into those worlds, from which a knower, after attaining them, will not return. |

Bhīṣma is here identified with the Sun that turns around and takes the northward path (see also above verse MBh 12.47(48).4). And who are the gods, who have mounted their fiery chariot, but are still waiting in a hidden place until the Sun sets out for his northward path? Are they the planets, all of which remain hidden in the sunlight and eventually rise together heliacally at the winter solstice? Is this again the motive of the super-conjunction and the simultaneous heliacal rising of all planets? It seems that the beginning of the Kaliyuga, the Mahābhārata war, Bhīṣma's death, and even Kṛṣṇa's death, were brought in connection with such a celestial configuration. Here, however, the text seems to suggest that the super-conjunction occurred on the *winter solstice*. On the other hand, it was found that the war occurred at the time of a planetary gathering more than two months *before* the winter solstice, shortly after the autumnal equinox in the month of Kārttika.

Here again, of course, one could try to find a historical celestial configuration that meets these conditions as best as possible. But it should not be assumed that such a configuration be actually connected with a historical event such as Bhīṣma's death. Evidently, the astronomical information concerning Bhīṣma's death, as given in the epic, is the fruit of an astro-theological speculation. If there was a super-conjunction at the beginning of the battle, it is not possible that another one occurred only two months later on the day of Bhīṣma's death. At best, it is possible that the planets were still not too far away from each other and visible together in the morning sky. Was this the case on the winter solstice 1198 BCE? At least, it can be stated that all planets except Mercury were visible in the morning sky.

Yet another detail deserves attention. Immediately after the conversation between Bhīṣma and Kṛṣṇa on that full moon night, when Bhīṣma learns that he will have to lie on his bed of arrows for another 56 days, the following occurs:

> ववौ शिवः सुखो वायुः सर्वगन्धवहः शुचिः
>
> शान्तायां दिशि शान्ताश्च प्रावदन्मृगपक्षिणः
>
> *vavau śivaḥ sukho vāyuḥ sarvagandhavahaḥ śuciḥ*
> *śāntāyāṃ diśi śāntāśca prāvadanmṛgapakṣiṇaḥ (MBh 12.52.25)*

> An auspicious, soothing wind blew that brought all sorts of fragrances and was pure.
> The place was peaceful, and the animals and birds peacefully made their sounds.

> ततो मुहूर्ताद्भगवान्सहस्रांशुर्दिवाकरः
>
> दहन्वनमिवैकान्ते प्रतीच्यां प्रत्यदृश्यत
>
> *tato muhūrtādbhagavānsahasrāṃśurdivākaraḥ*
> *dahanvanamivaikānte pratīcyāṃ pratyadṛśyata (26)*

> Shortly thereafter, the exalted one, the thousand-rayed sun,
> as if burning the forest in one place, was seen setting in the west.

> ततो महर्षयः सर्वे समुत्थाय जनार्दनम्
>
> भीष्ममामन्त्रयां चक्रू राजानं च युधिष्ठिरम्
>
> *tato maharṣayaḥ sarve samutthāya janārdanam*
> *bhīṣmamāmantrayāṃ cakrū rājānaṃ ca yudhiṣṭhiram (27)*

> Then all the great Ṛṣis rose and saluted
> Kṛṣṇa, Bhīṣma and King Yudhiṣṭhira.

ततः प्रणाममकरोत्केशवः पाण्डवस्तथा

सात्यकिः संजयश्चैव स च शारद्वतः कृपः

*tataḥ praṇāmamakarotkeśavaḥ pāṇḍavastathā*
*sātyakiḥ saṃjayaścaiva sa ca śāradvataḥ kṛpaḥ (28)*

Then Kṛṣṇa made a bow, and also Yudhiṣṭhira,
Sātyaki, Sañjaya and Kṛpa, the son of Śaradvat.

... and shortly thereafter, as has been seen, the full moon rises.

After sunset, “all great Ṛṣis” appear and greet those present. Again, the suspicion arises that they could be the seven planets coming together to form a conjunction. Although, as has been stated, if all planets formed a super-conjunction at the beginning of the war, they cannot do so again only two months later.

After a careful study of all textual evidence it should be clear that the astronomical and calendrical information concerning Bhīṣma’s death is in itself too vague and too contradictory to be suitable for a dating of the war. However, it is interesting that, again, the idea of a super-conjunction of all planets is alluded to in several places.

## Bhīṣma’s Death and the Super-conjunction of 1198 BCE

It was found that the Mahābhārata war must have taken place near the year 1198 BCE. In the autumn of that year, there was a remarkable celestial configuration that fits well with the clues given in the epic, a conjunction of all planets, accompanied by a lunar and a solar eclipse, both of which were observable from Kurukṣetra. Apparently it was assumed that the war began exactly on the day after one of the two eclipses, although it is not clear which one.

How well do the astronomical allusions around Bhīṣma’s death accord with celestial configuration in the year 1198 BCE? Despite all the ambiguities and contradictions in the text, it seems to be clear that Bhīṣma died shortly after the winter solstice. The winter solstice took place on the night from 31st December 1198 BCE to 1st January 1197 BCE. Bhīṣma could therefore have died on 1st or 2nd January. However, it has to be kept in mind that the winter solstice could not be easily determined to the day. If Bhīṣma’s death is assumed on 31st December at noon, there is the advantage that the lunar phase is 3 days before the full moon. This would be in line with the prediction of Kṛṣṇa, who on a full moon evening predicted that Bhīṣma would have to live for another 56 days. Secondly, it would be in line with that controversial verse, according to which "three parts (i. e. days) were left over" (*tribhāgaśeṣaḥ (śuklapakṣaḥ)*) of the bright fortnight on the day of Bhīṣma's death. However, the prophecy would have had to take place on the Kārttika full moon on 4th November, which was considered to be a possible starting date for the war. The war would thus actually have begun during the new moon near Jyeṣṭhā on 21st October. Until the death of Bhīṣma on 31st December there would have been 71 days. Most authors assume that Bhīṣma died on the 68th day after the beginning of the war, namely 58 days after his fall on the evening of the 10th day of battle. Despite all the contradictions in the text, it nevertheless appears that the year 1198 BCE harmonises quite well with some clues given by the text.

## Alternative Approaches III

Numerous attempts have been made to date the Mahābhārata war based on the astronomical and calendrical information concerning Bhīṣma's death. Given the many contradictions and problems in the text, no reliable result can be expected from such attempts. The results are also very different among the different authors. Some obviously take advantage of the vagueness of the text in order to "prove" *their* preferred date for the war. At the same time they avoid a full and frank discussion of the problems of the text and hide in silence everything that does not fit into their theory. The above investigation illustrates some of the major issues with the text.

Another problem that deserves closer examination is the astronomical sloppiness with which some authors approach the matter. Hopefully, this discussion will encourage future authors to work with more thoroughness.

For the dating of Bhīṣma's death, most authors use the following clues:

- At the beginning of the battle there was a new moon near Antares (Jyeṣṭhā).
- Bhīṣma was fatally injured on the 10th day of the battle. Since the war began on a new moon near Antares, this is the 9th day, or 9 nights, after the new moon
- In order to gain immortality, he could not die immediately, but had to wait for 58 days on his “bed of arrows” until the day of the winter solstice. Hence he died 67 days after the beginning of the war, i. e. on the 68th day, if one counts from the first day of the war, which was during the new moon in Jyeṣṭhā.

Although it was found that the first and third statements are very uncertain, they will be accepted in the following for the sake of argument.

As Antares slowly changes its position relative to the winter solstice due to the precession of the equinoxes, S. B. Roy calculates that Bhīṣma must have died around the year 1414 BCE.[210] However, M. Gupta arrives at the year 1949 BCE on the basis of the same facts[211], and P. V. Holay even at the year 3341 BCE +– 240 years.[212] Other authors arrive at different dates. How is this possible? Let us discuss the dating methods used by them in order to demonstrate what kind of errors are typically made. In square brackets [] the author of this work’s corrections are given.

It is important to preface that many of this author’s predecessors had to get along without a computer and electronic ephemerides. Accurate calculations were therefore extremely tedious for them and they had to resort to simplifications. Small errors resulting from such simplifications are of course not to be interpreted as a result of lack of expertise. But with some authors, unfortunately, real thinking errors and inaccurate work can be found.

---

[210] Roy, S.B., “Mahābhārata and Astronomy”, p. 84.

[211] Gupta, M., “The Date of Mahābhārata War. Purāṇic and Astronomical Evidence”, p. 48f.

[212] Holay, P.V., “The Year of the Kaurava-Pāṇḍava War”, p. 76f.

*S. B. Roy and T. Bhattacharya*

A very simple and suitable approach is chosen by S. B. Roy.[213] First he calculates the tropical ecliptic longitude of Antares in the year 1970, which was 249.30° [more precisely: 249.34°]. 67 days after the new moon conjunct Antares, the Sun was at 317° [more precisely: 317.5]. This was thus the position of the winter solstice in the year Bhīṣma died. Now, the tropical longitude of the winter solstice is always 270°. The shift of the solstice due to the precession is therefore 317° – 270° = 47° [more precisely: 317.5° – 270 ° = 47.5°]. Roy takes the speed of the precession as 72 years per degree [more precisely: 71.6275 years, corresponding to 50.26" per year; however, this value is only accurate for the present]. The year Bhīṣma died is thus 1970 – 47° x 72 = -1414 [more exactly: 1970 – 47.5° x 71.6275 = -1432.31, which is equivalent to 1432 BCE].

T. Bhattacharya in principle chooses the same way as Roy, and he arrives at the year 1432 BCE.[214] The only difference between the two approaches is that Roy has the battle begin on the full moon, whereas Bhattacharya gives preference to the new moon. However, this has no effect on the resulting date, because both assume the Sun in conjunction with Antares 67 days before the winter solstice. Still, a serious problem arises for Roy: If the Sun was conjunct with Antares during the full moon in Kṛttikā/Rohiṇī, then it could not have been in conjunction with Antares during the following new moon. The text, however, explicitly mentions a new moon in Jyeṣṭhā.

The calculations of Roy and Bhattacharya are not entirely accurate, as they ignore the variations in the precession, the variable velocity of the Sun in the relevant section of the ecliptic, and the proper motion of the star. With a very accurate calculation, the resulting year is 1470 BCE +– a few years.

It is already evident that the two authors, by giving precise years for the war, feign an accuracy of their calculations that they do not really accomplish. Even worse, they are apparently not aware that the exact year of the war cannot be determined in this way. If the

[213] Roy, S.B., “Mahābhārata and Astronomy”, p. 84.

[214] Bhattacharya, T., “The Bhārata Battle”.

battle started during a new moon in Jyeṣṭhā, then this does not necessarily mean that the Sun was in precise conjunction with the star Jyeṣṭhā (Antares). By current definition, Jyeṣṭhā is a lunar mansion the size of 13°20’. What definition exactly it had in ancient times, we do not know. This means that it is unknown where exactly within this area the new moon took place. It is only known that it took place somewhere near the star or within its lunar mansion. Besides, it should be noted that the position of a new moon was not easy to determine and was fraught with considerable uncertainties. All these facts result in an uncertainty of hundreds of years for the dating of the war. So, Roy and Bhattacharya pretend to date the war with year accuracy, while using a method that is not suitable for it. Unfortunately, this is a widespread characteristic of Indian dating attempts.

Apart from this, the calculations by the two authors are correct. It should, however, be noted again that the assumptions upon which they rest, i.e. the three astronomical and calendrical clues mentioned further above, are quite problematic in themselves.

*M. Gupta*

Let us turn to M. Gupta, who dates the death of Bhīṣma to the year 1949 BCE, starting from the same facts as the authors discussed above. What exactly does he do and why is his date so much earlier than Roy’s and Bhattacharya’s?

Like Roy, Gupta starts out from the assumption that Bhīṣma died 67 nights after the beginning of the battle and thus on the 68th day, counting from the Jyeṣṭhā new moon. However, he believes that the astronomical statements made in the Mahābhārata are based on the system of equal-sized *nakṣatras*. Indeed, the Jyeṣṭhā new moon did not need to occur near the star Antares, as Roy wants us to believe, but could have taken place as much as 10° after it. Now, if the distance between the Jyeṣṭhā new moon and the winter solstice were increased by 10°, then the war would have to be dated 720 years earlier. Owing to this, it becomes obvious how speculative not only Gupta’s, but also Roy’s and Bhattacharya’s approaches are.

Moreover, Gupta assumes, based on MBh 12.47(48), that Bhīṣma died on the 8th of the bright fortnight of the month of Māgha, while the Moon was in Rohiṇī. Although this verse is not contained in the critical edition of the Mahābhārata and certainly is a late interpolation, some authors consider it authentic. So let us assume that Bhīṣma in fact died on such a date, and see what part it plays in Gupta's dating of the battle!

Gupta believes that this date is compatible with the death of Bhīṣma 67 days after the Jyeṣṭhā new moon. He writes:

> ... there was an interval of 68 days or 67 nights (9 + 58) between the beginning of the War and the passing away of Bhīṣma. This shows that from Jyeshṭhā 68th star was ruling on that day. By straight computation it comes as Rohiṇī (2 rounds of zodiac 27 x 2 = 54 + 14 = 68 i.e. 14th star from Jyeshṭhā, i.e. Rohiṇī).[215]

To begin with, it has to be noted that the counting of 68 lunar mansions leads to Rohiṇī only if Jyeṣṭhā is counted as number one. In fact, only 67 full days are reckoned, from the sunrise of the Jyeṣṭhā new moon to the sunrise of the day when Bhīṣma died. Therefore one could also count 67 *nakṣatras* starting from the *nakṣatra* Mūla, the one that follows Jyeṣṭhā.

Now, in can be criticised that Gupta blindly trusts that the moon moves exactly one *nakṣatra* every day and that 67 days therefore correspond to a lunar motion of exactly 67 *nakṣatras*. To calculate the correct date, it must be kept in mind that the equations "*tithi* = day" and "*nakṣatra* = day" are not sufficiently accurate when one works with a greater number of days. The lunar month has 30 *tithis*, but only 29.5 days. Two months thus have 60 *tithis*, but only 59 days. Strictly speaking, the moon does not cross the full circle of the lunar mansions in 27 days, but in 27.322 days. Thus 67 days correspond to a lunar motion of only 66.2 *nakṣatras*. In other words, if one starts from a new moon in Jyeṣṭhā, then 67 days later on 8 Māgha (in the 8th *tithi*) the Moon would usually not be found in Rohiṇī, but in Kṛttikā.

The situation can also be illustrated as follows: In 67 days, the sun moved about 68°. If these 68° are reckoned from the *nakṣatra* Jyeṣṭhā, which extends from 226°40' to 240°, then the position of the Sun on the death day of Bhīṣma results between 294°40' and 308°. Now, the 8th *tithi* stands for a half-moon, i.e. for an elongation of the Moon of 90° +– 6°. Hence, the position of the Moon on

[215] Gupta, M., op. cit., p. 46.

the same day must be between 18°40 and 44°. As Rohiṇī starts at 40°, it would have been a rare edge case if the Moon had been in Rohiṇī on the 8th of waxing Māgha. It must be kept in mind, however, that it was not really trivial for ancient astronomers to localise the position of the new moon in Jyeṣṭhā.

Gupta believes that the Moon is in the area of Rohiṇī according to the current definition, i.e. between 40° and 53°20'. On the 8th of the month or in the 8th *tithi*, the angle between the Sun and the Moon is 90°+–6°. He further assumes that the summer solstice is in Maghā, that is between 120° and 133°40', because the Seven Ṛṣis are said to have been in Maghā at that time. From this interpretation of the motion of the Seven Ṛṣis, which of course is highly questionable, he concludes that the winter solstice must have been in the area between 300° and 313°40'.

From all this, Gupta draws the conclusion that the Sun is located between 40° – 96° (+ 360°) = 304° and 53°20' – 84° (+ 360°) = 329°20'. However, if the Sun must be at the solstice, which Gupta assumes in Maghā, only the range between 304° and 313°40' is possible.

However, this upper limit is incorrect. If the new moon near Jyeṣṭhā is assumed at the end of the *nakṣatra* Jyeṣṭhā at 240° and the Sun is moved by 68°, the solstitial Sun will be at 308° (not at 329°20' and not at 313°40'!). This is actually the maximum position of the Sun. The maximum position of the Moon in the 8th *tithi* is therefore 308° + 96° (– 360°) = 44° (not 53°20'!).

He then calculates the *ayanāṃśa* as 304° – 270° = 34° and, using a precession rate of 50" per year (= 72 years per degree), a temporal distance of 2448 years from the zero point, which he assumes in 499 CE, following the Sūryasiddhānta and Āryabhaṭa. Hence, the resulting year is 2448 – 499 = -1949. Strangely, he tacitly ignores his upper limit of 313°40', which would lead to the year -2645. If the correct upper limit of 308° were used, one would arrive at the year -2237. Hence, Gupta also pretends a precision that his calculation is not really able to provide. In addition, there is an error of 13 to 15 years that results from an inaccurate precession rate.

*K. Venkatachelam*

K. Venkatachelam chooses a similar approach as M. Gupta.[216] However, he dates the death of Bhīṣma 1000 years earlier, to 15th January 3139 BCE (-3138). The date suggests that he wants to date the war in accordance with the tradition, 36 years before the Kali-yuga era. However, he does not expressly refer to this era. Instead, he uses the precession of the equinoxes for the dating of the war, just like the authors discussed above. For reasons that need not be examined in detail, he assumes the death of Bhīṣma 1½ days after the winter solstice. Like M. Gupta, he locates the Moon in the 8th *tithi* in Rohiṇī. More specifically, based on a theory of another author, he puts the Moon in the third quarter of Rohiṇī at 49.55°. For the angle between the Sun and the Moon on the day of the solstice he chooses the exact value of 90°. Thus, the solstice results at 49.55° – 90° - 1.5° (+ 360°) = 318.05°, which is 14° later than the solstice calculated by Gupta. Since the precession moves 1° in 71.6 years, 14° correspond to just about 1000 years.

The assumptions and problems underlying this theory need not be discussed in detail. The following points should be made, though:

As was shown with M. Gupta's theory, the maximum position of the Sun 67 days after the beginning of the war is only 308° (not 318.05°!). Because of this difference of 10°, Venkatachelam's dating of the war to the year 3140 BCE is at least 720 years too early. Or, at least, his dating is not compatible with the alleged 67 days between the beginning of battle and the death of Bhīṣma.

Venkatachelam believes that his date is accurate to the year. According to him, Bhīṣma died at noon the day the Sun had passed the solstice by 1½°. This was the case on 15th January, 3139 BCE (-3138) Jul. (= 20th December, 3140 BCE Greg.). A calculation of the celestial configuration for that date confirms that the Sun itself, as indicated by Venkatachelam, is found in the last quarter of Śata-bhiṣaj (*ayanāṃśa* after Lahiri) and the Moon in the middle of Rohiṇī. However, the previous new moon occurred in the middle of sidereal Aquarius and the subsequent full moon near the end of Pūrvaphalgunī, and therefore this was not the month of Māgha, as

[216] Venkatachelam, *The Plot in Indian Chronology*, p. 170ff.

it should be, but Phālguna. Incidentally, all theories that assume the war before 3000 BCE and Bhīṣma's death on Śukla 8 after the winter solstice have the same problem. It can only be avoided by assuming some intercalary month, which, however, would have been inserted according to some speculative pre-Siddhāntic intercalation method.

The preceding new moons occurred on 7th January, 3139 BCE, 8th December, 3140 BCE, and 9th November, 3140 BCE. The last date would be 67 days before the death of Bhīṣma and would be the first day of the war. However, the new moon on 9th November does not take place in Jyeṣṭhā (Antares), as it should, but 25° away from Jyeṣṭhā in Mūla/Pūrvāṣāḍhā. The previous new moon on 10th October took place precisely at the star Anurādhā, which is 7° before Antares-Jyeṣṭhā. The number of days from there to the alleged death day of Bhīṣma is 97 days.

*K. S. Raghavan*

Raghavan also assumes that Bhīṣma died on the winter solstice with a waxing half-moon in Rohiṇī. However, he dates this event to 97 rather than 67 days after the new moon in Jyeṣṭhā.[217] He provides the following chronology: On the new moon in Jyeṣṭhā, the two armies went to the battlefield in Kurukṣetra. There they made the necessary preparations for the battle. These preparations took them a whole month, until the new moon in Pūrvāṣāḍhā, which marked the beginning of the month of Mārgaśīrṣa. The next day, Raghavan believes, a Navarātra (a nine-day autumn festival) began, and on the 10th of the month, an *āyudhapūjā* (a kind of "weapons consecration") was celebrated. Then they decided to unleash the battle on the next day, the 11th of the bright fortnight. Hence, from the Jyeṣṭhā new moon to the outbreak of the war, Raghavan counts 40 days. And from the outbreak of the war, he reckons the 58 days until the death of Bhīṣma. This is how he arrives at a period of 97 days from the new moon in Jyeṣṭhā to the death of Bhīṣma.

Unfortunately, again, this chronology is not consistent with important statements of the epic. For example, the 58 days must not be counted from the beginning of the battle, but only from the 10th

[217] Raghavan, *The Date of the Mahabharata and the Kali Yugadhi*, p. 11; 18f.

day of the battle. The text explicitly says that Bhīṣma was lying on his bed of arrows for 58 days. (see p. 369). However, this chapter is primarily concerned with calculation methods. So, let us consider these further.

Raghavan assumes the new moon at an exact conjunction with the star Jyeṣṭhā (Antares) and calculates its sidereal position at 224.75°. As Bhīṣma dies on the 8th of Māgha in Rohiṇī, Raghavan logically concludes that three lunar cycles rather than two must have passed. The position of the Sun at the winter solstice is therefore 224.75° + 87.3° (for three synodic months) + 6.8° (for the 8th *tithi*) = 318.85°. The Moon is assumed at an elongation of exactly 90° and thus is found at about 49°, at the very end of the *nakṣatra* Rohiṇī. Based on the rate of precession, Raghavan dates the war to about 3100 BCE.

Here again, it must be criticised that Raghavan alleges an accuracy of the calculation which cannot really be given. There is no reason to suppose that the new moon occurred in exact conjunction with the star Antares. it could also have occurred a couple of degrees before or after it, causing a shift in the dating by several centuries.

*P. V. Holay*

A slightly different approach is chosen by P. V. Holay.[218] He also believes the Moon to have been in Rohiṇī on the day of Bhīṣma's death, more precisely in exact conjunction with the star Aldebaran. For Aldebaran, he calculates the position 69.72689° referred to the equinox of the year 1995 CE. Then he computes the position of the new moon that occurred 7 days (7 *tithis*) before Bhīṣma's death, and then infers the position of the Sun. For the Moon he uses a daily motion of 13.176°. The new moon thus occurred at 69.72689° – 7° x 13.176 (+ 360°) = 337.492°. To find the Sun's position for the death of Bhīṣma, he adds the motion of the Sun for 7 days: 337.491° (sic!) + 7.032° = 344.532° [correct: 344.523°]. At this point (on the ecliptic of 1995) he assumes the winter solstice in the year when Bhīṣma died. As the tropical position of the winter solstice is always 270°, the precession to be considered is 344.523° – 270° = 74.523°. This value is multiplied by 71.6 years, and thus he arrives at 5336 years before the year 1995, i. e. 3341 BCE. As it is not known

[218] Holay, P.V., "The Year of the Kaurava-Pāṇḍava War", p. 76f.

exactly how close to Aldebaran the Moon really was, he mentions an uncertainty of +– 240 years. He does not say how he arrived at this error estimation.

This calculation is unfortunately completely screwed up. To obtain a correct average date of the war, one would rather do the following: For the 8th *tithi*, an elongation of the moon of 90° is chosen. On the winter solstice, the day when Bhīṣma died, the Moon was at 69.72689° (on the ecliptic of 1995 CE). It follows that on the same day the Sun was found 90 degrees before that at 339.72689°. The resulting precession is then 339.72689° – 270° = 69.72689°. This value multiplied by 71.6 years is 4992.45 years. If this number is subtracted from the year 1995, the resulting year is 2998 BCE (-2997).

The error estimation for this year can be derived from the fact that the Moon did not have to be in exact conjunction with Aldebaran, but could have been a couple of degrees away from it. Further uncertainty factors are the significantly varying speed of the Moon and the fact that the 8th *tithi* stands for an elongation of 90° +– 6°. The position of the winter solstice might therefore be accurate to about +–10°, which for the dating of the war means an uncertainty of +–700 years.

Holay dates the beginning of the war to 13th November, 3143 BCE. He does not derive this year from the episode of Bhīṣma's fall and death, but from a conjunction of all planets that occurred in that year, not too far away from the beginning of the Kaliyuga, which he assumes in 3104 BCE. However, the conjunction of 3143 BCE was very wide, and at no time were all the planets invisible.[219] The next winter solstice fell on 16th January. As a result, Holay has the same problems as Venkatachelam. Firstly, Bhīṣma would have died in Phālguna rather than Māgha. Secondly, there are either three lunar cycles, rather than two, between the beginning of the war and the death of Bhīṣma, or the war did not begin on the new moon near Jyeṣṭhā, but on the subsequent new moon near Pūrvāṣāḍhā. Holay believes that these problems can be solved by the insertion of a leap month. But fact is that he cannot start the war on the date which Kṛṣṇa had predicted or recommended.

---

[219] More detailed explanations are given on p. 178ff.

The condition “winter solstice on the 8th of the bright fortnight of Māgha” (Māgha Śukla 8) plays an important role for most authors. However, the dates that they gain from it vary widely. Another example is provided by Abhyankar and Ballabh, who argue as follows: Nowadays, Māgha Śukla 8 takes place on 5th February +– 15 days, which is between 30 and 60 days after the winter solstice, with an average of 45 days or a precession value of about 45°. From this, they calculate the year of the war to roughly 1200 BCE +– 1000 years.[220]

However, this calculation is flawed, too. In today’s Indian lunisolar calendar the month of Māgha is defined by the fact that in its course, i.e. between a new moon and the next new moon, the Sun enters the sidereal zodiac sign of Aquarius. (This also applies to the full moon calendar, which is a derivative of the new moon calendar.)[221] However, at the time of the great war, before the introduction of twelve-part zodiac in Late Antiquity, the calendar worked out differently. The month of Māgha was most probably defined by the fact – and that is the reason for its name – that its full moon took place in one of the two *nakṣatras* Maghā or Āśleṣā. Incidentally, the condition that the moon should be in Rohiṇī, is ignored by the authors. Since Rohiṇī starts at sidereal 40° and the 8th *tithi* covers the range of 84° to 96°, therefore the Sun must be located *after* sidereal 304° (4° Aquarius) for the Moon to fall into Rohiṇī. If Lahiri *ayanāṃśa* is chosen, Māgha Śukla 8 in Rohiṇī is only possible between 17th and 20th February for the current epoch. If the ancient definition for a month is used, the result is similar. The distance from the winter solstice is between 59 and 62 days or degrees. If this is multiplied by 71.6 years, the result is between 4224 and 4439 years. Subtracted from the current year (2014), the epoch 2330 BCE +– 100 years is arrived at.

---

220 Abhyankar, K.D., and G.M. Ballabh, “Astronomical and Historical Epoch of Kaliyuga”, p. 93f.

221 Leow Choon Lian, “Indian Calendars”; a Pañcāṅga calendar for current years is found here: http://www.mypanchang.com.

*Sengupta*

Sengupta bases his calculation on slightly different assumptions. As has been shown, there is no certainty that the war began on a Jyeṣṭhā new moon. There are indications that it could have begun on a full moon in Kṛttikā or a full moon of the month of Kārttika. (vide explanations on p. 216ff.) Sengupta believes that the war started 13 days after the new moon in Jyeṣṭhā, on a near full moon in Kṛttikā (two days too early!).[222] Like this, the number of days until the winter solstice results higher: There are 13 days until the beginning of the battle, then 10 days until Bhīṣma's fatal injury, and finally 58 days until his death. That is a total of 81 days, from which he calculates that the war must have taken place around the year 2450 BCE. He notes that this is consistent with Varāha-mihira's statement that Yudhiṣṭhira was crowned king 2526 years before the Śaka era, which corresponds to the year 2449 BCE.[223] Sengupta made his calculations in the 1940s, with extraordinary diligence and remarkable astronomical expertise. There is no need for corrections. However, it has been shown that the interpretation of the Kārttika full moon is questionable, so his theory breaks down at this point. (p. 217f.)

*Some Calculations Using the Computer*

As has been stated, 67 days (nights) after a Jyeṣṭhā new moon, the Moon is usually in Kṛttikā, not in Rohiṇī, especially if it has to be in the 8th *tithi*, the *tithi* of the half-moon. For this reason, the astronomical dating of the two statements "winter solstice 67 days after new moon Jyeṣṭhā" and "winter solstice in the 8th *tithi* after the new moon with the Moon in Rohiṇī", will be quite different.

The following procedure is chosen for this purpose: For all new moons in Jyeṣṭhā between 4000 BCE and the year 0, the position of the Sun 67 days later is calculated. If it is found between 269°

[222] Sengupta, *Ancient Indian Chronology*, p. 5.

[223] At a first glance, this is a surprising coincidence. Besides, Sengupta points out that in this year a new moon took place near the star Jyeṣṭhā. But Sengupta's interpretation of the sources is doubtful. His theory depends largely on whether his interpretation of the "full moon" in the *nakṣatra* Kṛttikā or the month of Kārttika is correct. Moreover, the epic does not state that the new moon must have been *close* to the star. Also, it has to be kept in mind that the exact position of a new moon could not be observed directly.

and 273°, it is considered a winter solstice. This error tolerance is chosen because the exact determination of the solstices was difficult for ancient sky watchers, and also because Bhīṣma wanted to die after rather than before the solstice. Secondly, for all dates within the same time range in which the Moon is found in Rohiṇī and has an elongation of 84° to 96°, it is examined whether the Sun is at the winter solstice. The calculations are done using the current definition of equal lunar mansions and the Lahiri *ayanāṃśa*. Using Āryabhaṭa's *ayanāṃśa*, the dates would result about 200–300 years later. The results found are as follows:

*Equal nakṣatras, Lahiri ayanāṃśa*

| | |
|---|---|
| Jyeṣṭhā + 67 days | 2500 BCE – 1300 BCE |
| Rohiṇī on Śukla 8 | 4000 BCE – 2100 BCE |
| Rohiṇī on Māgha Śukla 8 | 2400 BCE – 2200 BCE |

The time frames of the first two calculations overlap, but one should beware of drawing the conclusion that the war would have to be dated into the overlapping period 2500 – 2100 BCE. The information "Rohiṇī on Māgha Śukla 8" is probably a late interpolation and is based on an erroneous calculation, which mistakenly equated 67 days with 67 *nakṣatras*. (Cf. the dating attempts by M. Gupta and K. Venkatachelam.) Although the Moon, due to her variable speed, *can* be in Rohiṇī 67 days after a new moon in Jyeṣṭhā, she will then usually be in the 9th *tithi*. If, however, one wants her to be in the 8th *tithi*, then she will usually be located in Kṛttikā. Only in very rare cases she will result in Rohiṇī *and* in the 8th *tithi*.[224]

As it is not exactly known how the lunar mansions were defined in the Mahābhārata, another calculation was made where the principal stars of the respective *nakṣatras*, i.e. Antares (for Jyeṣṭhā) and Aldebaran (for Rohiṇī) are used and given an orb of 5°.

*Yogatārā with an orb of* +– 5°

| | |
|---|---|
| Jyeṣṭhā + 67 days | 1900 BCE – 1000 BCE |
| Rohiṇī on Māgha Śukla 8 | 3900 BCE – 2200 BCE |

Here, there is no overlap of the two periods, and the two conditions are incompatible.

224 E. g. on 3rd November, 2480 BCE (-2479), there was a new moon at the end of Jyeṣṭhā (Lahiri). The winter solstice was 67 days later, on 9th January, 2479 BCE (-2478), and the Moon was in the 8th *tithi* and in Rohiṇī.

However, with all these calculations, it must be kept in mind that the new moon in Jyeṣṭhā is in contradiction with other statements of the epic according to which the war began near a full moon.

Let us finally consider Sengupta's approach, who believes that the war began 13 days *after* the new moon in Jyeṣṭhā and on the day after a near-full moon in Kṛttikā! If it is assumed that the new moon occurred near Jyeṣṭhā within an orb of 5°, then the following time range is found:

| *Yogatārā with an orb of +– 5°* | |
|---|---|
| Jyeṣṭhā + 81 days | 2900 BCE – 1950 BCE |

However, this solution has problems, too, as has been seen. Firstly, it does not take seriously the Kārttika full moon mentioned in the epic, and secondly, it is not compatible with Bhīṣma's statement on the day he died, namely that it was the bright fortnight of Māgha and that the moon was in waxing phase. With Sengupta's approach it was actually in waning phase.

## Solar Eclipses Before and After the War

A solar eclipse is also said to have occurred 13 or 14 years before the war, at the time when the Pāṇḍavas went to their 13-year exile and left Hastināpura.

एवं तेषु नराग्र्येषु निर्यत्सु गजसाह्वयात्

अनभ्रे विद्युतश्चासन्भूमिश्च समकम्पत

*evaṃ teṣu narāgryeṣu niryatsu gajasāhvayāt*
*anabhre vidyutaścāsanbhūmiśca samakampata (MBh 2.71(79).25)*

> As these best of men left Hastināpura like this,
> there were lightnings in the cloudless [sky] and the earth shook;

राहुरग्रसदादित्यमपर्वणि विशां पते

उल्का चाप्यपसव्यं तु पुरं कृत्वा व्यशीर्यत

*rāhuragrasadādityamaparvaṇi viśāṃ pate*
*ulkā cāpyapasavyaṃ tu puraṃ kṛtvā vyaśīryata (26)*

> Rāhu swallowed the sun on the wrong date, O lord of men,
> and a meteorite broke into pieces after making a circumambulation to the right around the city.

A bit later, the same occurrences are mentioned again (MBh 2.72(80).21).

Another solar eclipse allegedly occurred 36 years after the war. It was observable in Dvārakā and indicated the destruction of the city and its inhabitants:

परस्परं च नक्षत्रं हन्यमानं पुनः पुनः

ग्रहैरपश्यन्सर्वे ते नात्मनस्तु कथंचन

*parasparaṃ ca nakṣatraṃ hanyamānaṃ punaḥ punaḥ*
*grahairapaśyansarve te nātmanastu kathaṃcana (14)*

| |
|---|
| That one lunar mansions killed another again and again,<br>they were able to see through the planets; however, they [could not see] themselves in any way. |

नदन्तं पाञ्चजन्यं च वृष्ण्यन्धकनिवेशने

समन्तात्प्रत्यवाश्यन्त रासभा दारुणस्वराः

*nadantaṃ pāñcajanyaṃ ca vṛṣṇyandhakaniveśane*
*samantātpratyavāśyanta rāsabhā dāruṇasvarāḥ (15)*

| |
|---|
| And when the Pāñcajanya shell resounded in the settlement of the Vṛṣṇis and Andhakas,<br>donkeys echoed it from all sides with gruesome sound. |

एवं पश्यन्हृषीकेशः संप्राप्तं कालपर्ययम्

त्रयोदश्याममावास्यां तान्दृष्ट्वा प्राब्रवीदिदम्

*evaṃ paśyanhṛṣīkeśaḥ saṃprāptaṃ kālaparyayam*
*trayodaśyāmamāvāsyāṃ tāndṛṣṭvā prābravīdidam (16)*

| |
|---|
| When Kṛṣṇa (Hṛṣīkeśa) saw that the time period was completed,<br>when he saw that the new moon was on the 13th, he said this to them (to the Yādavas): |

चतुर्दशी पञ्चदशी कृतेयं राहुणा पुनः

तदा च भारते युद्धे प्राप्ता चाद्य क्षयाय नः

*caturdaśī pañcadaśī kṛteyaṃ rāhuṇā punaḥ*
*tadā ca bhārate yuddhe prāptā cādya kṣayāya naḥ (17)*

| |
|---|
| "This 14th was made the 15th again by Rāhu.<br>This happened at the time of the Bhārata war, and today again for our downfall." |

विमृशन्नेव कालं तं परिचिन्त्य जनार्दनः

मेने प्राप्तं स षट्त्रिंशं वर्षं वै केशिसूदनः

*vimṛśanneva kālaṃ taṃ paricintya janārdanaḥ*
*mene prāptaṃ sa ṣaṭtriṃśaṃ varṣaṃ vai keśisūdanaḥ (MBh 16.3(2).18)*

When Kṛṣṇa perceived [the quality of] this time, he pondered and realised that the 36th year had arrived.

There is thus a triad of solar eclipses, of which one would hope for a dating of the war. This method was chosen by R. N. Iyengar. However, it has been shown already that his war date does not accord well with the configurations of the planets mentioned in the Mahābhārata. Is there another solution that would be compatible with the war year 1198 BCE?

13 years earlier, on 18th July 1211 BCE, there was a partial solar eclipse (30%), which could be observed in Kurukṣetra. What is interesting is that Saturn was in the lunar mansion of Rohiṇī, because in Bhīṣmaparva it is stated that Saturn "tormented" Rohiṇī during the war. Although planetary "tormenting" has been interpreted in a different way in this study, namely that it did not mean "Saturn located in Rohiṇī", but rather that Saturn, rising in Viśākhā, put "under pressure" Rohiṇī, which was located on the opposite horizon. Still, one might also consider that "Saturn in Rohiṇī" was intended. Then this statement would actually refer to the banishment of Pāṇḍavas 13 years before the war and would have been mixed into the war configuration by mistake. Interestingly, it takes Saturn just about 13 years to get from Rohiṇī to Viśākhā. However, the positions of the other planets in 1211 BCE do not appear in the celestial omens near the outbreak of war. Similar considerations were also made by RN Iyengar.[225]

There are more serious problems with the solar eclipse of Dvārakā 36 years after the war. Locally observable eclipses only occurred 34 and 41 years after the war (partial 79% and 88%). However, this study came to the conclusion that the text combined the super-conjunction of 1198 BCE with the total solar eclipse at sunrise of 27th March 1187 BCE. 37 years later, on 7th April 1150 BCE, a

[225] Iyengar, "Historicity of Celestial Observations of Mahābhārata", p. 11.

partial eclipse (13%) was seen in Dvārakā. Could this one have been meant?

Unfortunately, this solution is not very convincing. There is no spectacular match between the text and the astronomical events of those years. However, a clear refutation of 1198 BCE as the year of the war is not given either. Unfortunately, partial solar eclipses are not rare at all. Moreover, it is also unfortunate that the text does not provide planetary positions for the eclipse dates 13 years before and 36 years after the war. These could have helped to confirm or refute the proposed solutions. According to verse 14, the planets indicated that people would kill each other, but there is no clue in what way this was indicated by them.

## Conclusions

The Mahābhārata epic contains a remarkable quantity of astronomical and calendrical information that has led to attempts to date the great war using astronomical methods. After studying all this information, they can be classified into the following categories:

1. Firstly, there are clues concerning a conjunction of all planets, concerning sky observations made in the evenings and mornings that apparently served to determine heliacal risings and settings of the planets, as well as some clues concerning solar and lunar eclipses. All these clues, which are given in various places throughout the text, are in themselves not entirely consistent, but still with remarkable clarity point to a historical configuration that took place in 1198 BCE. Therefore, the great war can be dated near to this year. The same year was already found by K.G. Sankar and K.L. Daftari.

2. In the Bhīṣmaparva, there are two remarkably detailed descriptions of the celestial configuration at the beginning of the war, where even information about the positions of the planets is given. One of these descriptions is consistent with the super-conjunction in 1198 BCE. The other description is not compatible, and no date can be found that fits it. Moreover, there are statements concerning conjunctions of two or more planets scattered throughout the books that describe the battle. All these conjunctions did occur during the gathering of the planets in 1198 BCE, whereas all those conjunctions that are possible but are *not* mentioned in the epic, did *not* occur in the same year.

3. Some authors who tried an astronomical dating of the great war used astronomical clues about the fall and death of Bhīṣma. All these attempts use the information given in the text in a very selective way, they do not sufficiently take into account the contradictions between them, and mostly do not do their calculations in the appropriate way. As a consequence, the results given by the different authors differ widely. This study has come to the conclusion that the astronomical clues concerning Bhīṣma's fall and death are not well suited for a dating of the war, but that some of them harmonise quite well with the year 1198 BCE.

# *Parallels Outside India*

## Super-conjunctions and Eclipses in Ancient China

In ancient China, super-conjunctions were considered to be important omens, as well.[226] It was believed that a super-conjunction indicated the end of a great era, the downfall of a dynasty, and the transfer of the "Mandate of Heaven" (天命 *tiān mìng*) to a new dynasty. The parallels between the Chinese and Indian versions of this idea are striking, and it is possible that they go back to a common origin. Whether this origin lies in India or China is hard to decide.

Astronomers of the Han period (206 BCE – 220 CE) believed that at the beginning of time all the planets, the Sun and the Moon were in conjunction. In an ancient work titled *Lǐ hán wén jiā* (礼含文嘉) the following statement can be found:

> 太素:《礼含文嘉》曰:
> 推之以上元为始，起十一月甲子朔旦，夜半冬至，日月五星俱起牵牛之初。。。。(4)
>
> *tuī zhī yǐ shàng yuán wèi shǐ, qǐ shíyī yuè jiǎzǐ shuò dàn, yèbàn dōngzhì, rì yuè wǔ xīng jù qǐ qiān niú zhī chū.*
>
> Extrapolating by taking the Superior Epoch as the beginning, [it] began at dawn on the new moon day of the 11th month, day *jiazi* (1), winter solstice having occurred at midnight, when sun, moon, and the five planets all started from the initial [degree] of Ox-Leader. ...[227]

The cycles of time began on a winter solstice, which fell into the 11th month, as is still the case in the current Chinese calendar. The first day of the month was a new moon and a *jiǎzǐ* day in the

[226] I am indebted to David W. Pankenier (Lehigh University, Bethlehem, Pennsylvania) and Rafael Suter (University of Zürich) for helping me to understand the grammar and terminology of some of the Chinese texts discussed here. Possible errors in translations or interpretations are nevertheless my fault.

[227] *Chinese Text Project* (Post-Han -> Song-Ming -> 太平御览 -> 天部一 -> 太素 -> 4): http://ctext.org/text.pl?node=361905&if=en&remap=gb

sexagenary count.[228] On the morning of this day, the Sun, the Moon, and all the five planets rose synchronously with the beginning of the constellation of the Ox-Leader (*qiān niú*). The principle star of the Ox-Leader was either Altair (*α Aquilae*) or Dabih (*β Capricorni*). Between 450 and 300 BCE both these stars had a right ascension of about 270° (9h) and therefore indicated the winter solstice. During the Han period, Altair made its heliacal rising around the winter solstice.

Other interesting fragments from ancient works read as follows:

> 天部上:《尚书中候》曰:
> 天地开辟，甲子冬至。日月若悬璧，五星若编珠。
>
> *tiān dì kāipì, jiǎzǐ dōngzhì. rì yuè ruò xuán bì, wǔxīng ruò biān zhū.*
>
> Heaven and Earth opened (i. e. separated and came into existence). Day *jiǎzǐ*, winter solstice. Sun and moon were like a hanging jade disc (or: like hanging jade discs). The five planets were like strung pearls.[229]
>
> 瑞星:《尚书考灵曜》曰:
> 天地开辟，元历名月首，甲子冬首。日月五星，俱起牵牛。初，日月若悬璧，五星若编珠。
>
> *tiān dì kāipì, yuán lì míng yuè shǒu, jiǎzǐ dōng shǒu. rì yuè wǔxīng, jù qǐ qiān niú. chū, rì yuè ruò xuán bì, wǔxīng ruò biān zhū.*
>
> Heaven and Earth opened (i.e. separated and came into existence). The initial [calendar] count is said to be: beginning of the month, day *jiǎzǐ*, winter solstice, [and] the Sun, the Moon, and the five

---

[228] In the Han period calendar (四分历, *sì fēn lì*) there are the following time cycles:
– 19 years (年 *nián*) are 1 Metonic cycle (章 *zhāng*), after which the new moon falls on a winter solstice again.
– 4 Metonic cycles (76 years) are one obscuration cycle (蔀 *bù*), where the winter solstice occurs at the same time of the day again.
– 20 obscuration cycles (1520 years) are one era cycle (纪 *jì* or 遂 *suì*).
– 3 era cycles (4560 years) are one origin cycle (元 *yuán* or 首 *shoǔ*).

In the *Zhōu bì suàn jīng* (周髀算經), an astronomical text of the early Han period, another cycle of 7 origin cycles (31920 years) is mentioned, which is called a "mighty" cycle (極 *jí*).

[229] *Chinese Text Project* (Post-Han -> Song-Ming -> 太平御览 -> 天部一 -> 天部上 ->15): http://ctext.org/text.pl?node=361938&if=en&remap=gb

planets all rose [synchronously at] the beginning of [the constellation] Ox-Leader. The Sun and the Moon were like a hanging jade disc (or: like hanging jade discs), the five planets were like strung pearls. [230]

岁:《尚书考灵曜》曰：
天地开辟，元历纪名，月首甲子，冬至日月五纬俱起牵牛。初，日月若悬璧，五星若编珠，青龙甲子摄提格孳。［青龙，岁也。岁在寅曰摄提格。孳犹生也。］

*Tiān dì kāipì, yuán lì jì míng, yuè shǒu jiǎzǐ, dōngzhì rì yuè wǔ wěi jù qǐ qiān niú. Chū, rì yuè ruò xuán bì, wǔxīng ruò biān zhū, qīnglóng jiǎzǐ shè tí gé zī. [Qīnglóng, suì yě. Suì zài yín yuē shè tí gé. Zī yóu shēng yě.]*[231]

Heaven and Earth opened (i.e. separated and came into existence). The initial era of the [calendar] count is said to be: beginning of the month, day *jiǎzǐ*, winter solstice, [and] the Sun, the Moon, and the five planets[232] all rose [synchronously at] the beginning of [the constellation] Ox-Leader. The Sun and the Moon were like a hanging jade disc (or: like hanging jade discs), the five planets were like strung pearls. The Blue Dragon, [the year] *jiǎzǐ*, accedes his office and creates the right order.[233]

According to these texts, a super-conjunction also took place at the time when heaven and earth were created. The word *bì* (璧), which is translated as "jade disc", refers to a flat disc of jade that has a hole in its centre. *Bì* discs were already used in the Neolithic for cultic purposes that are not known exactly. However, in the current context, they might symbolise a total or annular solar eclipse, both

230 *Chinese Text Project* (Post-Han -> Song-Ming -> 太平御览 -> 天部七 -> 瑞星 ->3): http://ctext.org/text.pl?node=362301&if=en&remap=gb . Pankenier corrects the punctuation as follows: 天地开辟，元历[紀]名、月首甲子；冬首日、月、五星俱起牵牛初。(private communication of 15th October 2014).

231 Song-Ming -> 太平御览 -> 时序部二 -> 岁 -> 12

232 五纬，亦称五星，是中国将太白、岁星、辰星、荧惑、填星这五颗行星合起来的称呼，它们与五行分别对应金、木、水、火、土。五星与日、月合称七政。在中国古代星占学上，五星与五常、五方、五兽、五色、五行、五事、五严、五社、五藏等等均分别一一对应。(http://zh.wikipedia.org/wiki/zh.wikipedia.org/zh/五緯 )

233 The Blue Dragon includes the lunar mansions *jiăo* (角) through *jī* (箕) between Virgo and Sagittarius. When the Sun, the Moon, and the five planets rose on the winter solstice, the Blue Dragon could be seen in the eastern and southern sky.

of which resemble a jade disc in their appearance. The planets were allegedly seen in a configuration that resembled a bead chain. Whether the planets were visible during the total solar eclipse or in the morning of the same day, is not said, but from the text quoted further above it can be concluded that it must have been a configuration visible in the morning.

Jade disc, western Han Dynasty (4th – 2nd century BCE) (Wikipedia)
Total solar eclipse, 21st June 2001 (Espenak)
Annular solar eclipse, 20th May 2012 (Wikipedia)

In the *Hàn Shū* (漢書), a work on the history of the early Han Dynasty, there is the following passage concerning a comet or "broom star" (彗星, *huì xīng*), which appeared in the year 5 BCE and according to some, incidentally, could be the Star of Bethlehem:

> ［漢哀帝建平］二年二月，彗星出牽牛七十餘日。
>
> [Han Emperor Ai, reign *Jiànpíng*], second year, second month, a comet (*huìxīng*, 彗星) emerges (出) from Altair (*qiānniú*, 牽牛), for more than 70 days.
>
> 傳曰：「彗所以除舊布新也。牽牛，日、月、五星所從起，曆數之元，三正之始。彗而出之，改更之象也。其出久者，為其事大也。」
>
> Tradition says: "The use of a broom (*huì*, 彗) is the removal of the old [and] establishing of the new. Altair, from which the Sun, the Moon, and the five planets rise, [is] the starting point of the calendar calculation, the beginning of the three calendars. A *broom [star]* emerging from it is a picture of improvement. When its emergence lasts long, this means that its affairs are important (great)."[234]

[234] *Hàn shū* (漢書, 志, 天文志, 156), http://ctext.org/han-shu/tian-wen-zhi/.

There are also historical or pseudo-historical reports of super-conjunctions. The following report from the Bamboo Annals, if it were authentic, would be very old:

帝［姚］在位七十年，景星出翼，鳳皇在庭，

When emperor [*Yáo*] had been on the throne for 70 years, a brilliant star went forth from the constellation *Yì*, a phoenix was in the court,

朱草生，嘉禾秀，甘露潤，醴泉出，

pearl grass grew, excellent grain flourished; sweet dew moistened [the plants], and fresh springs sprang,

日月如合璧，五星如連珠。

**the Sun and the Moon were like united jade discs, the five planets were like strung pearls.**

... (some more omens) ...

洪水既平，歸功於舜，將以天下禪之，

Flooding waters were assuaged: [Emperor *Yáo*] attributed the merit to *Shùn* [and] wanted to resign in his favour.

乃潔齋修壇場於河、洛，擇良日率舜等升首山，遵河渚。

Then he purified himself and fasted and built altars near [the rivers] *Hé* and *Lùo*. He chose an auspicious day and told *Shùn* and others to climb up mount *Shoŭ* [and] to follow the islands of [the river] *Hé*.

有五老游焉，蓋五星之精也。

There were five old men who waded through it. They were allegedly the spirits of the five planets.

相謂曰：『《河圖》將來告帝以期，知我者重瞳黄姚。』

They spoke to each other: "The diagram of the *Hé* will come and tell the emperor at the [right] time. He who knows us is the one with the double pupils, the yellow *Yáo*."

五老因飛為流星，上入昴。

Then the five old men flew up, became wandering stars[235] and rose themselves into the [constellation] *Măo* (the Pleiades).

[235] In modern Chinese, 流星, literally meaning "wandering stars" refers to a "meteor" or "meteorite". In the current text it might rather refer to the planets.

二月辛丑昧明，禮備，

In the 2nd month, on the day *xīn chǒu*, [between] the dark and light, the rites were performed.

至於日昃，榮光出河，休氣四塞，白雲起，回風搖，

When the day declined, a glorious light came forth from the *Hé*. It ended the vapours [in the four] directions; white clouds rose up, and returning winds blew.

乃有龍馬銜甲，赤文綠色，緣壇而上，吐《甲圖》而去。

Then there was a horse, bearing in his mouth a cuirass, with red lines on a green ground. It circled around the altar, climbed it, spit out the cuirass scheme, and went away.

甲似龜，背廣九尺，其圖以白玉為檢，赤玉為柙，泥以黃金，約以青繩。

The cuirass was like a tortoise shell, nine cubits broad. Its scheme was provided with white jade [serving] as a writing surface, with red jade as its frame, covered with yellow gold, [and] bound with a green string.

檢文曰：『闓色授帝舜。』言虞夏當受天命，帝乃寫其言，藏於東序。

The writing surface said: “Pleased countenance directed to Emperor *Shún*”. It said *Yú* and the Xià [dynasty] should receive the Mandate of Heaven. The emperor wrote these words down [and] hid them in the Eastern college wall.

後二年二月仲辛，率群臣東沈璧於洛。

Then, in the 2nd year, 2nd month, on day *xīn* ... he led out all his ministers to the east and dropped a jade disc in the [river] Lùo.

禮畢，退俟，至於下昃，赤光起，

[When] the ceremony was over, he retired and waited. When [the day] declined, a red light rose.

元龜負書而出，背甲赤文成字，止於壇。

A *yuán* tortoise that carried a book came out [of the waters]. On its back, red lines formed writing. It rested on the altar.

其書言當禪舜，遂讓舜。

This inscription said that *Yáo* should resign in *Shún’s* favour. Thereupon he left [the throne] to *Shún*.

The text describes the transition of the Mandate of Heaven from Emperor Yao to Shun in the 23rd century BCE. It is explained as the result of several omens, among which a super-conjunction and a solar eclipse. According to some sources, however, the transition was not so peaceful but was also accompanied by major bloodshed. The text also states that the five planets "rose into the Pleiades" (上入昴), information that raises the question whether the event could be dated astronomically. However, the mythical character of the text itself makes it obvious that it must originate from a far more recent epoch.

Also, the question arises whether the description of a solar eclipse as a "conjunction of jade discs" (如合璧) is not an anachronism for such an early epoch, because it presupposes an understanding of the astronomical mechanism that leads to a solar eclipse, namely the understanding that the Moon covers the solar disc and blocks its light. Experts believe that such astronomical understanding existed only in the Han period, which began around 200 BCE.[236] If so, the comparison of solar eclipses with jade discs could have originated only in the Han period.

However, such astronomical understanding need not necessarily be assumed here. The comparison with the jade discs appears in different texts in the following wordings:

> 日月若悬璧 *rì yuè ruò xuán bì*
>
> The Sun and the Moon were like hanging jade discs.
>
> 日月如合璧 *rì yuè rú hé bì*
>
> The Sun and the Moon were like united jade discs.
>
> 日月若連璧 *rì yuè ruò lián bì*
>
> The Sun and the Moon were like connected jade discs.

Pankenier thinks of "the jade ornaments hanging from the sash commonly tied around the waist as a mark of status and authority by officials", and he adds: "my image is of a pair of jade bi hung from the sash whose length and position causes them to be superposed or overlap"[237]. If this image is taken as a symbol of a solar eclipse, does it necessarily mean that the astronomical mechanism was understood? Perhaps it does not. Chinese astronomers must have realised already in very ancient times that solar eclipses only occur

[236] Pankenier, personal communication of 19th October 2014.

[237] Pankenier, personal communication of 15th and 19th October 2014.

during new moons and during conjunctions of the Moon with the Sun. Also, they must have noticed that solar eclipses sometimes assume an appearance similar to that of "superposed jade discs", namely with a "central hole". This does not mean, however, that the nature of this "hole" was understood. Thus although the comparison of solar eclipses to jade discs appears only in texts from the Han period, it cannot be ruled out that it is actually older, especially when earlier literature is mostly lost.

Returning to Emperor Shun, he was displaced by Emperor Yu, who founded the Xia Dynasty. According to a text titled *Xiào jīng gōu mìng jué* (孝经钩命诀), Yu's taking over of the Mandate of Heaven was also accompanied by a gathering of all the planets:

> 《太平御鉴》引《孝经钩命诀》曰：
>
> 禹时，五星累累如贯珠，炳炳若连璧。
>
> *Yǔ shí, wǔxīng lěi lěi rú guàn zhū, bǐng bǐng ruò lián bì*
>
> At the time of [Emperor] Yu, the five planets were gathered like a row/chain of beads. They shone brightly like connected jade discs.

The following text reports a historical configuration that was allegedly astrologically linked to the foundation of the Zhou Dynasty by King Wu (Ji Fa). It is a fragment from the book *Xīn lùn* (新論) by the philosopher Huan Tan, who lived in the Han period (23 BCE – 56 CE) (translation by D. W. Pankenier):

> 桓谭《新论》曰：维四月，太子发上祭于毕下，至孟津之上。此武王已毕三年之丧，欲卒父业。升舟而得鱼，则地应也。・奄祭降乌，天应也。二年，闻纣杀比干、囚箕子，太师、少师抱乐器奔周。甲子，日月若连璧，五星若连珠。昧爽，武王朝至于南郊牧野，从天以讨纣，故兵不血刃而定天下。
>
> In the fourth month Heir Apparent Fa went up to sacrifice at Bi. Then he went down as far as Mengjin. At this time King Wu had already completed the three-year mourning period and desired to complete his father's enterprise. When he rode the boat and caught the fish it was Earth's sign to him. When the smoke of the sacrifice brought down the crow it was Heaven's sign to him. Within two years he heard that [Shang] Zhou had killed Bi Gan and imprisoned Jizi. The Grand Master and Lesser Master [of Shang] fled to Zhou carrying the musical instruments. **On day jiazi the sun and moon were like connected bi jades, the five planets like strung pearls.** In the twilight hour King Wu arrived at dawn at the southern

> suburb of Muye, following [the command] of Heaven to punish [Shang] Zhou. Therefore the blades of the weapons were not bloodied and the Empire was pacified.[238]

Pankenier believes that this text refers to the super-conjunction that could be seen end of May 1059 BCE in the western evening sky. On 19th May there was also an annular solar eclipse. However, since it took place while it was night in China, it was only an expected, not an observed, eclipse. The historical report is obviously "enhanced". In Pankenier's view this solar eclipse is not relevant, though.

The following text from the *tàipíng yùlǎn* (太平御览) might refer to the same date. The mentioned king Wen is the father of king Wu of the above quotation.

> 周文王:《桓子新论》曰：。。。其后，有凤凰衔书于郊。文王曰：”殷帝无道，虐乱天下，皇命已移，不得复久。“乃作《凤凰》之歌曰：”翼翼翔翔，鸾皇兮。衔书来游，以命昌兮。瞻天案图，殷将亡兮。苍苍皓天，始有萌兮。五神连精，合谋房兮。“
>
> Afterward there was a Phoenix in the suburbs which grasped a "Writing" in its beak. King Wen said, "The Yin [Shang] Lord does not act according to the Way, [he] tyrannizes and disorders all under Heaven. The August Mandate has already shifted, [he] will not persist for long." Thereupon King Wen composed the "Song of the Phoenix" which goes:
> "The Phoenix soars [down] on spreading wings,
> Clasping a "Writing" it comes gamboling, thereby to command Chang [King Wen].
> I gazed up at Heaven and examined the Diagram,
> Yin [Shang] is about to expire [it portended].
> **Great Heaven is azure, azure;**
> **First there (sc. in the heavens) was a presage (lit. "sprouting");**
> **The linked essences of the Five Spirits** [the planets in Han usage] **met in lodge Chamber [Sco] to deliberate.**"[239]

[238] D. W. Pankenier, "Astronomical Dates in Shang and Western Zhou", p. 16f., in: *Early China*, 7 1981-82; idem, *Astrology and Cosmology in Early China*, p. 208. Chinese Text from *Chinese Text Project* (Post-Han -> Song-Ming ->太平御览->兵部六十->征应 15): http://ctext.org/taiping-yulan/329/ens .

[239] Translation: D. W. Pankenier, „Astronomical Dates in Shang and Western Zhou", p. 16f., in: *Early China*, 7 1981-82. Chinese text from: *Chinese Text*

The sky was blue when the planets formed a conjunction. This seems to refer to early evening shortly after sunset or early morning shortly before sunrise. The “sprouting” could perhaps also indicate the heliacal rising of the five planets, which allegedly took place in the lunar mansion *fáng* (房) in the constellation Scorpius. The conjunction of 1059 BCE does not seem to accord well with this, because it was observed in the *evening* and in *Cancer*. However, Pankenier believes that the mentioning of the lunar mansion *fáng* is “a late interpolation arising from Han portentological revisionism”.[240]

Another example from Sima Qians (100 v. Chr.) *tiān guǎn shū* (天官書) reads as follows:

> 漢之興，五星聚于東井。
>
> *hàn zhī xìng, wǔ xīng jù yú dōng jǐng.*
>
> When the Han Dynasty rose, the five planets gathered in [the lunar mansion of] the eastern well.[241]

This event can be dated to end of May 205 BCE.

Sima Qian also makes the following statement about the astrological significance of super-conjunctions:

> 五星合，是為易行，有德，受慶，改立大人，掩有四方，子孫蕃 昌；無德，受殃若亡。五星皆大，其事亦大；皆小，事亦小。
>
> *wǔ xīng hé, shì wèi yì xíng, yǒu dé, shòu qìng, gǎi lì dà rén, yǎn yǒu sì fāng, zǐ sūn fān chāng; wú dé, shòu yāng ruò wáng. wǔ xīng jiē dà, qí shì yì dà; jiē xiǎo, shì yì xiǎo.*
>
> When the five planets join, this indicates a process of change. If there is virtue, one receives joyfulness. A great man is installed into the royal office, he will hold the four quarters in his hands. His children and grandchildren will prosper and thrive. If there is no virtue, one receives misfortune or death. When all planets are great

---

*Project* (Post-Han -> Song-Ming -> 太平御览 -> 兵部六十 -> 征应 15): http://ctext.org/taiping-yulan/329/ens .

240 Pankenier, *Astrology and Cosmology in Early China*, p. 206.

241 *Chinese Text Project* (Pre-Qin and Han -> Histories -> Shiji -> 書 -> 天官書 -> 120):
http://ctext.org/shiji/tian-guan-shu

> (= bright), then affairs will be great, too; when they are all small, affairs will be small.[242]

There are thus remarkable parallels between ancient Indian and ancient Chinese astrology and omen reading:

– There is talk of cycles that periodically bring back the same celestial configuration that was given at the beginning of times.

– These celestial cycles are correlated with historical eras on earth.

– Conjunctions of all planets are also correlated with the end of historical eras or the transfer of the Mandate of Heaven from one dynasty to another.

– The beginning of years and cycles is assumed on winter solstices.

There is a great number of other analogies, which cannot be documented here, which however would be worth studying in detail: the 28 lunar mansions, the importance of the polar star or celestial pole, eclipses on wrong dates, halos, rains of blood, confusion of the seasons of the year, etc. etc. There must certainly be some historical connection.

---

[242] *Chinese Text Project* (Histories -> Shiji -> 書 -> 天官書 -> 49): http://ctext.org/shiji/tian-guan-shu

## Super-conjunctions and Era Cycles in Hellenism

The earliest mention of great time cycles and super-conjunctions in Greek literature is found in Plato's *Timaeus* (39cd):

> τῶν δ᾽ἄλλων τὰς περιόδους οὐκ ἐννενοηκότες ἄνθρωποι, πλὴν ὀλίγοι τῶν πολλῶν, οὔτε ὀνομάζουσιν οὔτε πρὸς ἄλληλα συμμετροῦνται σκοποῦντες ἀριθμοῖς, [39d] ὥστε ὡς ἔπος εἰπεῖν οὐκ ἴσασιν χρόνον ὄντα τὰς τούτων πλάνας, πλήθει μὲν ἀμηχάνῳ χρωμένας, πεποικιλμένας δὲ θαυμαστῶς· ἔστιν δ᾽ὅμως οὐδὲν ἧττον κατανοῆσαι δυνατὸν ὡς ὅ γε τέλεος ἀριθμὸς χρόνου τὸν τέλεον ἐνιαυτὸν πληροῖ τότε, ὅταν ἁπασῶν τῶν ὀκτὼ περιόδων τὰ πρὸς ἄλληλα συμπερανθέντα τάχη σχῇ κεφαλὴν τῷ τοῦ ταὐτοῦ καὶ ὁμοίως ἰόντος ἀναμετρηθέντα κύκλῳ.
>
> Mankind, with hardly an exception, have not remarked the periods of the other stars, and they have no name for them, and do not measure them against one another by the help of number, and hence they can scarcely be said to know that their wanderings, being infinite in number and admirable for their variety, make up time. And yet there is no difficulty in seeing that the perfect number of time fulfils the perfect year when all the eight revolutions, having their relative degrees of swiftness, are accomplished together and attain their completion at the same time, measured by the rotation of the same and equally moving.[243]

The "rotation (κύκλος = circle, D.K.) of the same and equally moving" is the sphere of the fixed stars. The "eight revolutions" (περίοδοι) are the motions of the Sun, the Moon, the five planets and the daily rotation of the sphere of the fixed stars. At the end of a "great year" the eight motions all return to their initial point. This is a super-conjunction.

The beginning of the quotation is explained by the fact that the Greeks before Plato were not aware of the planets, with the only exception of Venus, which is mentioned already in Homer. Greek astronomy and astrology in the true sense are relatively young and have their origin in Mesopotamia.

---

[243] Translation B. Jowett, http://www.ellopos.net/elpenor/physis/plato-timaeus/time.asp?pg=3

Explicit testimony that the doctrine of the super-conjunctions came from Mesopotamia is found in Seneca's *Naturales quaestiones* III,29,1:

> *Quidam existimant terram quoque concuti et dirupto solo noua fluminum capita detegere, quae amplius ut e pleno profundant. Berosos, qui Belum interpretatus est, ait ista cursu siderum fieri; adeo quidem affirmat, ut conflagrationi atque diluuio tempus assignet: arsura enim terrena contendit, quandoque omnia sidera, quae nunc diuersos agunt cursus, in Cancrum conuenerint, sic sub eodem posita uestigio, ut recta linea exire per orbes omnium possit; inundationem futuram, cum eadem siderum turba in Capricornum conuenerit. Illic solstitium, hic bruma conficitur: magnae potentiae signa, quando in ipsa mutatione anni momenta sunt.*
>
> Some suppose that in the final catastrophe the earth, too will be shaken, and through clefts in the ground will uncover sources of fresh rivers which will flow forth from their full source in larger volume. Berosus, the translator of [the records of] Belus, affirms that the whole issue is brought about by the course of the planets. So positive is he on the point that he assigns a definite date both for the conflagration and the deluge. All that the earth inherits will, he assures us, be consigned to flame when the planets, which now move in different orbits, all assemble in Cancer, so arranged in one row that a straight line may pass through their spheres. When the same gathering takes place in Capricorn, then we are in danger of the deluge. Midsummer is at present brought round by the former, midwinter by the latter. They are zodiacal signs of great power seeing that they are the determining influences in the two great changes of the year.[244]

Berossus was a Babylonian astrologer and a priest of the god Bēl (= Marduk), who lived around 300 BCE and wrote in the Greek language. He emigrated to the Greek island of Kos, founded the first Greek astrology school and thus became the founder of Hellenistic astrology. Of his work "Babylonian History" (*Babyloniaca*), which was written in Greek, only fragments are extant.

Some authors have doubted the authenticity of the above-quoted testimony given by Seneca.[245] No cuneiform sources have become

---

[244] Translation from: Clarke, *Physical Science in the Time of Nero*, p. 150f.

[245] W. G. Lambert, "Berossus and Babylonian Eschatology", Iraq, 38.2 (Autumn 1976:171-173).

known that would prove a Mesopotamian origin of Berossus' theory. The idea of time cycles that re-iterate themselves again and again, does not appear to be very Babylonian, as becomes evident, e. g., from the Babylonian "creation epic" *Enūma Eliš*. Planetary cycles became an important issue only in Neo-Assyrian and Hellenistic astronomy. Of course, it cannot be ruled out that cuneiform sources will be discovered in the future that stem from Berossus' Babylonian tradition.

Another interesting testimony is found in the astrologer Antiochus of Athens, who, according to Cumont, lived in the 1st century BCE, however according to Pingree in the 2nd century CE:[246]

> Περὶ τῶν μεγίστων ἐτῶν καὶ τελείων ἀποκαταστάσεων τῶν ἑπτὰ ἀστέρων
>
> Κρόνος ποιεῖ τὴν μεγίστην ἀποκατάστασιν δι' ἐτῶν σξε´. Ζεὺς δὲ δι' ἐτῶν υκζ´· Ἄρης δὲ δι' ἐτῶν σπδ´· Ἥλιος δὲ δι' ἐτῶν ͵αυξα´· Ἀφροδίτη δὲ δι' ἐτῶν ͵αρνα´· Ἑρμῆς δὲ δι' ἐτῶν υπ´· Σελήνη δὲ δι' ἐτῶν κε´. ἡ δὲ κοσμικὴ ἀποκατάστασις γίνεται δι' ἐτῶν μυριάδων ροε´ ͵γε´ (var. ͵γς´) καὶ τότε γίνεται σύνοδος πάντων τῶν ἀστέρων κατὰ λ´ μοῖραν τοῦ Καρκίνου ἢ τὴν α´ μοῖραν τοῦ Λέοντος <καὶ> γίνεται ἐκπλήρωσις (ἐκπύρωσις ?)· ἐπὶ δὲ τοῦ Καρκίνου γίνεται κατακλυσμὸς, ἐν μέρει δὲ τοῦ κόσμου.
>
> On the greatest years and the ultimate restitution (*apokatastaseis*) of the seven stars
>
> Saturn makes the greatest revolution (*apokatastasis*) in 265 years (= 9 cycles), Jupiter in 427 years (= 36 cycles), Mars in 284 years (= 151 cycles), the Sun in 1461 years (= 1460 Julian years in Sothis years), Venus in 1151 years (= 1151 cycles), Mercury in 480 years (= 480 cycles), the Moon in 25 years. The cosmic restitution occurs in 17,53,005 (var. 17,53,200) years, and then an assembly of all the stars occurs at 30° Cancer or 1° Leo, and a fulfilment (conflagration) takes place. With the Cancer, however, an inundation takes place in a part of the world.
>
> (var. γίνεται δὲ ὁ κλῆρος καὶ ἡ σύνοδος πάντων τῶν ἀστέρων δι' ἐτῶν οζ´ κατὰ λ´ μοῖραν τοῦ καρκίνου ἢ τὴν α´ μοῖραν τοῦ λέοντος γίνεται ἡ ἐκπλήρωσις· ἐν δὲ ἐκείνῳ τῷ ἔτει γίνεται κατακλεισμὸς (sic) ἐν μέρει τοῦ κόσμου. γίνεται ἔκλειψις ἡλιακὴ σεληνιακή·

[246] Text according to Rhetorius, quoted from CCAG 1.163.15-23. Translation D.K.

ἀστικαὶ κινήσεις· μυκηθμοὶ· σεισμοὶ ἀλλεπάλληλοι· καὶ ἀνωμαλία στοιχείων.)

(*var*. And the lot and the assembly of all the stars occurs after 77 years at 30° Cancer or 1° Leo the fulfilment takes place (*! double verb!*). In that year an inundation takes place in a part of the world. A solar [and] lunar eclipse takes place, civil commotions, clamour, earthquakes in quick succession, and anomalous behaviour of the elements.)

Interestingly, the alleged starting and ending point of the cycles is the end of Cancer or beginning of Leo (which immediately follows Cancer). According to Berossus, there are two possible points, where super-conjunctions can take place, either at the beginning of Cancer or in the opposite point at the beginning of Capricorn. Thus there were different traditions of the doctrine of the Great Year, which considerably differed from each other.

This is also obvious from Cicero, *De natura deorum*, II.51. Divergent durations were apparently given for the Great Year:

*quod eo est admirabilius in is stellis, quas dicimus, quia tum occultantur tum rursus aperiuntur, tum adeunt tum recedunt, tum antecedunt tum autem subsecuntur, tum celerius moventur tum tardius, tum omnino ne moventur quidem sed ad quoddam tempus insistunt. quarum ex disparibus motionibus magnum annum mathematici nominaverunt, qui tum efficitur, cum solis et lunae et quinque errantium ad eandem inter se comparationem confectis omnium spatiis est facta conversio; [52] quae, quam longa sit, magna quaestio est, esse vero certam et definitam necesse est.*

And this regularity is all the more marvellous in the case of the stars we speak of, because at one time they are hidden and at another they are uncovered again ; now they approach, now retire ; now precede, now follow ; now move faster, now slower, now do not move at all but remain for a time stationary. On the diverse motions of the planets the mathematicians have based what they call the Great Year, which is completed when the sun, moon and five planets having all finished their courses have returned to the same positions relative to one another. The length of this period is hotly debated, but it must necessarily be a fixed and definite time.[247]

[247] Text and translation by Rackham, in: *Cicero in Twenty-Eight Volumes*, vol. XIX, London 1967, p. 172f.

Cicero himself allegedly gave a duration of the Great Year in his *Hortensius*, which is extant only in fragments. Tacitus states in *Dialogus de oratoribus* 16.7:

> *... ut Cicero in Hortensio scribit, is est magnus et verus annus, quo eadem positio caeli siderumque, quae cum maxime est, rursum existet, isque annus horum quos nos vocamus annorum duodecim milia nongentos quinquaginta quattuor complectitur ...*
>
> ... as Cicero writes in *Hortensius*, this is the great and true year, in which the same sidereal situation of the sky and the stars, which exists right now, returns again; and we say that this year of these [stars] comprises 12,954 years...[248]

This duration of the Great Year thus considerably differs from the duration given by Antiochus.

The doctrine of the great cycles was possibly combined with the idea that all mundane events re-iterate themselves exactly like the celestial configurations. Servius in his commentary to Vergil, *Eclogae* IV.4, writes:

> *dixit etiam, finitis omnibus saeculis rursus eadem innovari: quam rem etiam philosophi hac disputatione colligunt, dicentes, completo magno anno omnia sidera in ortus suos redire et ferri rursus eodem motu. quod si est idem siderum motus, necesse est ut omnia quae fuerunt habeant iterationem: universa enim ex astrorum motu pendere manifestum est. hoc secutus Vergilius dicit reverti aurea saecula et iterari omnia quae fuerunt.*
>
> He also says that, when all ages have ended, the same [ages (or: things)] renew themselves. This is also concluded by the philosophers, who say that when a Great Year is completed, all stars return to their origins and are carried in the same motion again. And when the motion of the stars is the same, it is necessary that all [things] that were have a repetition, because it is obvious that all [things] depend on the motion of the stars. Following this [consideration], Vergil says that golden ages return and all [things] that were repeat.[249]

[248] Latin text from: Tacitus, *Dialogus, Agricola, Germania* (ed. Page & Rouse), p. 58. Translation D.K.

[249] Latin text from: Thilo, *Servii Grammatici qui feruntur in Vergilii Bucolica et Georgica Commentarii*, p. 44; translation D.K.

In summary, it can be stated that the Western tradition of astronomical cycles is attested only since about 400 BCE (Plato, Berossus). Since Babylonian precursors of this doctrine are not known, it is likely that it was developed after 500 BCE as a side product of Babylonian planetary theories, in which planetary cycles played an important role.

If the Indian and Chinese testimonies of the super-conjunctions in the years 1198 and 1059 BCE are authentic, then of course the question arises whether the western cyclic models of history were not inspired by an Indian precursor. The idea of an eternal recurrence of the same seems to be rather Indian than Western in nature.

Still, the following points should be borne in mind:

1. The yuga theory of the Purāṇas, according to which a "great yuga" covers 43,20,000 years, is not found in the older Vedic literature and is even unknown to early works of Hellenistic Indian astrology (Yavanajātaka, Romakasiddhānta). It is thus obviously younger than the above-cited Western sources.

2. The planetary theories of the Siddhāntas are all younger than the above-cited Western sources. In pre-Hellenistic works of Indian astronomy and astrology (Vedāṅgajyotiṣa, Parāśaratantra), they do not appear.

On the other hand, the idea that all the planets come together and form a super-conjunction at the end of a cosmic age obviously first appeared in India and China. This idea is not found, e.g. in Homer's epics.

# *Appendices*

## A: Super-Conjunctions with New Moon 4000 BCE to 2500 CE

The list contains information about super-conjunctions, where all planets including the Moon disappeared in the glare of the Sun and became invisible. Besides, new moons, full moons, and eclipses are given that occurred near the time of the conjunction.

Calculations are made for Kurukṣetra, 76e51, 30n00, 250 m above sea level.

The visibility assumed is about 70 km, extinction coefficient 0.3. It must be noted that in case of better visibility heliacal risings of Mars could have occurred several weeks earlier than stated in the list, and heliacal settings could have occurred several weeks later. As well with Saturn and Mercury, the visibility periods would result considerably longer.

Heliacal risings and settings in brackets are based on a better visibility with an extinction coefficient of 0.2 or 0.15.

Calendar dates are given in astronomical year count (-1197 = 1198 BCE), dates before 1600 CE in Julian calendar, later ones in Gregorian calendar. Clock times are given in Universal Time (UT).

*Ayanāṃśa* according to Lahiri is used.

Calculations were made using unpublished software written by the author of this work based on the *Swiss Ephemeris*. Recent versions of the Swiss Ephemeris use the JPL Ephemerides DE406 and DE431, the precession model Vondrák (2011), ΔT according to Morrison/Stevenson (2004), visibility calculations according to Bradley Schaefer (1993, 2000), programmed by Victor Reijs, ported to C by Dieter Koch.

duration = 0.97780 days (6.46941 days ignoring moon)

------------------

-3919/01/20,12:57 Mars heliacal setting sid=350.7064 Rev tro=292.8653
-3919/03/02,13:03 Jupiter heliacal setting sid= 21.2069 Bha tro=323.3693
-3919/03/15,01:00 Mercury morning last sid=357.3485 Rev tro=299.5112
-3919/03/27,13:07 Venus heliacal setting sid= 41.4064 Roh tro=343.5786
-3919/03/30,00:11 Moon morning last sid= 8.6565 Aśv tro=310.8276
-3919/04/01,13:23 Saturn heliacal setting sid= 53.3430 Mṛg tro=355.5069

------------------

-3919/04/01,04:00 Sun / new moon sid= 37.6728 Kṛt tro=339.8385
-3919/04/01,04:00 Lunar Node sid=185.4637 Cit tro=127.6351

------------------

-3919/04/02,12:51 Moon evening first sid= 56.8280 Mṛg tro=358.9991
-3919/04/08,00:39 Venus heliacal rising sid= 34.4100 Kṛt tro=336.5824
-3919/04/16,00:27 Jupiter heliacal rising sid= 31.4851 Kṛt tro=333.6490
-3919/04/21,13:27 Mercury evening first sid= 70.2332 Ārd tro= 12.3909
-3919/05/22,23:33 Saturn heliacal rising sid= 60.0346 Mṛg tro= 2.2002
-3919/07/07,22:46 Mars heliacal rising sid=103.2802 Puṣ tro= 45.4455

------------------

-3919/02/15,05:09 Moon eclipsed (unobs.) sid=174.5972 Cit tro=116.7669
-3919/03/02,17:07 Sun eclipsed (unobs.) sid= 9.4813 Aśv tro=311.6462
-3919/03/16,15:00 Moon eclipsed (unobs.) sid=202.6940 Viś tro=144.8648
-3919/04/15,02:38 Moon full sid=230.9337 Jye tro=173.1051

==================

duration = 1.98275 days (11.38337 days ignoring moon)

------------------

-3439/06/01,14:00 Mercury heliacal setting sid=114.5872 Āśl tro= 63.3259
-3439/06/12,14:16 Mars heliacal setting sid=124.9107 Mag tro= 73.6409
-3439/07/13,23:14 Venus morning last sid=123.0683 Mag tro= 71.7971
-3439/07/27,14:35 Saturn heliacal setting sid=168.4876 Has tro=117.2220
-3439/08/27,22:40 Moon morning last sid=155.5166 UPh tro=104.2592
-3439/08/29,14:10 Jupiter heliacal setting sid=196.7914 Svā tro=145.5263

------------------

-3439/08/29,14:51 Sun / new moon sid=180.0479 Cit tro=128.7851
-3439/08/29,14:51 Lunar Node sid=246.1179 Mūl tro=194.8608

------------------

-3439/08/31,13:46 Moon evening first sid=209.2974 Viś tro=158.0402
-3439/09/09,23:23 Saturn heliacal rising sid=173.6584 Cit tro=122.3945
-3439/10/05,00:00 Jupiter heliacal rising sid=204.8941 Viś tro=153.6299
-3439/10/12,23:56 Mercury heliacal rising sid=208.5402 Viś tro=157.2852
-3439/10/20,23:59 Mars heliacal rising sid=214.0813 Anu tro=162.8155
-3439/10/23,13:09 Venus evening first sid=250.6237 Mūl tro=199.3562

------------------

-3439/08/14,05:54 Moon full sid=344.6925 UBh tro=293.4346
-3439/09/12,22:57 Moon full sid= 14.4909 Bha tro=323.2341
-3439/10/27,12:29 Sun eclipsed (unobs.) sid=239.8932 Jye tro=188.6318

duration = 2.45188 days (3.52195 days ignoring moon)

\------------------

-3341/08/08,14:41 Mars heliacal setting sid=183.6888 Cit tro=133.7561
-3341/11/09,13:08 Saturn heliacal setting sid=275.8794 UĀṣ tro=225.9522
-3341/11/29,00:41 Mercury morning last sid=257.7831 PĀṣ tro=207.8516
-3341/12/10,12:35 Jupiter heliacal setting sid=299.4567 Dha tro=249.5295
-3341/12/21,12:22 Venus heliacal setting sid=302.6514 Dha tro=252.7337
-3341/12/22,01:14 Moon morning last sid=286.3235 Śra tro=236.4047

\------------------

-3341/12/22,16:32 Sun / new moon sid=295.8826 Dha tro=245.9582
-3341/12/22,16:32 Lunar Node sid=143.0642 PPh tro= 93.1456

\------------------

-3341/12/24,12:04 Moon evening first sid=322.5237 PBh tro=272.6051
-3341/12/25,00:54 Saturn heliacal rising sid=281.2889 Śra tro=231.3632
-3341/12/31,01:16 Venus heliacal rising sid=296.7914 Dha tro=246.8743
-3340/01/08,12:35 Mercury evening first sid=328.3082 PBh tro=278.3797
-3340/01/18,01:19 Jupiter heliacal rising sid=308.6086 Śat tro=258.6832
(-3340/02/15,01:05 Mercury heliacal rising sid=329.7818 PBh tro=279.8637)
-3340/03/28,00:36 Mars heliacal rising sid= 0.5296 Aśv tro=310.6058
-3340/02/15,06:00 all planets visible with old moon, Me – Sa = 43°18’
-3340/03/14,06:00 all planets visible with old moon, Me – Sa = 70°06’

\------------------

-3341/12/08,06:17 Moon full sid=101.2890 Puṣ tro= 51.3695
-3340/01/07,00:35 Moon eclipsed (unobs.) sid=131.3626 Mag tro= 81.4446
-3340/01/21,03:16 Sun eclipsed (unobs.) sid=325.3177 PBh tro=275.3950

==================

duration = 3.52926 days (22.01220 days ignoring moon)

\------------------

-3243/11/03,13:18 Mars heliacal setting sid=274.7748 UĀṣ tro=226.1901
-3242/02/28,01:26 Venus morning last sid=348.3271 Rev tro=299.7459
-3242/03/18,00:50 Mercury morning last sid=353.8230 Rev tro=305.2482
-3242/03/30,13:24 Saturn heliacal setting sid= 47.2644 Roh tro=358.6888
-3242/04/07,13:20 Jupiter heliacal setting sid= 51.2116 Roh tro= 2.6355
-3242/04/14,00:19 Moon morning last sid= 25.7235 Bha tro=337.1555

\------------------

-3242/04/15,14:52 Sun eclipsed (unobs.) sid= 46.9009 Roh tro=358.3275
-3242/04/15,14:52 Lunar Node sid= 40.0201 Roh tro=351.4523

\------------------

-3242/04/17,13:01 Moon evening first sid= 71.2695 Ārd tro= 22.7015
-3242/04/29,13:38 Mercury evening first sid= 72.8000 Ārd tro= 24.2183
-3242/05/20,23:32 Saturn heliacal rising sid= 53.9719 Mṛg tro= 5.3982
-3242/05/20,23:37 Jupiter heliacal rising sid= 61.0495 Mṛg tro= 12.4749
-3242/05/24,13:36 Venus evening first sid= 93.2501 Pun tro= 44.6714
-3242/06/19,22:52 Mars heliacal rising sid= 79.4186 Ārd tro= 30.8443

\------------------

-3242/04/01,17:10 Moon eclipsed (69.7%) sid=213.7344 Anu tro=165.1660
-3242/05/01,02:24 Moon full sid=241.6129 Mūl tro=193.0452

duration = 0.98280 days (26.00621 days ignoring moon)
------------------
-3063/03/14,01:10 Venus morning last sid=359.6895 Rev tro=313.5551
-3063/04/26,13:48 Mars heliacal setting sid= 77.1533 Ārd tro= 31.0223
-3063/05/03,13:43 Saturn heliacal setting sid= 78.4916 Ārd tro= 32.3628
-3063/05/11,13:55 Mercury heliacal setting sid= 91.2576 Pun tro= 45.1358
-3063/05/13,23:24 Moon morning last sid= 45.6838 Roh tro=359.5624
-3063/05/16,13:41 Jupiter heliacal setting sid= 87.6022 Pun tro= 41.4731
------------------
-3063/05/15,22:33 Sun / new moon sid= 74.8301 Ārd tro= 28.7033
-3063/05/15,22:33 Lunar Node sid=173.5148 Cit tro=127.3936
------------------
-3063/05/17,13:16 Moon evening first sid= 98.1693 Puṣ tro= 52.0480
-3063/06/11,13:49 Venus evening first sid=109.5750 Āśl tro= 63.4426
-3063/06/19,22:57 Saturn heliacal rising sid= 84.5869 Pun tro= 38.4600
-3063/06/24,23:02 Jupiter heliacal rising sid= 96.3100 Puṣ tro= 50.1825
-3063/08/09,14:30 Mercury evening first sid=178.0932 Cit tro=131.9654
-3063/08/31,23:15 Mars heliacal rising sid=158.9903 UPh tro=112.8640
------------------
-3063/05/01,18:18 Moon full sid=241.3588 Mūl tro=195.2370
-3063/05/31,07:23 Moon full sid=269.4609 UĀṣ tro=223.3399
==================
duration = 1.01644 days (11.39591 days ignoring moon)
both Venus and Mercury heliacally rising
------------------
-2965/05/15,19:00 all planets visible with new moon, Sa – Mo = 100°33’
-2965/05/24,13:59 Mercury heliacal setting sid=103.2792 Puṣ tro= 58.5012
-2965/06/25,14:30 Mars heliacal setting sid=134.6456 PPh tro= 89.8600
-2965/08/18,14:00 Venus heliacal setting sid=185.5462 Cit tro=140.7733
-2965/08/20,14:17 Jupiter heliacal setting sid=183.1447 Cit tro=138.3634
-2965/08/27,14:22 Saturn heliacal setting sid=197.4811 Svā tro=152.7011
-2965/09/06,23:28 Moon morning last sid=173.3563 Cit tro=128.5837
------------------
-2965/09/07,22:37 Sun / new moon sid=185.6976 Cit tro=140.9194
-2965/09/07,22:37 Lunar Node sid= 70.4736 Ārd tro= 25.7012
------------------
-2965/09/07,23:52 Venus heliacal rising sid=174.9466 Cit tro=130.1750
-2965/09/09,13:36 Moon evening first sid=205.9879 Viś tro=161.2154
-2965/09/24,23:53 Jupiter heliacal rising sid=190.9504 Svā tro=146.1705
-2965/10/06,23:57 Mercury heliacal rising sid=199.0908 Svā tro=154.3202
-2965/10/10,23:54 Saturn heliacal rising sid=202.5799 Viś tro=157.8012
-2965/11/07,00:14 Mars heliacal rising sid=228.0553 Jye tro=183.2745
-2965/11/04,06:00 all planets visible with old moon, Me – Ve = 32°01’
------------------
-2965/08/24,21:46 Moon full sid=351.6388 Rev tro=306.8656
-2965/09/23,09:18 Moon full sid= 21.2921 Bha tro=336.5200
-2965/10/22,20:56 Moon eclipsed (unobs.) sid= 51.4517 Roh tro= 6.6805

duration = 2.50604 days (17.99605 days ignoring moon)

------------------
-2867/08/18,14:33 Mars heliacal setting sid=192.8984 Svā tro=149.4643
-2867/11/19,00:34 Mercury morning last sid=244.9327 Mūl tro=201.4991
-2867/11/23,00:54 Venus morning last sid=253.9337 PĀṣ tro=210.5000
-2867/11/26,12:37 Jupiter heliacal setting sid=283.3432 Śra tro=239.9137
-2867/12/14,12:42 Saturn heliacal setting sid=307.3651 Śat tro=263.9372
-2867/12/30,00:27 Moon morning last sid=279.5709 UĀṣ tro=236.1507

------------------
-2867/12/31,22:57 Sun / new moon sid=302.4697 Dha tro=259.0441
-2867/12/31,22:57 Lunar Node sid=327.3813 PBh tro=283.9615

------------------
-2866/01/01,12:36 Mercury evening first sid=318.6735 Śat tro=275.2431
-2866/01/02,12:04 Moon evening first sid=320.8648 PBh tro=277.4449
-2866/01/04,01:12 Jupiter heliacal rising sid=292.4533 Śra tro=249.0254
-2866/02/03,01:08 Saturn heliacal rising sid=313.5518 Śat tro=270.1265
-2866/02/09,12:44 Venus evening first sid=351.7457 Rev tro=308.3157
-2866/04/28,23:48 Mars heliacal rising sid= 24.9259 Bha tro=341.5014

------------------
-2867/12/17,00:52 Moon full sid=107.4158 Āśl tro= 63.9949
-2866/01/15,11:10 Moon eclipsed (41.8%) sid=137.0946 PPh tro= 93.6754
-2866/01/30,16:36 Sun eclipsed (unobs.) sid=332.0957 PBh tro=288.6718

==================
duration = 3.56267 days (8.42699 days ignoring moon)
both Venus and Mercury heliacally rising

------------------
-2348/07/20,14:39 Mars heliacal setting sid=158.7898 UPh tro=122.4685
-2348/07/27,23:05 Mercury morning last sid=126.5876 Mag tro= 90.2644
-2348/08/14,14:27 Saturn heliacal setting sid=181.1301 Cit tro=144.8125
-2348/08/27,14:04 Jupiter heliacal setting sid=187.9881 Svā tro=151.6702
-2348/09/20,13:29 Venus heliacal setting sid=217.8157 Anu tro=181.5069
-2348/09/24,23:39 Moon morning last sid=185.4980 Cit tro=149.1887

------------------
-2348/09/26,05:17 Sun eclipsed (unobs.) sid=200.7063 Viś tro=164.3915
-2348/09/26,05:17 Lunar Node sid= 6.3348 Aśv tro=330.0258

------------------
-2348/09/28,13:09 Moon evening first sid=229.8341 Jye tro=193.5248
-2348/09/28,23:44 Saturn heliacal rising sid=186.3940 Cit tro=150.0777
-2348/10/03,00:07 Jupiter heliacal rising sid=196.0271 Svā tro=159.7101
-2348/10/12,00:19 Venus heliacal rising sid=207.2325 Viś tro=170.9248
-2348/10/28,00:02 Mercury heliacal rising sid=215.7637 Anu tro=179.4560
-2347/01/02,01:02 Mars heliacal rising sid=280.2821 Śra tro=243.9665

------------------
-2348/09/10,21:25 Moon eclipsed (156.1%) sid= 5.3075 Aśv tro=328.9978
-2348/10/10,09:00 Moon full sid= 35.0717 Kṛt tro=358.7629

duration = 2.55838 days (19.42190 days ignoring moon)

------------------

-2288/06/02,14:19 Mars heliacal setting sid=108.3681 Āśl tro= 72.8706
-2288/07/12,23:01 Mercury morning last sid=110.0956 Āśl tro= 74.5986
-2288/08/08,23:29 Venus morning last sid=142.7550 PPh tro=107.2578
-2288/08/26,14:17 Saturn heliacal setting sid=193.1926 Svā tro=157.7012
-2288/09/17,13:44 Jupiter heliacal setting sid=209.3031 Viś tro=173.8114
-2288/09/21,23:49 Moon morning last sid=183.5688 Cit tro=148.0850

------------------

-2288/09/22,22:07 Sun / new moon sid=196.9604 Svā tro=161.4711
-2288/09/22,22:07 Lunar Node sid=285.1084 Śra tro=249.6249

------------------

-2288/09/24,13:13 Moon evening first sid=220.9004 Anu tro=185.4166
-2288/10/06,23:52 Mars heliacal rising sid=191.6467 Svā tro=156.1536
-2288/10/10,23:54 Saturn heliacal rising sid=198.4183 Svā tro=162.9279
-2288/10/14,23:56 Mercury heliacal rising sid=202.6815 Viś tro=167.1989
-2288/10/25,00:19 Jupiter heliacal rising sid=217.6895 Anu tro=182.1985
-2288/11/11,12:38 Venus evening first sid=261.5887 PĀṣ tro=226.0945

------------------

-2288/09/07,10:14 Moon full sid= 1.3713 Aśv tro=325.8871
-2288/10/07,02:38 Moon full sid= 31.3363 Kṛt tro=355.8528

==================

duration = 1.98837 days (12.46871 days ignoring moon)

------------------

-2109/08/29,14:17 Mars heliacal setting sid=200.4589 Viś tro=167.4164
-2109/08/29,23:45 Venus morning last sid=161.8804 Has tro=128.8350
-2109/09/21,13:50 Saturn heliacal setting sid=217.5136 Anu tro=184.4743
-2109/10/17,00:13 Mercury morning last sid=206.2450 Viś tro=173.2018
-2109/10/22,23:50 Moon morning last sid=209.7941 Viś tro=176.7625
-2109/10/23,13:01 Jupiter heliacal setting sid=243.9800 Mūl tro=210.9406

------------------

-2109/10/24,08:55 Sun eclipsed 31.7% sid=226.9224 Jye tro=193.8852
-2109/10/24,08:55 Lunar Node sid= 58.6403 Mṛg tro= 25.6089

------------------

-2109/10/25,12:44 Moon evening first sid=242.2103 Mūl tro=209.1787
-2109/11/05,00:16 Saturn heliacal rising sid=222.6017 Anu tro=189.5634
-2109/11/29,12:28 Venus evening first sid=277.0295 UĀṣ tro=243.9877
-2109/11/30,00:50 Jupiter heliacal rising sid=252.6169 Mūl tro=219.5789
-2109/12/10,12:35 Mercury evening first sid=292.9209 Śra tro=259.8833
-2108/05/15,23:17 Mars heliacal rising sid= 37.3222 Kṛt tro= 4.2902

------------------

-2109/10/08,19:55 Moon full sid= 31.0972 Kṛt tro=358.0652
-2109/11/07,09:10 Moon eclipsed (129.7%) sid= 61.2368 Mṛg tro= 28.2057

duration = 0.36029 days (0.36029 days ignoring moon)

------------------

-2092/10/01,13:43 Mars heliacal setting sid=234.6033 Jye tro=201.7935
-2091/03/14,01:02 Venus morning last sid=353.0330 Rev tro=320.2279
-2091/04/30,13:38 Jupiter heliacal setting sid= 66.0632 Mṛg tro= 33.2630
-2091/05/07,13:53 Saturn heliacal setting sid= 76.1476 Ārd tro= 43.3484
-2091/06/06,23:13 Moon morning last sid= 74.6644 Ārd tro= 41.8734
-2091/06/07,14:15 Mercury heliacal setting sid=112.1907 Āśl tro= 79.3993

------------------

-2091/06/08,05:27 Sun eclipsed (unobs.) sid= 90.9312 Pun tro= 58.1348
-2091/06/08,05:27 Lunar Node sid= 77.5156 Ārd tro= 44.7248

------------------

-2091/06/07,22:54 Mars heliacal rising sid= 60.8553 Mṛg tro= 28.0556
-2091/06/09,13:35 Moon evening first sid=107.5961 Āśl tro= 74.8053
-2091/06/09,23:09 Jupiter heliacal rising sid= 75.1371 Ārd tro= 42.3387
-2091/06/13,14:01 Venus evening first sid=105.3734 Puṣ tro= 72.5709
-2091/06/21,22:56 Saturn heliacal rising sid= 82.0118 Pun tro= 49.2145
-2091/07/11,22:58 Mercury heliacal rising sid=104.9908 Puṣ tro= 72.1962

------------------

-2091/05/09,18:26 Sun eclipsed (unobs.) sid= 62.9011 Mṛg tro= 30.1036
-2091/05/25,06:50 Moon eclipsed (175.4%) sid=257.6489 PĀṣ tro=224.8573
-2091/06/23,15:44 Moon full sid=285.6816 Śra tro=252.8914

==================

duration = 2.60835 days (11.35883 days ignoring moon)
both Venus and Mercury heliacally rising

------------------

-1972/05/16,18:00 all planets visible with new moon, Ve – Ju = 23°47’
-1972/05/14,13:48 Jupiter heliacal setting sid= 78.9817 Ārd tro= 47.8246
-1972/05/23,14:00 Saturn heliacal setting sid= 92.0173 Pun tro= 60.8614
-1972/05/26,14:09 Mercury heliacal setting sid= 99.8204 Puṣ tro= 68.6710
-1972/06/07,13:56 Venus heliacal setting sid= 99.9920 Puṣ tro= 68.8448
-1972/06/10,14:27 Mars heliacal setting sid=114.5776 Āśl tro= 83.4202
-1972/06/11,23:03 Moon morning last sid= 81.0502 Pun tro= 49.9020

------------------

-1972/06/12,21:49 Sun / new moon sid= 94.8995 Puṣ tro= 63.7459
-1972/06/12,21:49 Lunar Node sid=293.8177 Dha tro=262.6698

------------------

-1972/06/14,13:39 Moon evening first sid=119.4977 Āśl tro= 88.3497
-1972/06/21,23:04 Jupiter heliacal rising sid= 87.5283 Pun tro= 56.3729
-1972/06/24,23:13 Venus heliacal rising sid= 90.1900 Pun tro= 59.0433
-1972/07/03,23:01 Mercury heliacal rising sid= 96.8653 Puṣ tro= 65.7111
-1972/07/06,22:52 Saturn heliacal rising sid= 97.6865 Puṣ tro= 66.5325
-1972/10/16,23:59 Mars heliacal rising sid=199.8208 Svā tro=168.6679

------------------

-1972/05/28,13:39 Moon full sid=260.2799 PĀṣ tro=229.1312
-1972/06/27,03:55 Moon eclipsed (100.4%) sid=288.6154 Śra tro=257.4680
-1972/07/12,05:28 Sun eclipsed (unobs.) sid=123.0484 Mag tro= 91.8963

```
duration =  2.59798 days (25.99876 days ignoring moon)
------------------
-1912/03/30,00:41 Venus morning last         sid=   6.8567 Aśv        tro=336.5153
-1912/04/16,13:50 Mars heliacal setting      sid=  60.3084 Mṛg        tro= 29.9695
-1912/05/10,13:59 Mercury heliacal setting   sid=  83.5932 Pun        tro= 53.2634
-1912/06/06,14:01 Jupiter heliacal setting   sid=101.1977 Puṣ         tro= 70.8618
-1912/06/07,14:11 Saturn heliacal setting    sid=106.8743 Āśl         tro= 76.5391
-1912/06/07,23:16 Moon morning last          sid=  72.9182 Ārd        tro= 42.5900
------------------
-1912/06/09,04:03 Sun / new moon             sid=  90.9550 Pun        tro= 60.6215
-1912/06/09,04:03 Lunar Node                 sid=212.6209 Viś         tro=182.2930
------------------
-1912/06/10,13:37 Moon evening first         sid=111.6852 Āśl         tro= 81.3572
-1912/07/03,14:09 Venus evening first        sid=124.2190 Mag         tro= 93.8800
-1912/07/12,23:03 Jupiter heliacal rising    sid=109.1861 Āśl         tro= 78.8519
-1912/07/20,22:57 Saturn heliacal rising     sid=112.3430 Āśl         tro= 82.0097
-1912/08/13,14:23 Mercury evening first      sid=176.6282 Cit         tro=146.2937
-1912/08/22,23:18 Mars heliacal rising       sid=142.5228 PPh         tro=112.1886
------------------
-1912/05/25,19:28 Moon full                  sid=257.2814 PĀṣ         tro=226.9528
-1912/06/24,09:43 Moon full                  sid=285.5195 Śra         tro=255.1920
==================
duration =  1.97386 days (3.51532 days ignoring moon)
------------------
-1716/08/03,14:36 Mars heliacal setting      sid=170.5460 Has         tro=142.9071
-1716/12/12,01:09 Venus morning last         sid=264.9790 PĀṣ         tro=237.3421
-1716/12/20,12:27 Jupiter heliacal setting   sid=297.6621 Dha         tro=270.0297
-1715/01/14,12:49 Mercury heliacal setting   sid=325.1601 PBh         tro=297.5357
-1715/01/23,00:52 Moon morning last          sid=295.3037 Dha         tro=267.6811
-1715/01/24,12:57 Saturn heliacal setting    sid=337.4970 UBh         tro=309.8674
------------------
-1715/01/25,00:57 Sun / new moon             sid=319.0629 Śat         tro=291.4349
-1715/01/25,00:57 Lunar Node                 sid=   6.5553 Aśv        tro=338.9330
------------------
-1715/01/26,12:20 Moon evening first         sid=336.4954 UBh         tro=308.8730
-1715/01/28,01:19 Jupiter heliacal rising    sid=306.8297 Śat         tro=279.1994
-1715/02/10,00:56 Mercury heliacal rising    sid=311.7382 Śat         tro=284.1160
-1715/02/27,13:04 Venus evening first        sid=   1.4561 Aśv        tro=333.8231
-1715/03/21,00:31 Saturn heliacal rising     sid=344.4439 UBh         tro=316.8169
-1715/03/22,00:30 Mars heliacal rising       sid=344.1418 UBh         tro=316.5122
------------------
-1715/01/10,07:50 Moon full                  sid=124.3271 Mag         tro= 96.7038
-1715/02/08,17:13 Moon full                  sid=153.6362 UPh         tro=126.0144
```

duration = 3.62001 days (19.36337 days ignoring moon)
------------------
-1295/05/04,23:51 Venus morning last sid= 37.8485 Kṛt tro= 15.9936
-1295/05/19,14:14 Mars heliacal setting sid= 88.5877 Pun tro= 66.7356
-1295/05/21,14:02 Saturn heliacal setting sid= 85.8697 Pun tro= 64.0198
-1295/06/03,14:15 Mercury heliacal setting sid=103.8925 Puṣ tro= 82.0493
-1295/06/15,14:09 Jupiter heliacal setting sid=106.5377 Puṣ tro= 84.6882
-1295/06/25,22:56 Moon morning last sid= 84.3129 Pun tro= 62.4715
------------------
-1295/06/27,14:24 Sun / new moon sid=104.5019 Puṣ tro= 82.6551
-1295/06/27,14:24 Lunar Node sid=148.7039 UPh tro=126.8628
------------------
-1295/06/29,13:49 Moon evening first sid=128.1972 Mag tro=106.3560
-1295/07/04,22:52 Saturn heliacal rising sid= 91.5773 Pun tro= 69.7294
-1295/07/09,22:58 Mercury heliacal rising sid= 97.7578 Puṣ tro= 75.9117
-1295/07/21,23:08 Jupiter heliacal rising sid=114.4966 Āśl tro= 92.6486
-1295/08/12,14:04 Venus evening first sid=160.6796 Has tro=138.8286
-1295/09/21,23:44 Mars heliacal rising sid=169.1914 Has tro=147.3440
------------------
-1295/06/13,10:19 Moon full sid=270.9628 UĀṣ tro=249.1207
-1295/07/12,18:00 Moon full sid=299.0535 Dha tro=277.2129
-1295/07/27,06:15 Sun eclipsed (unobs.) sid=133.0876 Mag tro=111.2422
==================
duration = 3.52401 days (11.47897 days ignoring moon)
both Venus and Mercury heliacally rising
------------------
-1197/07/09,14:41 Mars heliacal setting sid=140.2731 PPh tro=119.7751
-1197/07/30,23:12 Mercury morning last sid=121.8809 Mag tro=101.3811
-1197/09/15,13:50 Saturn heliacal setting sid=205.2169 Viś tro=184.7240
-1197/09/17,13:38 Jupiter heliacal setting sid=200.8968 Viś tro=180.4031
(-1197/10/06 13:21 Mercury heliacal setting sid=224.6233 Anu tro=204.1378)
-1197/10/13,12:48 Venus heliacal setting sid=231.3999 Jye tro=210.9153
-1197/10/19,23:55 Moon morning last sid=201.4079 Viś tro=180.9228
------------------
-1197/10/21,08:40 Sun eclipsed 86.9% sid=217.6359 Anu tro=197.1452
-1197/10/21,08:40 Lunar Node sid= 45.6699 Roh tro= 25.1851
------------------
-1197/10/23,12:29 Moon evening first sid=244.2529 Mūl tro=223.7678
-1197/10/25,00:18 Jupiter heliacal rising sid=209.2035 Viś tro=188.7106
-1197/10/30,00:12 Mercury heliacal rising sid=210.0254 Viś tro=189.5418
-1197/10/30,00:15 Saturn heliacal rising sid=210.3411 Viś tro=189.8493
-1197/11/03,00:36 Venus heliacal rising sid=221.0282 Anu tro=200.5447
-1197/12/05,00:40 <Mars heliacal rising sid=243.8340 Mūl tro=223.3407
-1197/11/18,06:00 all planets visible with old moon, Ma – Sa = 18°41’
------------------
-1197/10/06,03:18 Moon full sid= 22.2040 Bha tro= 1.7185
-1197/11/04,14:33 Moon eclipsed (70.9%) sid= 52.0338 Roh tro= 31.5492

duration = 2.46558 days (10.47524 days ignoring moon)

------------------

| | | |
|---|---|---|
| -1099/09/02,14:06 Mars heliacal setting | sid=198.9949 Svā | tro=179.8566 |
| -1099/12/12,00:53 Mercury morning last | sid=254.9479 PĀṣ | tro=235.8105 |
| -1098/01/02,12:35 Jupiter heliacal setting | sid=305.0827 Dha | tro=285.9500 |
| -1098/01/06,12:48 Saturn heliacal setting | sid=315.6467 Śat | tro=296.5151 |
| -1098/01/11,01:28 Venus morning last | sid=289.2980 Śra | tro=270.1618 |
| -1098/01/13,01:02 Moon morning last | sid=285.9724 Śra | tro=266.8482 |
| ------------------ | | |
| -1098/01/14,12:01 Sun eclipsed 33.4% | sid=304.1239 Dha | tro=284.9942 |
| -1098/01/14,12:01 Lunar Node | sid=304.2085 Dha | tro=285.0846 |
| ------------------ | | |
| -1098/01/15,12:12 Moon evening first | sid=318.6008 Śat | tro=299.4767 |
| -1098/01/21,12:52 Mercury evening first | sid=324.6016 PBh | tro=305.4657 |
| -1098/02/10,01:16 Jupiter heliacal rising | sid=314.2906 Śat | tro=295.1598 |
| -1098/03/02,00:43 Saturn heliacal rising | sid=322.2669 PBh | tro=303.1379 |
| -1098/03/15,00:36 Mercury heliacal rising | sid=336.0620 UBh | tro=316.9365 |
| -1098/04/02,13:22 Venus evening first | sid= 30.2472 Kṛt | tro= 11.1140 |
| -1098/05/18,23:08 Mars heliacal rising | sid= 34.7441 Kṛt | tro= 15.6153 |
| ------------------ | | |
| -1099/12/29,20:18 Moon eclipsed (unobs.) | sid=108.4368 Āśl | tro= 89.3119 |
| -1098/01/28,09:25 Moon eclipsed (unobs.) | sid=137.9249 PPh | tro=118.8015 |

==================

duration = 0.98471 days (3.39495 days ignoring moon)

------------------

| | | |
|---|---|---|
| -1060/03/02,13:25 Mercury heliacal setting | sid= 8.5441 Aśv | tro=349.9444 |
| -1060/04/02,13:30 Jupiter heliacal setting | sid= 32.8528 Kṛt | tro= 14.2477 |
| -1060/04/19,13:55 Mars heliacal setting | sid= 57.8894 Mṛg | tro= 39.2832 |
| -1060/05/08,23:45 Venus morning last | sid= 40.8561 Roh | tro= 22.2483 |
| -1060/05/10,23:36 Moon morning last | sid= 47.9617 Roh | tro= 29.3654 |
| -1060/05/11,13:57 Saturn heliacal setting | sid= 74.6874 Ārd | tro= 56.0840 |
| ------------------ | | |
| -1060/05/11,19:19 Sun / new moon | sid= 58.7085 Mṛg | tro= 40.1068 |
| -1060/05/11,19:19 Lunar Node | sid=282.4247 Śra | tro=263.8287 |
| ------------------ | | |
| -1060/05/12,13:35 Moon evening first | sid= 68.8125 Ārd | tro= 50.2163 |
| -1060/05/14,23:26 Jupiter heliacal rising | sid= 42.6607 Roh | tro= 24.0570 |
| -1060/05/29,14:05 Mercury evening first | sid= 89.4221 Pun | tro= 70.8131 |
| -1060/06/24,22:58 Saturn heliacal rising | sid= 80.4318 Pun | tro= 61.8305 |
| -1060/08/16,13:58 Venus evening first | sid=163.7356 Has | tro=145.1319 |
| -1060/08/25,23:24 Mars heliacal rising | sid=140.2444 PPh | tro=121.6436 |
| ------------------ | | |
| -1060/04/26,07:20 Moon full | sid=223.9383 Anu | tro=205.3415 |
| -1060/05/25,16:58 Moon full | sid=251.9334 Mūl | tro=233.3377 |
| -1060/06/10,05:39 Sun eclipsed (unobs.) | sid= 86.7131 Pun | tro= 68.1127 |

duration = 2.50451 days (21.50795 days ignoring moon)

------------------

| | | |
|---|---|---|
| -0958/08/13,14:24 Mars heliacal setting | sid=177.1878 Cit | tro=159.9843 |
| -0958/09/21,00:12 Venus morning last | sid=176.8194 Cit | tro=159.6141 |
| -0958/10/16,00:10 Mercury morning last | sid=197.3927 Svā | tro=180.1887 |
| -0958/10/24,13:01 Saturn heliacal setting | sid=242.1990 Mūl | tro=224.9997 |
| -0958/11/15,12:33 Jupiter heliacal setting | sid=257.9188 PĀṣ | tro=240.7193 |
| -0958/11/16,00:06 Moon morning last | sid=225.5314 Anu | tro=208.3397 |

------------------

| | | |
|---|---|---|
| -0958/11/17,11:45 Sun / new moon | sid=243.9226 Mūl | tro=226.7253 |
| -0958/11/17,11:45 Lunar Node | sid= 98.0548 Puṣ | tro= 80.8633 |

------------------

| | | |
|---|---|---|
| -0958/11/18,12:12 Moon evening first | sid=256.7652 PĀṣ | tro=239.5737 |
| -0958/12/07,00:44 Saturn heliacal rising | sid=247.2224 Mūl | tro=230.0247 |
| -0958/12/09,12:33 Mercury evening first | sid=283.7450 Śra | tro=266.5454 |
| -0958/12/15,12:18 Venus evening first | sid=284.3811 Śra | tro=267.1789 |
| -0958/12/22,01:09 Jupiter heliacal rising | sid=266.4201 PĀṣ | tro=249.2222 |
| -0957/04/21,23:41 Mars heliacal rising | sid= 6.9723 Aśv | tro=349.7779 |

------------------

| | | |
|---|---|---|
| -0958/11/02,01:38 Moon full | sid= 48.1851 Roh | tro= 30.9930 |
| -0958/12/01,14:04 Moon full | sid= 78.3219 Ārd | tro= 61.1309 |
| -0958/12/17,02:34 Sun eclipsed 55.4% | sid=274.1528 UĀṣ | tro=256.9569 |
| -0958/12/31,04:01 Moon eclipsed (unobs.) | sid=108.3275 Āśl | tro= 91.1380 |

==================

duration = 1.53013 days (8.44428 days ignoring moon)

------------------

| | | |
|---|---|---|
| -0242/02/05,13:11 Saturn heliacal setting | sid=338.7278 UBh | tro=331.4188 |
| -0242/02/24,13:28 Mars heliacal setting | sid=358.3006 Rev | tro=350.9895 |
| -0242/03/10,00:34 Mercury morning last | sid=326.7224 PBh | tro=319.4139 |
| -0242/03/21,13:24 Jupiter heliacal setting | sid= 16.0695 Bha | tro= 8.7610 |
| -0242/03/25,13:21 Venus heliacal setting | sid= 15.9066 Bha | tro= 8.6074 |
| -0242/03/29,00:25 Moon morning last | sid= 1.9550 Aśv | tro=354.6547 |

------------------

| | | |
|---|---|---|
| -0242/03/29,16:50 Sun / new moon | sid= 11.8271 Aśv | tro= 4.5214 |
| -0242/03/29,16:50 Lunar Node | sid=291.3589 Śra | tro=284.0588 |

------------------

| | | |
|---|---|---|
| -0242/03/30,13:08 Moon evening first | sid= 23.8539 Bha | tro= 16.5536 |
| -0242/04/03,00:00 Saturn heliacal rising | sid=345.6975 UBh | tro=338.3907 |
| -0242/04/05,00:10 Venus heliacal rising | sid= 9.4811 Aśv | tro= 2.1822 |
| -0242/04/21,13:47 Mercury evening first | sid= 46.5917 Roh | tro= 39.2783 |
| -0242/05/03,23:32 Jupiter heliacal rising | sid= 26.2682 Bha | tro= 18.9613 |
| -0242/07/21,23:00 Mars heliacal rising | sid= 98.9452 Puṣ | tro= 91.6405 |

------------------

| | | |
|---|---|---|
| -0242/03/15,15:08 Moon full | sid=178.1417 Cit | tro=170.8410 |
| -0242/04/14,04:22 Moon full | sid=206.7686 Viś | tro=199.4687 |

```
duration =  2.60940 days (17.00002 days ignoring moon)
------------------
-0144/05/09,14:16 Mars heliacal setting      sid= 71.9487 Ārd    tro= 65.9924
-0144/06/05,23:22 Venus morning last         sid= 64.7136 Mṛg    tro= 58.7559
-0144/06/23,14:29 Saturn heliacal setting    sid=113.4000 Āśl    tro=107.4479
-0144/07/05,14:23 Jupiter heliacal setting   sid=119.8825 Āśl    tro=113.9301
-0144/07/19,22:50 Moon morning last          sid= 99.6841 Puṣ    tro= 93.7401
-0144/07/20,23:13 Mercury morning last       sid=106.1111 Puṣ    tro=100.1552
------------------
-0144/07/21,15:04 Sun / new moon             sid=120.7023 Mag    tro=114.7530
-0144/07/21,15:04 Lunar Node                 sid=188.4007 Svā    tro=182.4570
------------------
-0144/07/23,13:50 Moon evening first         sid=144.4623 PPh    tro=138.5185
-0144/08/06,23:13 Saturn heliacal rising     sid=118.9962 Āśl    tro=113.0458
-0144/08/10,23:28 Jupiter heliacal rising    sid=127.7857 Mag    tro=121.8348
-0144/09/07,13:29 Venus evening first        sid=180.5516 Cit    tro=174.5974
-0144/09/13,23:40 Mars heliacal rising       sid=153.4047 UPh    tro=147.4531
-0144/10/21,00:05 Mercury heliacal rising    sid=194.3207 Svā    tro=188.3793
------------------
-0144/07/07,13:23 Moon full                  sid=287.1885 Śra    tro=281.2439
-0144/08/05,21:38 Moon full                  sid=315.4689 Śat    tro=309.5256
==================
duration =  1.97435 days (18.39813 days ignoring moon)
------------------
0035/07/01,23:20 Venus morning last          sid= 89.5770 Pun    tro= 86.1011
0035/07/21,14:31 Saturn heliacal setting     sid=142.7210 PPh    tro=139.2512
0035/07/28,14:32 Mars heliacal setting       sid=154.6880 UPh    tro=151.2165
0035/08/07,14:07 Jupiter heliacal setting    sid=152.0865 UPh    tro=148.6167
0035/08/20,23:43 Moon morning last           sid=137.8899 PPh    tro=134.4282
0035/08/21,14:04 Mercury heliacal setting    sid=174.7557 Cit    tro=171.2874
------------------
0035/08/21,18:54 Sun eclipsed (unobs.)       sid=149.0975 UPh    tro=145.6304
0035/08/21,18:54 Lunar Node                  sid=322.0614 PBh    tro=318.5999
------------------
0035/08/23,13:27 Moon evening first          sid=173.0881 Has    tro=169.6266
0035/09/08,23:37 Saturn heliacal rising      sid=148.7549 UPh    tro=145.2867
0035/09/13,23:58 Jupiter heliacal rising     sid=160.1615 Has    tro=156.6928
0035/09/29,00:01 Mercury heliacal rising     sid=171.0906 Has    tro=167.6302
0035/09/30,12:59 Venus evening first         sid=202.1797 Viś    tro=198.7075
0036/02/23,00:43 Mars heliacal rising        sid=307.5819 Śat    tro=304.1181
------------------
0035/08/07,19:18 Moon eclipsed (57.9%)       sid=315.5057 Śat    tro=312.0435
0035/09/06,08:29 Moon full                   sid=344.3904 UBh    tro=340.9293
```

duration = 0.02208 days (21.48016 days ignoring moon)

------------------

0052/08/16,14:13 Mars heliacal setting sid=175.4838 Cit tro=172.2463
0053/01/25,12:56 Jupiter heliacal setting sid=319.6489 Śat tro=316.4192
0053/01/26,01:26 Venus morning last sid=295.4843 Dha tro=292.2509
0053/02/06,13:10 Mercury heliacal setting sid=336.4947 UBh tro=333.2721
0053/02/13,13:16 Saturn heliacal setting sid=344.8259 UBh tro=341.5978
0053/03/07,00:16 Moon morning last sid=322.4379 PBh tro=319.2177

------------------

0053/03/09,00:35 Sun eclipsed 74.6% sid=350.0400 Rev tro=346.8144
0053/03/09,00:35 Lunar Node sid=342.4115 UBh tro=339.1915

------------------

0053/03/07,00:47 Jupiter heliacal rising sid=329.3509 PBh tro=326.1230
0053/03/10,12:57 Moon evening first sid= 10.5806 Aśv tro= 7.3604
0053/03/14,00:25 Mercury heliacal rising sid=327.8482 PBh tro=324.6248
0053/04/10,23:46 Saturn heliacal rising sid=351.8246 Rev tro=348.5988
0053/04/22,13:39 Venus evening first sid= 42.5559 Roh tro= 39.3252
0053/04/23,23:33 Mars heliacal rising sid= 3.9406 Aśv tro= 0.7127

------------------

0053/02/21,12:00 Moon eclipsed (47.7%) sid=154.7497 UPh tro=151.5291
0053/03/23,01:14 Moon full sid=183.7546 Cit tro=180.5349

==================

duration = 0.02330 days (11.54019 days ignoring moon)

------------------

0133/10/17,13:02 Mars heliacal setting sid=233.8659 Jye tro=231.7539
0133/11/01,00:29 Mercury morning last sid=206.7836 Viś tro=204.6700
0133/11/13,12:29 Jupiter heliacal setting sid=248.1762 Mūl tro=246.0667
0133/11/15,12:35 Saturn heliacal setting sid=255.9484 PĀṣ tro=253.8399
0133/12/01,12:16 Venus heliacal setting sid=261.4260 PĀṣ tro=259.3261
0133/12/13,00:40 Moon morning last sid=247.7962 Mūl tro=245.6958

------------------

0133/12/14,09:19 Sun / new moon sid=264.2490 PĀṣ tro=262.1431
0133/12/14,09:19 Lunar Node sid=219.0760 Anu tro=216.9759

------------------

0133/12/13,01:13 Venus heliacal rising sid=254.6324 PĀṣ tro=252.5331
0133/12/15,11:59 Moon evening first sid=277.5578 UĀṣ tro=275.4576
0133/12/20,01:05 Jupiter heliacal rising sid=256.5917 PĀṣ tro=254.4838
0133/12/21,12:32 Mercury evening first sid=287.3778 Śra tro=285.2676
0133/12/30,00:57 Saturn heliacal rising sid=261.1248 PĀṣ tro=259.0182
0134/06/08,22:53 Mars heliacal rising sid= 51.5380 Roh tro= 49.4345

------------------

0133/10/31,12:43 Moon eclipsed (153%) sid= 39.5780 Kṛt tro= 37.4758
0133/11/14,14:37 Sun eclipsed (unobs.) sid=233.8654 Jye tro=231.7582
0133/11/30,01:06 Moon full sid= 69.6111 Ārd tro= 67.5101
0133/12/29,12:17 Moon full sid= 99.6577 Puṣ tro= 97.5582

duration = 3.55721 days (24.00536 days ignoring moon)

------------------

| | | | |
|---|---|---|---|
| 0232/02/10,01:13 | Venus morning last | sid=307.1219 Śat | tro=306.3638 |
| 0232/03/03,00:36 | Mercury morning last | sid=317.7402 Śat | tro=316.9861 |
| 0232/03/06,13:21 | Jupiter heliacal setting | sid=358.3811 Rev | tro=357.6274 |
| 0232/03/14,13:40 | Mars heliacal setting | sid= 13.7898 Bha | tro= 13.0343 |
| 0232/03/21,13:40 | Saturn heliacal setting | sid= 17.1034 Bha | tro= 16.3509 |
| 0232/04/05,23:52 | Moon morning last | sid=351.6396 Rev | tro=350.8946 |
| ------------------ | | | |
| 0232/04/08,05:04 | Sun / new moon | sid= 18.5500 Bha | tro= 17.7995 |
| 0232/04/08,05:04 | Lunar Node | sid=116.0820 Āśl | tro=115.3372 |
| ------------------ | | | |
| 0232/04/09,13:14 | Moon evening first | sid= 35.2276 Kṛt | tro= 34.4825 |
| 0232/04/14,13:48 | Mercury evening first | sid= 37.1855 Kṛt | tro= 36.4269 |
| 0232/04/17,23:50 | Jupiter heliacal rising | sid= 8.4659 Aśv | tro= 7.7135 |
| 0232/05/10,23:13 | Saturn heliacal rising | sid= 23.5403 Bha | tro= 22.7895 |
| 0232/05/11,13:51 | Venus evening first | sid= 60.0945 Mṛg | tro= 59.3388 |
| 0232/08/01,23:12 | Mars heliacal rising | sid=108.0973 Āśl | tro=107.3479 |
| ------------------ | | | |
| 0232/03/23,23:12 | Moon full | sid=183.7595 Cit | tro=183.0142 |
| 0232/04/22,07:27 | Moon full | sid=212.1317 Viś | tro=211.3871 |

==================

duration = 0.02760 days (1.38293 days ignoring moon)
both Venus and Mercury heliacally rising

------------------

| | | | |
|---|---|---|---|
| 0533/04/13,14:00 | Mars heliacal setting | sid= 41.5530 Roh | tro= 44.9741 |
| 0533/06/21,14:29 | Saturn heliacal setting | sid=107.5803 Āśl | tro=111.0071 |
| 0533/07/25,14:00 | Venus heliacal setting | sid=138.8551 PPh | tro=142.2914 |
| 0533/07/29,23:23 | Mercury morning last | sid=110.9688 Āśl | tro=114.3921 |
| 0533/08/03,14:06 | Jupiter heliacal setting | sid=145.7301 PPh | tro=149.1583 |
| 0533/08/04,22:38 | Moon morning last | sid=110.4447 Āśl | tro=113.8807 |
| ------------------ | | | |
| 0533/08/06,08:58 | Sun / new moon | sid=131.4962 Mag | tro=134.9269 |
| 0533/08/06,08:58 | Lunar Node | sid= 43.6078 Roh | tro= 47.0441 |
| ------------------ | | | |
| 0533/08/04,23:18 | Saturn heliacal rising | sid=113.2120 Āśl | tro=116.6409 |
| 0533/08/07,13:38 | Moon evening first | sid=149.4153 UPh | tro=152.8514 |
| 0533/08/14,23:42 | Venus heliacal rising | sid=127.8155 Mag | tro=131.2529 |
| 0533/08/23,23:29 | Mars heliacal rising | sid=127.8643 Mag | tro=131.2918 |
| 0533/09/10,23:54 | Jupiter heliacal rising | sid=154.0064 UPh | tro=157.4359 |
| 0533/10/29,00:16 | Mercury heliacal rising | sid=197.9930 Svā | tro=201.4323 |
| 0533/11/01,06:00 | all planets visible with old moon, Me – Sa = 77°54’ | | |
| ------------------ | | | |
| 0533/07/22,01:28 | Moon full | sid=296.7324 Dha | tro=300.1679 |
| 0533/08/20,16:12 | Moon full | sid=325.3863 PBh | tro=328.8229 |

duration = 1.57346 days (9.01246 days ignoring moon)

------------------

| | | |
|---|---|---|
| 0909/01/29,13:14 Mars heliacal setting | sid=324.8367 PBh | tro=333.4830 |
| 0909/03/10,00:25 Mercury morning last | sid=319.4202 Śat | tro=328.0704 |
| 0909/03/16,13:39 Saturn heliacal setting | sid= 8.1893 Aśv | tro= 16.8402 |
| 0909/04/13,13:48 Jupiter heliacal setting | sid= 30.9754 Kṛt | tro= 39.6265 |
| 0909/04/14,13:35 Venus heliacal setting | sid= 28.7109 Kṛt | tro= 37.3711 |
| 0909/04/21,23:43 Moon morning last | sid= 16.6741 Bha | tro= 25.3333 |
| ------------------ | | |
| 0909/04/22,18:35 Sun / new moon | sid= 28.1591 Kṛt | tro= 36.8129 |
| 0909/04/22,18:35 Lunar Node | sid=331.4353 PBh | tro=340.0948 |
| ------------------ | | |
| 0909/04/23,13:29 Moon evening first | sid= 39.5203 Kṛt | tro= 48.1795 |
| 0909/04/23,13:53 Mercury evening first | sid= 42.1505 Roh | tro= 50.7963 |
| 0909/04/26,23:36 Venus heliacal rising | sid= 21.2173 Bha | tro= 29.8780 |
| 0909/05/05,23:19 Saturn heliacal rising | sid= 14.5461 Bha | tro= 23.1991 |
| 0909/05/22,23:13 Jupiter heliacal rising | sid= 40.1821 Roh | tro= 48.8350 |
| 0909/07/09,23:01 Mars heliacal rising | sid= 80.8241 Pun | tro= 89.4780 |
| ------------------ | | |
| 0909/04/08,15:12 Moon full | sid=194.4925 Svā | tro=203.1512 |
| 0909/05/08,04:49 Moon full | sid=222.9745 Anu | tro=231.6344 |

==================

duration = 3.59922 days (36.39544 days ignoring moon)

------------------

| | | |
|---|---|---|
| 1007/04/29,14:18 Mars heliacal setting | sid= 53.9611 Mṛg | tro= 63.9767 |
| 1007/07/05,23:30 Venus morning last | sid= 88.1312 Pun | tro= 98.1473 |
| 1007/07/23,23:23 Mercury morning last | sid=101.7105 Puṣ | tro=111.7267 |
| 1007/07/24,14:14 Jupiter heliacal setting | sid=132.1528 Mag | tro=142.1738 |
| 1007/07/25,14:25 Saturn heliacal setting | sid=141.3429 PPh | tro=151.3648 |
| 1007/08/13,23:03 Moon morning last | sid=115.6681 Āśl | tro=125.6976 |
| ------------------ | | |
| 1007/08/15,15:23 Sun / new moon | sid=137.0719 PPh | tro=147.0959 |
| 1007/08/15,15:23 Lunar Node | sid=228.5172 Jye | tro=238.5470 |
| ------------------ | | |
| 1007/08/17,13:26 Moon evening first | sid=160.8089 Has | tro=170.8385 |
| 1007/08/30,23:54 Jupiter heliacal rising | sid=140.2327 PPh | tro=150.2549 |
| 1007/09/05,23:43 Mars heliacal rising | sid=137.5678 PPh | tro=147.5886 |
| 1007/09/13,23:44 Saturn heliacal rising | sid=147.5312 UPh | tro=157.5544 |
| 1007/09/30,12:51 Venus evening first | sid=195.5659 Svā | tro=205.5847 |
| 1007/10/23,00:16 Mercury heliacal rising | sid=188.6388 Svā | tro=198.6705 |
| ------------------ | | |
| 1007/08/01,15:00 Moon full | sid=303.5253 Dha | tro=313.5544 |
| 1007/08/30,23:58 Moon full | sid=332.0280 PBh | tro=342.0579 |

duration = 2.53572 days (36.42234 days ignoring moon)

------------------

| | | | |
|---|---|---|---|
| 1186/07/17,14:36 | Mars heliacal setting | sid=137.4261 PPh | tro=149.9309 |
| 1186/07/25,23:40 | Venus morning last | sid=106.9587 Āśl | tro=119.4605 |
| 1186/08/21,13:55 | Mercury heliacal setting | sid=168.1479 Has | tro=180.6560 |
| 1186/08/25,13:38 | Jupiter heliacal setting | sid=163.8271 Has | tro=176.3344 |
| 1186/08/25,13:51 | Saturn heliacal setting | sid=170.8388 Has | tro=183.3469 |
| 1186/09/13,23:57 | Moon morning last | sid=153.5573 UPh | tro=166.0729 |
| ------------------ | | | |
| 1186/09/14,20:48 | Sun eclipsed (unobs.) | sid=165.7562 Has | tro=178.2664 |
| 1186/09/14,20:48 | Lunar Node | sid= 2.2421 Aśv | tro= 14.7579 |
| ------------------ | | | |
| 1186/09/16,12:48 | Moon evening first | sid=188.8949 Svā | tro=201.4105 |
| 1186/09/30,23:59 | Mercury heliacal rising | sid=165.4801 Has | tro=177.9955 |
| 1186/10/03,00:19 | Jupiter heliacal rising | sid=172.1177 Has | tro=184.6259 |
| 1186/10/13,00:05 | Saturn heliacal rising | sid=176.6291 Cit | tro=189.1385 |
| 1186/10/19,12:29 | Venus evening first | sid=213.4886 Anu | tro=225.9936 |
| 1187/01/03,01:01 | Mars heliacal rising | sid=254.1028 PĀṣ | tro=266.6134 |
| ------------------ | | | |
| 1186/08/31,19:26 | Moon full | sid=331.9577 PBh | tro=344.4729 |
| 1186/09/30,09:43 | Moon eclipsed (176.4%) | sid= 1.1166 Aśv | tro= 13.6326 |

==================

duration = 1.97941 days (9.50264 days ignoring moon)

------------------

| | | | |
|---|---|---|---|
| 1344/07/20,14:34 | Mars heliacal setting | sid=140.2540 PPh | tro=154.9620 |
| 1344/11/01,00:46 | Venus morning last | sid=203.2806 Viś | tro=217.9881 |
| 1344/12/22,12:35 | Mercury heliacal setting | sid=282.2827 Śra | tro=297.0033 |
| 1344/12/30,12:37 | Jupiter heliacal setting | sid=285.4207 Śra | tro=300.1349 |
| 1345/01/03,00:35 | Moon morning last | sid=258.5764 PĀṣ | tro=273.2988 |
| 1345/01/03,12:50 | Saturn heliacal setting | sid=295.3530 Dha | tro=310.0683 |
| ------------------ | | | |
| 1345/01/04,15:10 | Sun / new moon | sid=278.0517 UĀṣ | tro=292.7686 |
| 1345/01/04,15:10 | Lunar Node | sid=178.1102 Cit | tro=192.8329 |
| ------------------ | | | |
| 1345/01/05,12:20 | Moon evening first | sid=288.8977 Śra | tro=303.6202 |
| 1345/01/13,00:53 | Mercury heliacal rising | sid=266.5623 PĀṣ | tro=281.2856 |
| 1345/01/17,00:56 | Mars heliacal rising | sid=265.7389 PĀṣ | tro=280.4520 |
| 1345/01/18,12:44 | Venus evening first | sid=301.9803 Dha | tro=316.6914 |
| 1345/02/07,01:01 | Jupiter heliacal rising | sid=294.5503 Dha | tro=309.2660 |
| 1345/02/24,00:31 | Saturn heliacal rising | sid=301.4306 Dha | tro=316.1479 |
| ------------------ | | | |
| 1344/12/20,09:19 | Moon full | sid= 82.5219 Pun | tro= 97.2436 |
| 1345/01/18,20:27 | Moon full | sid=112.4950 Āśl | tro=127.2181 |

duration =  0.98158 days (21.43917 days ignoring moon)
------------------
1803/08/03,23:31 Mercury morning last sid=  96.3985 Puṣ tro=117.5032
1803/08/17,14:10 Saturn heliacal setting sid=149.0258 UPh tro=170.1372
1803/08/24,14:06 Mars heliacal setting sid=161.1893 Has tro=182.2989
1803/09/11,00:09 Venus morning last sid=137.2804 PPh tro=158.3874
1803/09/14,23:59 Moon morning last sid=139.0959 PPh tro=160.2149
1803/09/17,13:22 Jupiter heliacal setting sid=170.1980 Has tro=191.3094
------------------
1803/09/15,23:54 Sun / new moon sid=151.0244 UPh tro=172.1380
1803/09/15,23:54 Lunar Node sid=300.4832 Dha tro=321.6025
------------------
1803/09/18,12:55 Moon evening first sid=181.1865 Cit tro=202.3055
1803/10/08,23:54 Saturn heliacal rising sid=155.4383 UPh tro=176.5510
1803/10/26,00:22 Jupiter heliacal rising sid=178.4844 Cit tro=199.5970
1803/11/03,00:14 Mercury heliacal rising sid=182.1313 Cit tro=203.2516
1803/11/30,12:14 Venus evening first sid=237.9896 Jye tro=259.0996
1804/04/16,23:38 Mars heliacal rising sid=334.9983 UBh tro=356.1165
------------------
1803/08/03,07:05 Moon eclipsed (unobs.) sid=288.9240 Śra tro=310.0415
1803/08/17,08:31 Sun eclipsed 20.5% sid=122.3075 Mag tro=143.4202
1803/09/01,15:19 Moon eclipsed (unobs.) sid=316.9301 Śat tro=338.0487
1803/10/01,00:02 Moon full sid=345.7343 UBh tro=   6.8537
==================
duration =  2.55998 days (30.96974 days ignoring moon)
------------------
1820/09/20,13:33 Mars heliacal setting sid=187.2930 Svā tro=208.6384
1821/03/11,13:21 Jupiter heliacal setting sid=341.1547 UBh tro=   2.5083
1821/03/13,13:33 Mercury heliacal setting sid=348.0066 Rev tro=   9.3669
1821/03/17,13:36 Saturn heliacal setting sid=352.6390 Rev tro=  13.9938
1821/03/22,00:32 Venus morning last sid=323.6085 PBh tro=344.9589
1821/03/31,23:45 Moon morning last sid=326.2550 PBh tro=347.6172
------------------
1821/04/02,15:14 Sun / new moon sid=351.2015 Rev tro=  12.5582
1821/04/02,15:14 Lunar Node sid=320.8754 PBh tro=342.2378
------------------
1821/04/03,13:12 Moon evening first sid=   5.1422 Aśv tro=  26.5045
1821/04/21,23:48 Jupiter heliacal rising sid=351.1187 Rev tro=  12.4738
1821/05/08,23:20 Saturn heliacal rising sid=359.1200 Rev tro=  20.4770
1821/05/20,23:05 Mars heliacal rising sid=  10.4373 Aśv tro=  31.7921
1821/06/11,14:30 Mercury evening first sid=  72.7924 Ārd tro=  94.1440
1821/07/01,14:16 Venus evening first sid=  88.7272 Pun tro=110.0818
------------------
1821/02/17,01:05 Moon eclipsed (unobs.) sid=126.8821 Mag tro=148.2430
1821/03/04,05:50 Sun eclipsed (unobs.) sid=322.0208 PBh tro=343.3767
1821/03/18,18:44 Moon eclipsed (unobs.) sid=156.3838 UPh tro=177.7456
1821/04/17,12:31 Moon full sid=185.7955 Cit tro=207.1582

duration =  2.47933 days (23.48916 days ignoring moon)
------------------
1961/08/29,13:59 Mars heliacal setting sid=164.7210 Has tro=188.0313
1961/12/17,01:14 Venus morning last sid=231.6531 Jye tro=254.9634
1962/01/02,12:41 Saturn heliacal setting sid=276.5383 UĀṣ tro=299.8543
1962/01/23,12:45 Jupiter heliacal setting sid=292.3290 Śra tro=315.6451
1962/01/26,12:56 Mercury heliacal setting sid=299.3830 Dha tro=322.7064
1962/02/04,01:03 Moon morning last sid=277.9810 UĀṣ tro=301.3055
------------------
1962/02/05,00:12 Sun eclipsed (unobs.) sid=292.3957 Śra tro=315.7148
1962/02/05,00:12 Lunar Node sid=114.8352 Āśl tro=138.1600
------------------
1962/02/06,12:33 Moon evening first sid=315.2870 Śat tro=338.6117
1962/02/19,00:40 Mercury heliacal rising sid=283.9974 Śra tro=307.3221
1962/02/19,00:46 Saturn heliacal rising sid=282.1005 Śra tro=305.4187
1962/03/05,00:41 Jupiter heliacal rising sid=301.9565 Dha tro=325.2741
1962/03/06,13:14 Venus evening first sid=331.4295 PBh tro=354.7430
1962/04/24,23:29 Mars heliacal rising sid=340.7651 UBh tro=   4.0823
------------------
1962/01/20,18:17 Moon full sid=  96.9071 Puṣ tro=120.2312
1962/02/19,13:03 Moon eclipsed (unobs.) sid=126.9759 Mag tro=150.3010
==================
duration =  3.59965 days (29.00512 days ignoring moon)
------------------
2000/04/02,23:59 Mercury morning last sid=322.4944 PBh tro=346.3440
2000/04/11,00:07 Venus morning last sid=341.3727 UBh tro=   5.2176
2000/04/21,13:47 Jupiter heliacal setting sid=  20.0870 Bha tro=  43.9356
2000/04/21,13:59 Saturn heliacal setting sid=  24.1326 Bha tro=  47.9820
2000/04/21,14:05 Mars heliacal setting sid=  27.5167 Kṛt tro=  51.3636
2000/05/01,23:09 Moon morning last sid=348.7400 Rev tro=  12.5969
------------------
2000/05/04,04:12 Sun / new moon sid=  20.1540 Bha tro=  44.0054
2000/05/04,04:12 Lunar Node sid=  94.6337 Puṣ tro=118.4908
------------------
2000/05/05,13:32 Moon evening first sid=  40.5411 Roh tro=  64.3981
2000/05/20,14:13 Mercury evening first sid=  49.2432 Roh tro=  73.0873
2000/05/30,23:13 Jupiter heliacal rising sid=  29.4065 Kṛt tro=  53.2567
2000/06/06,23:01 Saturn heliacal rising sid=  30.0252 Kṛt tro=  53.8768
2000/07/22,14:12 Venus evening first sid=107.5326 Āśl tro=131.3813
2000/09/04,23:39 Mars heliacal rising sid=118.5355 Āśl tro=142.3883
------------------
2000/04/18,17:42 Moon full sid=185.1339 Cit tro=208.9904
2000/05/18,07:35 Moon full sid=213.8131 Anu tro=237.6706

(no more dates until at least 2500 CE)

## B: Super-Conjunctions without New Moon

This list contains information on super-conjunctions where all planets disappeared in the glare of the Sun, but no new moon took place within the duration of the super-conjunction. In almost all these cases, a full moon did occur during the same period of time. Information on such full moons are also given. Most interesting might be those cases where the full moon is accompanied by a lunar eclipse. Other new and full moons that occurred near a super-conjunction are listed below the heliacal risings of the planets.

duration = 11.98562 days

------------------

| | | | |
|---|---|---|---|
| -3877/06/22,23:23 | Venus morning last | sid=103.2187 Puṣ | tro= 45.9558 |
| -3877/08/16,14:37 | Mars heliacal setting | sid=195.9235 Svā | tro=138.6657 |
| -3877/09/03,14:27 | Saturn heliacal setting | sid=209.8330 Viś | tro=152.5785 |
| -3877/09/21,23:47 | Mercury morning last | sid=193.0337 Svā | tro=135.7753 |
| -3877/09/23,13:56 | Jupiter heliacal setting | sid=225.2037 Anu | tro=167.9491 |
| ------------------ | | | |
| -3877/09/25,23:56 | Moon full | sid= 30.2531 Kṛt | tro=333.0064 |
| -3877/09/25,23:56 | Lunar Node | sid= 83.0686 Pun | tro= 25.8221 |
| ------------------ | | | |
| -3877/10/05,13:35 | Venus evening first | sid=234.2856 Jye | tro=177.0275 |
| -3877/10/16,00:01 | Saturn heliacal rising | sid=214.6783 Anu | tro=157.4250 |
| -3877/10/30,00:24 | Jupiter heliacal rising | sid=233.4953 Jye | tro=176.2416 |
| -3877/12/16,00:38 | Mercury heliacal rising | sid=274.4167 UĀṣ | tro=217.1743 |
| -3876/04/20,00:10 | Mars heliacal rising | sid= 23.4762 Bha | tro=326.2289 |
| ------------------ | | | |
| -3877/08/27,13:29 | Moon full | sid= 0.4661 Aśv | tro=303.2182 |
| -3877/09/10,22:01 | Sun / new moon | sid=194.9419 Svā | tro=137.6891 |
| -3877/10/10,17:25 | Sun / new moon | sid=225.2813 Anu | tro=168.0294 |
| -3877/10/25,10:55 | Moon full | sid= 60.3478 Mṛg | tro= 3.1020 |

==================

duration = 1.37662 days

------------------

| | | | |
|---|---|---|---|
| -3383/01/04,12:51 | Mars heliacal setting | sid=332.0093 PBh | tro=281.4996 |
| -3383/05/22,13:42 | Jupiter heliacal setting | sid= 95.4460 Puṣ | tro= 44.9428 |
| -3383/06/20,23:19 | Venus morning last | sid= 98.5325 Puṣ | tro= 48.0263 |
| -3383/06/24,14:16 | Saturn heliacal setting | sid=133.9608 PPh | tro= 83.4593 |
| -3383/06/28,14:02 | Mercury heliacal setting | sid=140.3954 PPh | tro= 89.8910 |
| ------------------ | | | |
| -3383/06/27,11:57 | Moon full | sid=297.5675 Dha | tro=247.0732 |
| -3383/06/27,11:57 | Lunar Node | sid=245.4731 Mūl | tro=194.9790 |
| ------------------ | | | |
| -3383/06/29,23:04 | Jupiter heliacal rising | sid=103.9037 Puṣ | tro= 53.4019 |
| -3383/07/02,22:46 | Mars heliacal rising | sid= 94.7764 Puṣ | tro= 44.2736 |
| -3383/08/08,22:58 | Saturn heliacal rising | sid=139.4425 PPh | tro= 88.9432 |
| -3383/08/21,23:07 | Mercury heliacal rising | sid=154.9209 UPh | tro=104.4273 |
| -3383/10/01,13:36 | Venus evening first | sid=226.9242 Jye | tro=176.4219 |
| ------------------ | | | |
| -3383/05/29,03:46 | Moon full | sid=269.4275 UĀṣ | tro=218.9321 |
| -3383/06/12,05:25 | Sun / new moon | sid=102.8777 Puṣ | tro= 52.3774 |
| -3383/07/11,20:28 | Sun / new moon | sid=131.4808 Mag | tro= 80.9816 |
| -3383/07/26,19:57 | Moon full | sid=326.1251 PBh | tro=275.6321 |

```
duration =  11.34954 days
------------------
-3204/05/14,13:58 Mars heliacal setting     sid= 95.4513 Puṣ     tro= 47.3961
-3204/06/15,13:52 Mercury heliacal setting  sid=132.0377 Mag     tro= 83.9866
-3204/06/27,14:11 Jupiter heliacal setting  sid=129.4184 Mag     tro= 81.3665
-3204/07/17,23:16 Venus morning last        sid=126.0855 Mag     tro= 78.0305
-3204/07/20,14:33 Saturn heliacal setting   sid=160.6810 Has     tro=112.6311
------------------
-3204/07/27,22:07 Moon full                 sid=326.2666 PBh     tro=278.2240
-3204/07/27,22:07 Lunar Node                sid= 18.9561 Bha     tro=330.9137
------------------
-3204/07/31,22:56 Mercury heliacal rising   sid=132.5236 Mag     tro= 84.4776
-3204/07/31,23:07 Jupiter heliacal rising   sid=136.9114 PPh     tro= 88.8614
-3204/09/03,23:19 Saturn heliacal rising    sid=166.0115 Has     tro=117.9637
-3204/09/16,23:31 Mars heliacal rising      sid=177.1892 Cit     tro=129.1393
-3204/10/25,13:05 Venus evening first       sid=251.1351 Mūl     tro=203.0843
------------------
-3204/06/28,09:32 Moon full                 sid=297.5302 Dha     tro=249.4860
-3204/07/12,09:08 Sun / new moon            sid=131.0785 Mag     tro= 83.0296
-3204/08/10,21:02 Sun / new moon            sid=160.0308 Has     tro=111.9835
-3204/08/26,10:11 Moon full                 sid=355.5097 Rev     tro=307.4686
==================
duration =  19.37290 days
------------------
-3025/07/18,23:02 Mercury morning last      sid=120.3939 Mag     tro= 74.7843
-3025/07/31,14:24 Jupiter heliacal setting  sid=162.3228 Has     tro=116.7167
-3025/08/10,23:29 Venus morning last        sid=148.8739 UPh     tro=103.2640
-3025/08/15,14:29 Saturn heliacal setting   sid=185.5750 Cit     tro=139.9705
-3025/08/15,14:36 Mars heliacal setting     sid=189.8152 Svā     tro=144.2083
------------------
-3025/08/28,01:18 Moon full                 sid=355.1849 Rev     tro=309.5877
-3025/08/28,01:18 Lunar Node                sid=152.4624 UPh     tro=106.8654
------------------
-3025/09/03,23:33 Jupiter heliacal rising   sid=169.8370 Has     tro=124.2322
-3025/09/28,23:45 Saturn heliacal rising    sid=190.6999 Svā     tro=145.0966
-3025/10/20,00:00 Mercury heliacal rising   sid=212.1746 Viś     tro=166.5800
-3025/11/15,12:41 Venus evening first       sid=270.3158 UĀṣ     tro=224.7092
-3024/04/21,00:00 Mars heliacal rising      sid= 19.0090 Bha     tro=333.4113
------------------
-3025/07/29,07:44 Moon eclipsed (31.7%)     sid=325.8234 PBh     tro=280.2249
-3025/08/12,22:28 Sun eclipsed (unobs.)     sid=160.1401 Has     tro=114.5368
-3025/09/11,08:46 Sun / new moon            sid=189.5513 Svā     tro=143.9491
-3025/09/26,18:42 Moon full                 sid= 25.1434 Bha     tro=339.5472
```

```
duration =  15.98419 days
------------------
-2726/07/22,23:17 Venus morning last        sid=127.7188 Mag      tro= 86.2042
-2726/08/01,14:40 Mars heliacal setting     sid=173.0606 Has      tro=131.5490
-2726/09/21,23:49 Mercury morning last      sid=185.3637 Cit      tro=143.8520
-2726/10/03,13:41 Saturn heliacal setting   sid=234.6081 Jye      tro=193.1015
-2726/10/12,13:20 Jupiter heliacal setting  sid=237.7157 Jye      tro=196.2082
------------------
-2726/10/20,08:31 Moon full                 sid= 47.3388 Roh      tro=  5.8393
-2726/10/20,08:31 Lunar Node                sid=121.9317 Mag      tro= 80.4324
------------------
-2726/10/28,12:57 Venus evening first       sid=250.2185 Mūl      tro=208.7077
-2726/11/17,00:27 Saturn heliacal rising    sid=239.7203 Jye      tro=198.2145
-2726/11/20,00:35 Jupiter heliacal rising   sid=246.5336 Mūl      tro=205.0271
-2726/12/17,00:44 Mercury heliacal rising   sid=268.2043 UĀṣ      tro=226.7085
-2725/03/05,00:52 Mars heliacal rising      sid=336.1222 UBh      tro=294.6190
------------------
-2726/09/20,21:21 Moon full                 sid= 17.3774 Bha      tro=335.8772
-2726/10/05,02:02 Sun / new moon            sid=211.7743 Viś      tro=170.2689
-2726/11/03,20:56 Sun / new moon            sid=242.1772 Mūl      tro=200.6725
-2726/11/18,19:28 Moon full                 sid= 77.4518 Ārd      tro= 35.9532
==================
duration =  11.42878 days
------------------
-2625/02/03,13:07 Mars heliacal setting     sid=353.8629 Rev      tro=313.7373
-2625/02/23,13:13 Mercury heliacal setting  sid= 11.3759 Aśv      tro=331.2593
-2625/03/09,13:20 Saturn heliacal setting   sid= 22.8560 Bha      tro=342.7343
-2625/03/26,00:53 Venus morning last        sid=  7.1113 Aśv      tro=326.9859
-2625/04/19,13:33 Jupiter heliacal setting  sid= 58.1277 Mṛg      tro= 18.0067
------------------
-2625/04/19,16:46 Moon full                 sid=226.6711 Jye      tro=186.5578
-2625/04/19,16:46 Lunar Node                sid=336.6431 UBh      tro=296.5300
------------------
-2625/04/30,23:51 Saturn heliacal rising    sid= 29.6598 Kṛt      tro=349.5401
-2625/05/21,13:50 Mercury evening first     sid= 90.2114 Pun      tro= 50.0853
-2625/05/30,23:23 Jupiter heliacal rising   sid= 67.4797 Ārd      tro= 27.3601
-2625/06/27,14:01 Venus evening first       sid=122.0031 Mag      tro= 81.8804
-2625/07/11,22:47 Mars heliacal rising      sid=100.5403 Puṣ      tro= 60.4214
-2625/07/29,22:58 Mercury heliacal rising   sid=126.0649 Mag      tro= 85.9522
------------------
-2625/03/21,09:54 Moon full                 sid=198.6777 Svā      tro=158.5637
-2625/04/05,04:39 Sun / new moon            sid= 32.8399 Kṛt      tro=352.7208
-2625/05/04,19:14 Sun / new moon            sid= 61.0327 Mṛg      tro= 20.9144
-2625/05/18,23:40 Moon full                 sid=254.5136 PĀṣ      tro=214.4012
```

duration = 20.00308 days

------------------

-2250/09/24,13:52 Mars heliacal setting sid=228.2620 Jye tro=193.2900
-2250/12/01,12:45 Saturn heliacal setting sid=289.0440 Śra tro=254.0763
-2250/12/08,12:29 Jupiter heliacal setting sid=289.7296 Śra tro=254.7612
-2250/12/14,00:56 Mercury morning last sid=265.1434 PĀṣ tro=230.1714
-2250/12/26,01:19 Venus morning last sid=281.9789 Śra tro=247.0073

------------------

-2249/01/04,06:15 Moon full sid=121.3408 Mag tro= 86.3815
-2249/01/04,06:15 Lunar Node sid=264.1048 PĀṣ tro=229.1457

------------------

-2249/01/15,01:24 Jupiter heliacal rising sid=298.6436 Dha tro=263.6767
-2249/01/17,01:07 Saturn heliacal rising sid=294.6114 Dha tro=259.6456
-2249/01/21,12:42 Mercury evening first sid=333.0684 PBh tro=298.0985
-2249/03/13,13:07 Venus evening first sid= 18.0494 Bha tro=343.0809
-2249/06/04,22:58 Mars heliacal rising sid= 57.9085 Mṛg tro= 22.9453

------------------

-2250/11/21,14:53 Sun eclipsed (unobs.) sid=257.0201 PĀṣ tro=222.0532
-2250/12/05,15:16 Moon eclipsed (89.5%) sid= 91.3090 Pun tro= 56.3483
-2250/12/21,05:55 Sun / new moon sid=287.1865 Śra tro=252.2209
-2249/01/19,18:10 Sun / new moon sid=316.8717 Śat tro=281.9076
-2249/02/02,22:02 Moon full sid=150.9396 UPh tro=115.9817

==================

duration = 0.38323 days

------------------

-2053/05/05,13:59 Mars heliacal setting sid= 78.9759 Ārd tro= 46.6974
-2053/07/17,14:21 Jupiter heliacal setting sid=142.3074 PPh tro=110.0337
-2053/08/12,23:33 Venus morning last sid=144.5589 PPh tro=112.2823
-2053/08/15,23:23 Mercury morning last sid=143.9002 PPh tro=111.6236
-2053/08/20,14:21 Saturn heliacal setting sid=184.7473 Cit tro=152.4762

------------------

------------------

-2053/08/20,23:33 Jupiter heliacal rising sid=149.7706 UPh tro=117.4986
-2053/09/07,23:29 Mars heliacal rising sid=159.3673 UPh tro=127.0944
-2053/10/04,23:51 Saturn heliacal rising sid=190.0229 Svā tro=157.7532
-2053/11/13,00:22 Mercury heliacal rising sid=229.9566 Jye tro=197.6968
-2053/11/14,12:34 Venus evening first sid=262.1245 PĀṣ tro=229.8514

------------------

-2053/07/23,12:27 Moon full sid=313.7812 Śat tro=281.5156
-2053/08/06,14:48 Sun / new moon sid=147.5479 UPh tro=115.2776
-2053/08/22,02:36 Moon full sid=342.8136 UBh tro=310.5494
-2053/08/22,02:36 Lunar Node sid= 58.0221 Mṛg tro= 25.7582
-2053/09/05,02:02 Sun / new moon sid=176.7129 Cit tro=144.4438
-2053/09/20,16:01 Moon full sid= 12.3435 Aśv tro=340.0804

duration = 8.41539 days
------------------
-1874/07/21,23:08 Mercury morning last sid=117.2388 Āśl tro= 87.4221
-1874/07/31,14:38 Mars heliacal setting sid=167.5904 Has tro=137.7766
-1874/08/18,14:13 Jupiter heliacal setting sid=174.5081 Cit tro=144.6964
-1874/09/01,23:50 Venus morning last sid=163.6902 Has tro=133.8747
-1874/09/15,13:55 Saturn heliacal setting sid=210.0481 Viś tro=180.2382
------------------
-1874/09/21,03:46 Moon eclipsed (177.1%) sid= 11.8946 Aśv tro=342.0916
-1874/09/21,03:46 Lunar Node sid=191.5868 Svā tro=161.7840
------------------
-1874/09/23,23:53 Jupiter heliacal rising sid=182.4641 Cit tro=152.6533
-1874/10/22,00:01 Mercury heliacal rising sid=206.3011 Viś tro=176.4993
-1874/10/30,00:13 Saturn heliacal rising sid=215.1618 Anu tro=185.3526
-1874/12/01,12:23 Venus evening first sid=277.5670 UĀṣ tro=247.7541
-1873/03/06,00:46 Mars heliacal rising sid=330.9004 PBh tro=301.0937
------------------
-1874/08/22,09:13 Moon full sid=342.1626 UBh tro=312.3588
-1874/09/06,05:28 Sun eclipsed (unobs.) sid=176.9168 Cit tro=147.1080
-1874/10/05,15:23 Sun eclipsed (unobs.) sid=206.5189 Viś tro=176.7107
-1874/10/20,22:32 Moon full sid= 42.0672 Roh tro= 12.2649
==================
duration = 0.44284 days
both Venus and Mercury heliacally rising
------------------
-1814/06/14,14:29 Mars heliacal setting sid=117.3799 Āśl tro= 88.3855
-1814/07/05,23:02 Mercury morning last sid= 99.0119 Puṣ tro= 70.0176
-1814/09/06,13:39 Venus heliacal setting sid=199.6465 Svā tro=170.6654
-1814/09/07,13:52 Jupiter heliacal setting sid=195.1873 Svā tro=166.1979
-1814/09/27,13:38 Saturn heliacal setting sid=222.2384 Anu tro=193.2506
------------------
------------------
-1814/09/28,00:16 Venus heliacal rising sid=189.0757 Svā tro=160.0958
-1814/10/08,23:56 Mercury heliacal rising sid=193.2679 Svā tro=164.2877
-1814/10/15,00:10 Jupiter heliacal rising sid=203.4647 Viś tro=174.4763
-1814/10/23,00:03 Mars heliacal rising sid=204.3160 Viś tro=175.3259
-1814/11/11,00:25 Saturn heliacal rising sid=227.3469 Jye tro=198.3600
-1814/11/09,06:00 all planets visible, but no old moon, Me – Ve = 31°39’
------------------
-1814/08/19,13:33 Moon full sid=338.9820 UBh tro=309.9997
-1814/09/02,13:31 Sun / new moon sid=172.8639 Has tro=143.8766
-1814/09/18,03:17 Moon full sid= 8.4442 Aśv tro=339.4630
-1814/09/18,03:17 Lunar Node sid=110.3535 Āśl tro= 81.3724
-1814/10/02,03:04 Sun / new moon sid=202.5535 Viś tro=173.5671
-1814/10/17,15:58 Moon full sid= 38.3223 Kṛt tro= 9.3418

| | | |
|---|---|---|
| duration = 7.98347 days | | |
| ------------------ | | |
| -1575/07/18,14:39 Mars heliacal setting | sid=152.5159 UPh | tro=126.8122 |
| -1575/08/15,23:38 Venus morning last | sid=144.9954 PPh | tro=119.2900 |
| -1575/09/21,23:51 Mercury morning last | sid=177.7356 Cit | tro=152.0317 |
| -1575/11/03,12:49 Jupiter heliacal setting | sid=250.8589 Mūl | tro=225.1597 |
| -1575/11/07,12:53 Saturn heliacal setting | sid=260.8228 PĀṣ | tro=235.1247 |
| ------------------ | | |
| -1575/11/13,15:33 Moon full | sid= 64.4683 Mṛg | tro= 38.7772 |
| -1575/11/13,15:33 Lunar Node | sid=161.1384 Has | tro=135.4475 |
| ------------------ | | |
| -1575/11/15,12:29 Venus evening first | sid=260.0066 PĀṣ | tro=234.3038 |
| -1575/12/10,01:00 Jupiter heliacal rising | sid=259.3122 PĀṣ | tro=233.6142 |
| -1575/12/18,00:53 Mercury heliacal rising | sid=262.0717 PĀṣ | tro=236.3839 |
| -1575/12/22,00:52 Saturn heliacal rising | sid=266.0118 PĀṣ | tro=240.3152 |
| -1575/12/28,01:01 Mars heliacal rising | sid=269.7157 UĀṣ | tro=244.0164 |
| ------------------ | | |
| -1575/10/15,03:30 Moon full | sid= 34.3833 Kṛt | tro= 8.6914 |
| -1575/10/29,05:46 Sun / new moon | sid=228.7341 Jye | tro=203.0370 |
| -1575/11/27,23:57 Sun / new moon | sid=259.1314 PĀṣ | tro=233.4352 |
| -1575/12/13,02:33 Moon full | sid= 94.5414 Puṣ | tro= 68.8515 |
| ================== | | |
| duration = 11.47678 days | | |
| ------------------ | | |
| -1537/12/31,01:28 Venus morning last | sid=281.6709 Śra | tro=256.4923 |
| -1536/01/31,12:47 Jupiter heliacal setting | sid=336.3258 UBh | tro=311.1525 |
| -1536/02/16,01:07 Mercury morning last | sid=317.2016 Śat | tro=292.0265 |
| -1536/02/16,13:18 Mars heliacal setting | sid=358.6935 Rev | tro=333.5190 |
| -1536/03/02,13:24 Saturn heliacal setting | sid= 9.9211 Aśv | tro=344.7497 |
| ------------------ | | |
| -1536/03/11,08:27 Moon full | sid=182.7260 Cit | tro=157.5622 |
| -1536/03/11,08:27 Lunar Node | sid=139.3281 PPh | tro=114.1644 |
| ------------------ | | |
| -1536/03/14,00:50 Jupiter heliacal rising | sid=346.4439 UBh | tro=321.2723 |
| -1536/03/18,13:13 Venus evening first | sid= 19.0485 Bha | tro=353.8729 |
| -1536/03/23,13:24 Mercury evening first | sid= 27.5472 Kṛt | tro= 2.3703 |
| -1536/04/23,23:51 Saturn heliacal rising | sid= 16.6640 Bha | tro=351.4944 |
| -1536/07/16,22:49 Mars heliacal rising | sid=100.9617 Puṣ | tro= 75.7932 |
| ------------------ | | |
| -1536/01/26,10:36 Sun eclipsed 40.9% | sid=318.5175 Śat | tro=293.3465 |
| -1536/02/10,22:17 Moon eclipsed (unobs.) | sid=153.7857 UPh | tro=128.6209 |
| -1536/02/24,23:35 Sun / new moon | sid=347.7324 Rev | tro=322.5626 |
| -1536/03/25,14:36 Sun / new moon | sid= 16.5191 Bha | tro=351.3502 |
| -1536/04/09,16:10 Moon full | sid=210.9937 Viś | tro=185.8305 |

duration = 13.00673 days
------------------
-1474/01/07,12:54 Mars heliacal setting sid=319.9375 Śat tro=295.6188
-1474/02/23,13:14 Mercury heliacal setting sid= 4.1637 Aśv tro=339.8553
-1474/04/14,00:20 Venus morning last sid= 17.9780 Bha tro=353.6618
-1474/04/19,13:46 Saturn heliacal setting sid= 54.6736 Mṛg tro= 30.3618
-1474/05/10,13:47 Jupiter heliacal setting sid= 71.6942 Ārd tro= 47.3824
------------------
-1474/05/13,21:56 Moon full sid=242.7858 Mūl tro=218.4819
-1474/05/13,21:56 Lunar Node sid= 15.8855 Bha tro=351.5818
------------------
-1474/05/23,13:57 Mercury evening first sid= 85.7024 Pun tro= 61.3854
-1474/06/05,23:02 Saturn heliacal rising sid= 60.8372 Mṛg tro= 36.5275
-1474/06/17,23:08 Jupiter heliacal rising sid= 80.2948 Pun tro= 55.9850
-1474/07/01,22:46 Mars heliacal rising sid= 83.8797 Pun tro= 59.5693
-1474/07/21,14:12 Venus evening first sid=139.1962 PPh tro=114.8837
------------------
-1474/04/14,14:50 Moon eclipsed (unobs.) sid=214.7162 Anu tro=190.4113
-1474/04/29,05:06 Sun / new moon sid= 48.7936 Roh tro= 24.4838
-1474/05/28,20:09 Sun / new moon sid= 76.9804 Ārd tro= 52.6717
==================
duration = 6.35560 days
both Venus and Mercury heliacally rising
------------------
-0821/05/12,19:00 all planets visible with new moon, Sa – Me = 33°41’
-0821/05/26,14:15 Mercury heliacal setting sid= 92.2250 Pun tro= 76.9237
-0821/06/01,14:28 Mars heliacal setting sid= 98.2640 Puṣ tro= 82.9548
-0821/06/04,14:07 Jupiter heliacal setting sid= 92.0392 Pun tro= 76.7315
-0821/06/26,14:00 Venus heliacal setting sid=114.1186 Āśl tro= 98.8208
-0821/06/27,14:27 Saturn heliacal setting sid=121.2421 Mag tro=105.9364
------------------
------------------
-0821/07/03,22:59 Mercury heliacal rising sid= 88.1415 Pun tro= 72.8373
-0821/07/10,23:07 Jupiter heliacal rising sid=100.0773 Puṣ tro= 84.7716
-0821/07/14,23:20 Venus heliacal rising sid=103.7396 Puṣ tro= 88.4427
-0821/08/10,23:17 Saturn heliacal rising sid=126.7726 Mag tro=111.4689
-0821/10/06,23:53 Mars heliacal rising sid=180.6294 Cit tro=165.3252
------------------
-0821/05/24,04:19 Moon full sid=248.3017 Mūl tro=233.0012
-0821/06/08,16:43 Sun / new moon sid= 83.0671 Pun tro= 67.7619
-0821/06/22,15:08 Moon full sid=276.3519 UĀṣ tro=261.0529
-0821/06/22,15:08 Lunar Node sid=334.0935 UBh tro=318.7946
-0821/07/08,01:36 Sun / new moon sid=111.1270 Āśl tro= 95.8233
-0821/07/22,04:33 Moon full sid=304.7229 Dha tro=289.4254
-0821/08/06,11:32 Sun eclipsed 15% sid=139.5515 PPh tro=124.2493
-0821/08/20,20:32 Moon eclipsed (138.5%) sid=333.5453 UBh tro=318.2492

duration = 17.98211 days
------------------
-0761/04/05,13:49 Mars heliacal setting sid= 41.3698 Roh tro= 26.8878
-0761/04/21,00:05 Venus morning last sid= 20.2438 Bha tro= 5.7602
-0761/06/25,23:03 Mercury morning last sid= 81.4188 Pun tro= 66.9399
-0761/06/26,14:18 Jupiter heliacal setting sid=113.6232 Āśl tro= 99.1459
-0761/07/11,14:35 Saturn heliacal setting sid=135.6966 PPh tro=121.2207
------------------
-0761/07/19,10:42 Moon full sid=301.7017 Dha tro=287.2331
-0761/07/19,10:42 Lunar Node sid=251.2973 Mūl tro=236.8289
------------------
-0761/07/29,14:09 Venus evening first sid=142.7243 PPh tro=128.2442
-0761/07/31,23:21 Jupiter heliacal rising sid=121.3430 Mag tro=106.8672
-0761/08/15,23:14 Mars heliacal rising sid=127.2493 Mag tro=112.7727
-0761/08/26,23:25 Saturn heliacal rising sid=141.3831 PPh tro=126.9088
-0761/09/30,23:50 Mercury heliacal rising sid=177.6745 Cit tro=163.2079
------------------
-0761/06/19,19:24 Moon full sid=273.2900 UĀṣ tro=258.8199
-0761/07/04,08:10 Sun / new moon sid=107.1833 Āśl tro= 92.7085
-0761/08/02,16:06 Sun / new moon sid=135.4687 PPh tro=120.9953
-0761/08/18,01:18 Moon full sid=330.4789 PBh tro=316.0115
==================
duration = 13.97913 days
------------------
-0582/05/14,23:37 Venus morning last sid= 43.7903 Roh tro= 31.7738
-0582/07/04,14:40 Mars heliacal setting sid=132.1885 Mag tro=120.1770
-0582/07/24,14:17 Mercury heliacal setting sid=151.1714 UPh tro=139.1620
-0582/07/28,14:15 Jupiter heliacal setting sid=145.7699 PPh tro=133.7609
-0582/08/07,14:21 Saturn heliacal setting sid=164.3339 Has tro=152.3263
------------------
-0582/08/18,06:00 Moon full sid=329.7786 PBh tro=317.7783
-0582/08/18,06:00 Lunar Node sid= 24.9425 Bha tro= 12.9424
------------------
-0582/08/21,13:51 Venus evening first sid=165.4512 Has tro=153.4391
-0582/09/03,23:43 Jupiter heliacal rising sid=153.8605 UPh tro=141.8530
-0582/09/08,23:34 Mercury heliacal rising sid=154.5465 UPh tro=142.5455
-0582/09/24,23:49 Saturn heliacal rising sid=170.0838 Has tro=158.0776
-0582/11/26,00:35 Mars heliacal rising sid=230.7241 Jye tro=218.7173
------------------
-0582/07/19,14:49 Moon full sid=300.9969 Dha tro=288.9953
-0582/08/03,21:39 Sun / new moon sid=135.7850 PPh tro=123.7786
-0582/09/02,06:09 Sun / new moon sid=164.5426 Has tro=152.5373
-0582/09/16,23:35 Moon full sid=359.1615 Rev tro=347.1622

| | | |
|---|---|---|
| duration = 10.47752 days | | |
| ------------------ | | |
| -0520/06/18,14:37 Mars heliacal setting | sid=115.3921 Āśl | tro=104.2421 |
| -0520/08/07,23:22 Mercury morning last | sid=126.5931 Mag | tro=115.4424 |
| -0520/09/14,13:43 Saturn heliacal setting | sid=200.6468 Viś | tro=189.5026 |
| -0520/10/05,00:19 Venus morning last | sid=188.2820 Svā | tro=177.1330 |
| -0520/10/18,12:53 Jupiter heliacal setting | sid=228.0546 Jye | tro=216.9103 |
| ------------------ | | |
| -0520/10/20,17:47 Moon full | sid= 33.2142 Kṛt | tro= 22.0776 |
| -0520/10/20,17:47 Lunar Node | sid=261.4686 PĀṣ | tro=250.3322 |
| ------------------ | | |
| -0520/10/29,00:21 Saturn heliacal rising | sid=205.7967 Viś | tro=194.6534 |
| -0520/10/31,00:13 Mars heliacal rising | sid=204.1142 Viś | tro=192.9683 |
| -0520/11/07,00:14 Mercury heliacal rising | sid=213.6021 Anu | tro=202.4668 |
| -0520/11/24,00:51 Jupiter heliacal rising | sid=236.3193 Jye | tro=225.1761 |
| -0520/12/27,12:23 Venus evening first | sid=293.3120 Śra | tro=282.1663 |
| ------------------ | | |
| -0520/09/20,23:18 Moon full | sid= 3.2354 Aśv | tro=352.0982 |
| -0520/10/05,14:50 Sun / new moon | sid=197.9315 Svā | tro=186.7890 |
| -0520/11/04,01:37 Sun / new moon | sid=227.7739 Jye | tro=216.6322 |
| -0520/11/19,12:16 Moon eclipsed (unobs.) | sid= 63.6544 Mṛg | tro= 52.5188 |
| -0520/12/03,14:13 Sun eclipsed (unobs.) | sid=257.9036 PĀṣ | tro=246.7631 |
| -0520/12/19,04:13 Moon eclipsed (unobs.) | sid= 93.6650 Puṣ | tro= 82.5309 |
| ================== | | |
| duration = 4.48833 days | | |
| ------------------ | | |
| -0482/11/01,12:52 Mars heliacal setting | sid=251.9245 Mūl | tro=241.3033 |
| -0482/12/24,12:41 Saturn heliacal setting | sid=297.7867 Dha | tro=287.1703 |
| -0481/01/04,01:13 Mercury morning last | sid=272.2741 UĀṣ | tro=261.6540 |
| -0481/01/13,12:42 Jupiter heliacal setting | sid=311.2300 Śat | tro=300.6136 |
| -0481/02/07,01:23 Venus morning last | sid=309.7922 Śat | tro=299.1731 |
| ------------------ | | |
| ------------------ | | |
| -0481/02/11,13:06 Mercury evening first | sid=340.7389 UBh | tro=330.1191 |
| -0481/02/12,00:55 Saturn heliacal rising | sid=303.7048 Dha | tro=293.0908 |
| -0481/02/23,00:58 Jupiter heliacal rising | sid=320.9192 PBh | tro=310.3044 |
| -0481/05/05,13:45 Venus evening first | sid= 57.7428 Mṛg | tro= 47.1259 |
| -0481/06/15,22:52 Mars heliacal rising | sid= 61.6840 Mṛg | tro= 51.0716 |
| ------------------ | | |
| -0481/01/17,19:10 Moon full | sid=123.0621 Mag | tro=112.4539 |
| -0481/02/01,10:40 Sun / new moon | sid=317.7665 Śat | tro=307.1534 |
| -0481/02/16,13:05 Moon full | sid=152.8008 UPh | tro=142.1938 |
| -0481/02/16,13:05 Lunar Node | sid=239.6651 Jye | tro=229.0583 |
| -0481/03/02,19:52 Sun / new moon | sid=346.8963 Rev | tro=336.2842 |
| -0481/03/18,04:38 Moon full | sid=181.9256 Cit | tro=171.3193 |

duration = 9.99335 days

------------------

| | | | |
|---|---|---|---|
| 0193/07/31,14:30 | Mars heliacal setting | sid=157.5706 UPh | tro=156.2826 |
| 0193/10/11,00:25 | Venus morning last | sid=189.3621 Svā | tro=188.0728 |
| 0193/11/29,12:33 | Saturn heliacal setting | sid=268.6861 UĀṣ | tro=267.4035 |
| 0193/12/07,12:21 | Jupiter heliacal setting | sid=271.3597 UĀṣ | tro=270.0764 |
| 0193/12/21,12:36 | Mercury heliacal setting | sid=288.3074 Śra | tro=287.0316 |
| ------------------ | | | |
| 0193/12/25,17:50 | Moon full | sid= 95.4178 Puṣ | tro= 94.1434 |
| 0193/12/25,17:50 | Lunar Node | sid=137.1172 PPh | tro=135.8430 |
| ------------------ | | | |
| 0193/12/31,12:27 | Venus evening first | sid=291.8686 Śra | tro=290.5826 |
| 0194/01/11,01:04 | Mercury heliacal rising | sid=272.9268 UĀṣ | tro=271.6544 |
| 0194/01/13,01:04 | Saturn heliacal rising | sid=273.8975 UĀṣ | tro=272.6170 |
| 0194/01/14,01:16 | Jupiter heliacal rising | sid=280.1774 Śra | tro=278.8960 |
| 0194/03/11,00:26 | Mars heliacal rising | sid=321.1573 PBh | tro=319.8761 |
| ------------------ | | | |
| 0193/11/26,06:07 | Moon full | sid= 65.3379 Mṛg | tro= 64.0620 |
| 0193/12/11,13:54 | Sun / new moon | sid=260.9784 PĀṣ | tro=259.6976 |
| 0194/01/10,06:50 | Sun / new moon | sid=291.2078 Śra | tro=289.9285 |
| 0194/01/24,07:03 | Moon eclipsed (19.2%) | sid=125.4481 Mag | tro=124.1751 |
| 0194/02/08,21:02 | Sun eclipsed (unobs.) | sid=320.9983 PBh | tro=319.7203 |

==================

duration = 1.37274 days both Venus and Mercury heliacally rising

------------------

0330/05/07,19:00 all planets bisible with new moon, Ju – Me = 27°37’

| | | | |
|---|---|---|---|
| 0330/05/22,14:28 | Mars heliacal setting | sid= 81.8440 Pun | tro= 82.4531 |
| (0330/05/27,14:25 | Mercury heliacal setting | sid= 84.0120 Pun | tro= 84.6581) |
| 0330/06/23,14:23 | Jupiter heliacal setting | sid=104.5919 Puṣ | tro=105.2041 |
| 0330/07/14,14:02 | Venus heliacal setting | sid=128.0381 Mag | tro=128.6599 |
| 0330/07/14,23:13 | Mercury morning last | sid= 96.8061 Puṣ | tro= 97.4149 |
| 0330/07/28,14:26 | Saturn heliacal setting | sid=149.5659 UPh | tro=150.1807 |
| ------------------ | | | |
| ------------------ | | | |
| 0330/07/29,23:23 | Jupiter heliacal rising | sid=112.5621 Āśl | tro=113.1760 |
| 0330/08/02,23:39 | Venus heliacal rising | sid=117.3321 Āśl | tro=117.9550 |
| 0330/09/16,23:47 | Saturn heliacal rising | sid=155.6726 UPh | tro=156.2889 |
| 0330/09/27,23:51 | Mars heliacal rising | sid=163.9279 Has | tro=164.5424 |
| (0330/10/13,23:59 | Mercury heliacal rising | sid=185.0217 Cit | tro=185.2305) |

0330/10/27,06:00 all planets visible with old moon, Me – Sa = 35°02’

------------------

| | | | |
|---|---|---|---|
| 0330/06/17,05:51 | Moon full | sid=264.4384 PĀṣ | tro=265.0579 |
| 0330/07/02,18:14 | Sun / new moon | sid= 99.2388 Puṣ | tro= 99.8537 |
| 0330/07/16,16:07 | Moon full | sid=292.5566 Śra | tro=293.1777 |
| 0330/08/01,03:54 | Sun / new moon | sid=127.4681 Mag | tro=128.0845 |
| 0330/08/01,03:54 | Lunar Node | sid= 13.1374 Aśv | tro= 13.7594 |
| 0330/08/15,05:00 | Moon full | sid=321.0829 PBh | tro=321.7054 |

duration =  0.98902 days

------------------

0473/06/06,14:39 Mars heliacal setting sid=  96.9945 Puṣ tro=  99.5858
0473/06/07,14:24 Saturn heliacal setting sid=  93.0250 Pun tro=  95.6182
0473/06/24,14:32 Mercury heliacal setting sid=115.4790 Āśl tro=118.0783
0473/07/13,14:19 Jupiter heliacal setting sid=124.7991 Mag tro=127.3935
0473/07/18,23:31 Venus morning last sid=104.5392 Puṣ tro=107.1295

------------------

------------------

0473/07/19,23:15 Saturn heliacal rising sid=  98.4606 Puṣ tro=101.0557
0473/07/29,23:12 Mercury heliacal rising sid=106.7786 Āśl tro=109.3783
0473/08/19,23:40 Jupiter heliacal rising sid=132.8980 Mag tro=135.4937
0473/10/14,12:40 Venus evening first sid=213.6284 Anu tro=216.2215
0473/10/16,00:04 Mars heliacal rising sid=181.5344 Cit tro=184.1298

------------------

0473/06/26,01:04 Moon full sid=272.2024 UĀṣ tro=274.8036
0473/07/11,05:19 Sun / new moon sid=106.7043 Āśl tro=109.3008
0473/07/25,09:07 Moon eclipsed (102.2%) sid=300.3669 Dha tro=302.9694
0473/07/25,09:07 Lunar Node sid=125.5937 Mag tro=128.1965
0473/08/09,19:12 Sun eclipsed (unobs.) sid=135.1888 PPh tro=137.7865
0473/08/23,18:55 Moon full sid=328.8018 PBh tro=331.4053

==================

duration =  18.45795 days

------------------

0669/09/30,13:17 Mars heliacal setting sid=214.5539 Anu tro=219.8782
0670/01/27,13:09 Saturn heliacal setting sid=324.2482 PBh tro=329.5800
0670/02/05,13:03 Jupiter heliacal setting sid=326.3739 PBh tro=331.7051
0670/02/21,01:00 Venus morning last sid=314.7790 Śat tro=320.1071
0670/02/28,13:27 Mercury heliacal setting sid=354.5130 Rev tro=359.8512

------------------

0670/03/12,13:28 Moon full sid=169.3272 Has tro=174.6674
0670/03/12,13:28 Lunar Node sid=279.6556 UĀṣ tro=284.9960

------------------

0670/03/19,00:27 Jupiter heliacal rising sid=336.3323 UBh tro=341.6649
0670/03/26,23:57 Saturn heliacal rising sid=331.2962 PBh tro=336.6303
0670/05/27,14:03 Venus evening first sid=  72.5567 Ārd tro=  77.8877
0670/05/29,14:16 Mercury evening first sid=  78.8385 Ārd tro=  84.1680
0670/05/29,22:58 Mars heliacal rising sid=  38.4218 Kṛt tro=  43.7556

------------------

0670/02/10,19:43 Moon full sid=139.8244 PPh tro=145.1638
0670/02/25,14:01 Sun / new moon sid=334.5334 UBh tro=339.8677
0670/03/26,22:36 Sun / new moon sid=    3.4102 Aśv tro=    8.7453
0670/04/11,05:00 Moon full sid=198.2373 Svā tro=203.5782

duration =  8.00473 days

------------------

0810/09/01,13:52 Mars heliacal setting sid=186.2363 Cit tro=193.5100
0810/11/09,00:33 Mercury morning last sid=209.6197 Viś tro=216.8931
0810/11/15,12:33 Saturn heliacal setting sid=250.3429 Mūl tro=257.6207
0810/11/16,00:59 Venus morning last sid=221.4426 Anu tro=228.7154
0810/12/20,12:32 Jupiter heliacal setting sid=278.6307 UĀṣ tro=285.9093

------------------

0810/12/29,22:39 Sun / new moon sid=275.3048 UĀṣ tro=282.5864
0810/12/29,22:39 Lunar Node sid=  74.3548 Ārd tro=  81.6420

------------------

0810/12/28,12:38 Mercury evening first sid=288.7651 Śra tro=296.0412
0810/12/29,00:57 Saturn heliacal rising sid=255.3925 PĀṣ tro=262.6724
0811/01/27,01:09 Jupiter heliacal rising sid=287.4875 Śra tro=294.7681
0811/02/01,12:57 Venus evening first sid=318.7808 Śat tro=326.0575
0811/05/09,23:07 Mars heliacal rising sid=  15.6009 Bha tro=  22.8833

------------------

0810/11/30,12:27 Sun eclipsed 50.1% sid=245.2996 Mūl tro=252.5795
0810/12/14,18:12 Moon full sid=  79.8255 Ārd tro=  87.1118
0811/01/13,13:42 Moon full sid=110.1694 Āśl tro=117.4573
0811/01/28,09:09 Sun / new moon sid=305.1457 Dha tro=312.4287

==================

duration =  2.99977 days

------------------

0968/09/06,13:43 Mars heliacal setting sid=190.6127 Svā tro=200.0923
0969/02/07,01:09 Venus morning last sid=299.9204 Dha tro=309.4033
0969/04/01,13:46 Saturn heliacal setting sid=  23.4587 Bha tro=  32.9476
0969/05/05,14:20 Mercury heliacal setting sid=  59.8544 Mṛg tro=  69.3502
0969/05/07,13:59 Jupiter heliacal setting sid=  54.8863 Mṛg tro=  64.3757

------------------

------------------

0969/05/10,13:58 Venus evening first sid=  54.3481 Mṛg tro=  63.8337
0969/05/13,23:02 Mars heliacal rising sid=  19.5701 Bha tro=  29.0583
0969/05/19,23:06 Saturn heliacal rising sid=  29.6308 Kṛt tro=  39.1216
0969/06/14,23:07 Jupiter heliacal rising sid=  63.6714 Mṛg tro=  73.1626
0969/06/16,23:01 Mercury heliacal rising sid=  59.4307 Mṛg tro=  68.9244

------------------

0969/04/05,09:12 Moon full sid=190.9627 Svā tro=200.4587
0969/04/19,10:42 Sun / new moon sid=  24.5789 Bha tro=  34.0699
0969/05/04,17:52 Moon full sid=219.2946 Anu tro=228.7916
0969/05/04,17:52 Lunar Node sid=249.4593 Mūl tro=258.9565
0969/05/19,01:36 Sun eclipsed (unobs.) sid=  53.0002 Roh tro=  62.4924
0969/06/03,01:16 Moon full sid=247.2955 Mūl tro=256.7938
0969/06/17,16:25 Sun eclipsed (unobs.) sid=  81.2344 Pun tro=  90.7280

duration = 2.34972 days

------------------

1562/03/15,00:31 Venus morning last sid=329.9937 PBh tro=347.7335
1562/05/08,14:06 Jupiter heliacal setting sid= 51.6885 Roh tro= 69.4338
1562/05/30,14:27 Saturn heliacal setting sid= 78.2625 Ārd tro= 96.0096
1562/06/09,23:07 Mercury morning last sid= 52.1104 Roh tro= 69.8544
1562/06/12,14:46 Mars heliacal setting sid= 97.5532 Puṣ tro=115.2989

------------------

------------------

1562/06/14,23:09 Jupiter heliacal rising sid= 60.2802 Mṛg tro= 78.0273
1562/06/23,14:16 Venus evening first sid= 93.7696 Puṣ tro=111.5131
1562/07/11,23:13 Saturn heliacal rising sid= 83.7314 Pun tro=101.4805
1562/07/16,14:25 Mercury evening first sid=124.2583 Mag tro=142.0035
1562/10/27,00:16 Mars heliacal rising sid=185.1358 Cit tro=202.8862

------------------

1562/05/18,13:31 Moon full sid=228.7016 Jye tro=246.4550
1562/06/01,22:41 Sun / new moon sid= 62.4434 Mṛg tro= 80.1923
1562/06/16,20:30 Moon full sid=256.6581 PĀṣ tro=274.4131
1562/06/16,20:30 Lunar Node sid=289.3256 Śra tro=307.0808
1562/07/01,14:00 Sun / new moon sid= 90.6993 Pun tro=108.4497
1562/07/16,03:31 Moon eclipsed (139.5%) sid=284.6009 Śra tro=302.3574
1562/07/31,05:14 Sun eclipsed (unobs.) sid=119.0570 Āśl tro=136.8087

==================

duration = 10.99589 days

------------------

1624/06/06,14:40 Mars heliacal setting sid= 80.4912 Pun tro= 99.0977
1624/07/19,14:31 Saturn heliacal setting sid=120.4112 Mag tro=139.0218
1624/08/11,14:02 Jupiter heliacal setting sid=137.7223 PPh tro=156.3331
1624/08/19,23:55 Venus morning last sid=119.5503 Āśl tro=138.1568
1624/08/23,23:44 Mercury morning last sid=119.8310 Āśl tro=138.4370

------------------

1624/08/28,09:46 Moon full sid=316.7167 Śat tro=335.3356
1624/08/28,09:46 Lunar Node sid=165.9449 Has tro=184.5639

------------------

1624/09/03,23:38 Saturn heliacal rising sid=126.2490 Mag tro=144.8609
1624/09/19,00:03 Jupiter heliacal rising sid=145.9935 PPh tro=164.6050
1624/10/17,00:03 Mars heliacal rising sid=165.0757 Has tro=183.6863
1624/11/10,12:19 Venus evening first sid=222.4946 Anu tro=241.1034
1624/11/22,00:32 Mercury heliacal rising sid=205.2753 Viś tro=223.8971

------------------

1624/07/30,01:57 Moon full sid=288.4828 Śra tro=307.1008
1624/08/14,04:12 Sun / new moon sid=122.9733 Mag tro=141.5863
1624/09/12,19:17 Sun eclipsed (unobs.) sid=151.6938 UPh tro=170.3075
1624/09/26,19:43 Moon eclipsed (171.2%) sid=345.4307 UBh tro= 4.0502
1624/10/12,08:52 Sun eclipsed (unobs.) sid=180.8179 Cit tro=199.4322

duration = 8.47979 days
both Venus and Mercury heliacally rising

------------------

2277/08/31, 19:00 all planets visible with new moon, Sa – Me = 33°27’
2277/09/07,13:32 Jupiter heliacal setting sid=155.4173 UPh tro=183.1458
2277/09/10,13:44 Mars heliacal setting sid=172.4712 Has tro=200.1988
2277/10/01,13:12 Saturn heliacal setting sid=184.6449 Cit tro=212.3746
(2277/10/02,13:10 Mercury heliacal setting sid=186.6714 Svā tro=218.2692)
2277/10/08,12:44 Venus heliacal setting sid=189.8944 Svā tro=217.6319

------------------

2277/10/12,13:50 Moon full sid=351.7374 Rev tro= 19.4743
2277/10/12,13:50 Lunar Node sid=124.7862 Mag tro=152.5233

------------------

2277/10/17,00:15 Jupiter heliacal rising sid=163.8893 Has tro=191.6185
2277/10/30,00:13 Mercury heliacal rising sid=172.8086 Has tro=200.5455
2277/10/30,00:36 Venus heliacal rising sid=179.0540 Cit tro=206.7924
2277/11/17,00:24 Saturn heliacal rising sid=190.1838 Svā tro=217.9147
2278/05/07,23:16 Mars heliacal rising sid=350.6573 Rev tro= 18.3917

------------------

2277/08/14,08:50 Moon eclipsed (unobs.) sid=294.3068 Dha tro=322.0423
2277/08/29,20:38 Sun eclipsed (unobs.) sid=129.0981 Mag tro=156.8286
2277/09/12,21:39 Moon eclipsed (unobs.) sid=322.5497 PBh tro=350.2860
2277/09/28,05:56 Sun / new moon sid=157.6513 UPh tro=185.3824
2277/10/27,15:00 Sun / new moon sid=186.6544 Cit tro=214.3861
2277/11/11,07:39 Moon full sid= 21.3387 Bha tro= 49.0765

==================

duration = 3.00098 days

------------------

2337/07/23,14:39 Mars heliacal setting sid=121.3255 Mag tro=149.8880
2337/09/01,00:02 Venus morning last sid=120.8169 Mag tro=149.3776
2337/09/30,13:04 Jupiter heliacal setting sid=176.2303 Cit tro=204.7962
2337/10/17,12:54 Saturn heliacal setting sid=197.7583 Svā tro=226.3255
2337/11/05,00:30 Mercury morning last sid=180.8555 Cit tro=209.4185

------------------

2337/11/09,09:33 Moon full sid= 18.0281 Bha tro= 46.6028
2337/11/09,09:33 Lunar Node sid= 42.0514 Roh tro= 70.6264

------------------

2337/11/08,00:31 Jupiter heliacal rising sid=184.5358 Cit tro=213.1028
2337/11/20,12:15 Venus evening first sid=221.1880 Anu tro=249.7515
2337/12/01,00:35 Saturn heliacal rising sid=203.0206 Viś tro=231.5894
2337/12/25,12:33 Mercury evening first sid=260.7167 PĀṣ tro=289.2834
2337/12/29,00:51 Mars heliacal rising sid=226.0059 Anu tro=254.5736

------------------

2337/10/10,18:31 Moon full sid=348.5985 Rev tro= 17.1722
2337/10/24,20:43 Sun / new moon sid=182.5362 Cit tro=211.1049
2337/11/23,10:17 Sun eclipsed 94.1% sid=212.1252 Viś tro=240.6950
2337/12/08,23:37 Moon eclipsed (67.5%) sid= 47.8278 Roh tro= 76.4040

# C: Cycles of Super-Conjunctions

The table shows time intervals between the super-conjunctions listed in appendices A and B. The left column gives the year, the second column the time interval until the next super-conjunction, the third column the interval until the over-next super-conjunction, etc. It turns out that there is no strict regularity, that the pattern even changes through the centuries and millennia, but that there are still certain cycles. Eye-catching is a cycle of about 98 or 197 (= 98 + 99) years. Other frequent cycles consist of 38 and 60 years (together 98 years again), as well as 179 and 239 years.

| *year* | *time intervals in years* | | | |
|---|---|---|---|---|
| -3919 | 42 | 480 | | |
| -3877 | 438 | | | |
| -3439 | 56 | ***98*** | ***197*** | |
| -3383 | 42 | 141 | **179** | |
| -3341 | ***99*** | 137 | | |
| -3242 | ***38*** | **179** | 217 | |
| -3204 | 141 | **179** | 239 | |
| -3063 | ***38*** | ***98*** | ***197*** | |
| -3025 | ***60*** | 159 | | |
| -2965 | ***99*** | | | |
| -2866 | 140 | 241 | | |
| -2726 | ***101*** | | | |
| -2625 | 277 | | | |
| -2348 | ***60*** | ***98*** | 239 | |
| -2288 | ***38*** | **179** | ***197*** | |
| -2250 | 141 | 159 | ***197*** | |
| -2109 | *18* | 56 | 137 | ***197*** |
| -2091 | ***38*** | 119 | **179** | 217 |
| -2053 | *81* | 141 | **179** | 239 |
| -1972 | ***60*** | ***98*** | 158 | |
| -1912 | ***38*** | ***98*** | ***197*** | |
| -1874 | **60** | 159 | | |
| -1814 | ***99*** | 239 | | |
| -1715 | 140 | **179** | 241 | |
| -1575 | ***39*** | ***101*** | 280 | |
| -1536 | ***62*** | 241 | | |
| -1474 | **179** | | | |
| -1295 | ***98*** | ***197*** | | |
| -1197 | ***99*** | 137 | 237 | |
| -1098 | ***38*** | 140 | | |
| -1060 | ***102*** | 239 | | |
| -958 | 137 | ***197*** | | |
| -821 | ***60*** | 239 | | |
| -761 | **179** | 241 | | |

| | | | | |
|---|---|---|---|---|
| -582 | **62** | ***101*** | | |
| -520 | ***39*** | | | |
| -481 | 239 | | | |
| -242 | ***98*** | | | |
| -144 | **179** | ***197*** | | |
| 35 | *18* | ***98*** | 158 | ***197*** |
| 53 | *80* | 140 | **179** | |
| 133 | ***60*** | ***98*** | ***196*** | |
| 193 | ***39*** | 137 | | |
| 232 | ***98*** | 241 | | |
| 330 | 143 | 203 | | |
| 473 | ***60*** | ***197*** | | |
| 533 | 137 | 277 | | |
| 670 | 140 | 239 | | |
| 810 | ***99*** | 159 | ***197*** | |
| 909 | ***60*** | ***98*** | 277 | |
| 969 | ***38*** | 217 | | |
| 1007 | **179** | | | |
| 1186 | 128 | | | |
| 1344 | 218 | | | |
| 1562 | ***62*** | | | |
| 1624 | **179** | ***197*** | | |
| 1803 | *18* | 158 | ***197*** | |
| 1821 | 140 | **179** | | |
| 1961 | ***39*** | | | |
| 2000 | 277 | | | |
| 2277 | ***60*** | | | |
| 2337 | | | | |

## D: Super-Conjunctions that Fulfil some Criteria from Mahābhārata

Super-conjunctions between 4000 BCE and 1 BCE that occur near a Kārttika full moon and/or a new moon in Jyeṣṭhā. Ideally, the new moon would have to be accompanied by a solar eclipse and the full moon by a lunar eclipse, Venus and Mercury would have to make a heliacal rising rather than an evening first appearance, Jupiter and Saturn would have to make their rising in the lunar mansion Viśākhā. Only the super-conjunction of the year 1198 BCE fulfils all these criteria.

---

3878 BCE

26th September, morning: *Full moon in Kṛttikā*. All planets are invisible.

10th October, shortly before midnight: *New moon near the star Jyeṣṭhā*. Venus is visible as an evening star.

---

2727 BCE

20th October, evening: *Full moon in Rohiṇī*. All planets are invisible.

4th November: New moon in Mūla. Venus has appeared as evening star.

---

2349 BCE

26th September, forenoon: A solar eclipse in Viśākhā, not observable in Kurukṣetra. All planets are invisible. A month earlier, there was a total lunar eclipse in Aśvinī, which was observable.

10th October, evening: *Full moon in Kṛttikā*. Jupiter and Saturn have appeared in Svāti and Citrā.

*Venus appears on 12th as morning star, Mercury on 28th*.

26th October: *New moon in Jyeṣṭhā*. Mercury and Mars are still invisible.

---

2289 BCE

7th October, morning: *Full moon in Kṛttikā*. Mars has just made his morning first, all other planets are invisible.

22th October: *New moon near the star Jyeṣṭhā*. Mars, Saturn, and Mercury have appeared in the morning sky.

---

2110 BCE

9th October, morning: *Full moon in Kṛttikā*. Mars, Venus, and Saturn are invisible.

24th October, afternoon: *Partial solar eclipse of about 32% in Jyeṣṭhā*. All planets are invisible.

7th November, afternoon: Total lunar eclipse in Mṛgaśīrṣa, not observable. All planets are still invisible.

---

1875 BCE

5th October, evening: Solar eclipse in Viśākhā, not observable. Jupiter has made his heliacal rising in Citrā, all other planets are invisible.

20th October, morning: *Full moon in Rohiṇī*. Only Jupiter is visible.

4th November, morning: *New moon in Jyeṣṭhā* (Mūla). Meanwhile, Mercury and Saturn have appeared, too.

---

1815 BCE

17th October, evening: *Full moon in Kṛttikā*. During the past days, *Mercury and Venus have become morning stars*. *Jupiter has appeared in Viśākhā*.

1st November, morning: *New moon in Jyeṣṭhā*. All planets except Saturn are already visible in the morning sky. Saturn will appear in Jyeṣṭhā.

---

1576 BCE

15th October, morning: *Full moon in Kṛttikā*.

29th October, noon: *New moon in Jyeṣṭhā*. Jupiter and Saturn are still evening stars.

---

1198 BCE

21st October, afternoon: *Solar eclipse of* 87% *in Anurādhā (Jyeṣṭhā).* All planets are invisible.

4th November, evening: Lunar eclipse 71% *in Rohiṇī*. *Jupiter and Saturn have appeared in Viśākhā*. *Mercury and Venus have appeared as morning stars*. Only Mars is still delayed.

---

959 BCE

2nd November, morning: *Full moon in Rohiṇī*. Jupiter is still visible in the evening.

17th November: *New moon in Mūla (Jyeṣṭhā)*. All planets are invisible.

---

521 BCE

20th October, evening: *Full moon in Kṛttikā*. All planets are invisible.

4th November, morning: *New moon in Jyeṣṭhā*. *Saturn and Mars have appeared in Viśākhā.* Jupiter will appear in Jyeṣṭhā.

# E: All Planets Near the Moon in the Morning Sky

This list shows clusters of planets around the old moon crescent that were visible in the morning sky between 3500 BCE and 1 BCE.

Very good visibility is assumed (extinction coefficient 0.15).

Data provided:
- date with astronomical year count;
- distribution range of the planets in degrees (*dmax*);
- minimum elongation (*emin*);
- positions of the celestial bodies in the lunar mansions (Lahiri).

Clusters with smallest possible *dmax* and greatest possible *emin* are most eye-catching. The most spectacular clusters are underlined.

The rare clusters that are immediately preceded by super-conjunctions are listed in italics.

05.09.-3443 dmax=77.93 emin=11.77 me=Has ve=Cit ma=UPh ju=Puṣ sa=Mag su=Cit mo=Puṣ

15.02.-3340 dmax=43.30 emin=20.01 me=PBh ve=Dha ma=PBh ju=Śat sa=Śra su=Rev mo=Śra
16.02.-3340 dmax=43.39 emin=20.82 me=PBh ve=Dha ma=PBh ju=Śat sa=Śra su=Rev mo=Dha
17.02.-3340 dmax=44.07 emin=21.04 me=PBh ve=Śat ma=PBh ju=Śat sa=Śra su=Rev mo=Śat
18.02.-3340 dmax=46.02 emin=19.99 me=PBh ve=Śat ma=PBh ju=Śat sa=Śra su=Rev mo=PBh

13.03.-3340 dmax=64.16 emin=23.75 me=Rev ve=PBh ma=Rev ju=PBh sa=Śra su=Bha mo=Śra
14.03.-3340 dmax=65.62 emin=23.22 me=Rev ve=PBh ma=Rev ju=PBh sa=Śra su=Bha mo=Dha
15.03.-3340 dmax=67.09 emin=22.67 me=Rev ve=PBh ma=Rev ju=PBh sa=Śra su=Bha mo=Śat

27.12.-3285 dmax=60.77 emin=25.31 me=UĀṣ ve=UĀṣ ma=Jye ju=Anu sa=Mūl su=Dha mo=Anu
28.12.-3285 dmax=60.57 emin=26.42 me=UĀṣ ve=UĀṣ ma=Jye ju=Anu sa=Mūl su=Dha mo=Jye
29.12.-3285 dmax=61.31 emin=26.60 me=UĀṣ ve=UĀṣ ma=Jye ju=Anu sa=Mūl su=Dha mo=Mūl
30.12.-3285 dmax=62.13 emin=26.69 me=UĀṣ ve=UĀṣ ma=Jye ju=Anu sa=Mūl su=Dha mo=PĀṣ
31.12.-3285 dmax=63.01 emin=26.73 me=UĀṣ ve=UĀṣ ma=Jye ju=Anu sa=Mūl su=Dha mo=UĀṣ

10.12.-3283 dmax=34.08 emin=13.20 me=PĀṣ ve=Mūl ma=Jye ju=PĀṣ sa=UĀṣ su=Śra mo=UĀṣ

29.08.-3206 dmax=73.62 emin=14.66 me=Has ve=PPh ma=UPh ju=Pun sa=PPh su=Cit mo=Mag
30.08.-3206 dmax=73.46 emin=15.73 me=Has ve=PPh ma=UPh ju=Pun sa=PPh su=Cit mo=PPh

22.12.-3200 dmax=66.12 emin=12.40 me=UĀṣ ve=Mūl ma=UĀṣ ju=PĀṣ sa=Anu su=Dha mo=Śra

06.07.-3182 dmax=41.59 emin=14.25 me=Āśl ve=Pun ma=Ārd ju=Pun sa=Ārd su=Mag mo=Ārd
07.07.-3182 dmax=42.75 emin=13.44 me=Āśl ve=Pun ma=Ārd ju=Pun sa=Ārd su=Mag mo=Pun
08.07.-3182 dmax=43.97 emin=12.58 me=Āśl ve=Pun ma=Ārd ju=Pun sa=Ārd su=Mag mo=Puṣ
09.07.-3182 dmax=45.21 emin=11.69 me=Āśl ve=Pun ma=Ārd ju=Pun sa=Ārd su=Mag mo=Āśl

30.10.-3144 dmax=51.55 emin=18.27 me=Anu ve=Svā ma=Cit ju=Has sa=Cit su=Mūl mo=Has
31.10.-3144 dmax=51.46 emin=19.25 me=Anu ve=Svā ma=Cit ju=Has sa=Cit su=Mūl mo=Cit
01.11.-3144 dmax=51.53 emin=20.08 me=Anu ve=Svā ma=Cit ju=Has sa=Cit su=Mūl mo=Svā
02.11.-3144 dmax=51.73 emin=20.77 me=Anu ve=Svā ma=Cit ju=Has sa=Cit su=Mūl mo=Viś
03.11.-3144 dmax=52.06 emin=21.34 me=Anu ve=Svā ma=Cit ju=Has sa=Cit su=Mūl mo=Anu
04.11.-3144 dmax=60.69 emin=13.61 me=Anu ve=Svā ma=Svā ju=Has sa=Cit su=Mūl mo=Jye

02.01.-3105 dmax=53.63 emin=6.66 me=Śra ve=Dha ma=Śra ju=Mūl sa=UĀṣ su=Dha mo=Śra

05.03.-3103 dmax=44.06 emin=20.46 me=UBh ve=UBh ma=UBh ju=Śat sa=Dha su=Aśv mo=Dha
06.03.-3103 dmax=45.21 emin=20.20 me=UBh ve=Rev ma=UBh ju=Śat sa=Dha su=Aśv mo=Śat
07.03.-3103 dmax=46.35 emin=19.95 me=UBh ve=Rev ma=UBh ju=Śat sa=Dha su=Aśv mo=PBh
08.03.-3103 dmax=47.50 emin=19.70 me=UBh ve=Rev ma=UBh ju=Śat sa=Dha su=Aśv mo=UBh
09.03.-3103 dmax=50.15 emin=17.94 me=UBh ve=Rev ma=Rev ju=Śat sa=Dha su=Aśv mo=Rev
10.03.-3103 dmax=61.94 emin=7.05 me=Rev ve=Rev ma=Rev ju=Śat sa=Dha su=Aśv mo=Aśv

17.12.-3048 dmax=58.84 emin=23.52 me=PĀṣ ve=PĀṣ ma=Anu ju=Viś sa=PĀṣ su=Śra mo=Viś
18.12.-3048 dmax=59.12 emin=24.15 me=PĀṣ ve=PĀṣ ma=Anu ju=Viś sa=PĀṣ su=Śra mo=Anu
19.12.-3048 dmax=59.51 emin=24.68 me=PĀṣ ve=PĀṣ ma=Jye ju=Viś sa=PĀṣ su=Śra mo=Jye
20.12.-3048 dmax=59.97 emin=25.13 me=UĀṣ ve=PĀṣ ma=Jye ju=Viś sa=PĀṣ su=Śra mo=Mūl
21.12.-3048 dmax=60.52 emin=25.50 me=UĀṣ ve=PĀṣ ma=Jye ju=Viś sa=PĀṣ su=Śra mo=UĀṣ
22.12.-3048 dmax=74.92 emin=12.01 me=UĀṣ ve=PĀṣ ma=Jye ju=Viś sa=PĀṣ su=Dha mo=Śra

07.09.-3003 dmax=74.76 emin=5.57 me=Cit ve=UPh ma=PPh ju=Mag sa=Puṣ su=Cit mo=Has

*02.11.-2965 dmax=30.96 emin=15.55 me=Anu ve=Svā ma=Anu ju=Svā sa=Viś su=Mūl mo=Svā*
*03.11.-2965 dmax=31.49 emin=15.09 me=Jye ve=Svā ma=Anu ju=Svā sa=Viś su=Mūl mo=Viś*
*04.11.-2965 dmax=32.03 emin=14.62 me=Jye ve=Svā ma=Anu ju=Svā sa=Viś su=Mūl mo=Anu*
*05.11.-2965 dmax=32.56 emin=14.14 me=Jye ve=Svā ma=Anu ju=Svā sa=Viś su=Mūl mo=Jye*

27.06.-2945 dmax=34.87 emin=15.16 me=Puṣ ve=Puṣ ma=Mṛg ju=Pun sa=Pun su=Āśl mo=Ārd
28.06.-2945 dmax=35.46 emin=14.90 me=Puṣ ve=Puṣ ma=Mṛg ju=Pun sa=Pun su=Āśl mo=Pun
29.06.-2945 dmax=36.06 emin=14.63 me=Puṣ ve=Puṣ ma=Mṛg ju=Pun sa=Pun su=Āśl mo=Puṣ
30.06.-2945 dmax=43.82 emin=7.20 me=Puṣ ve=Puṣ ma=Mṛg ju=Pun sa=Pun su=Āśl mo=Āśl

24.10.-2907 dmax=54.53 emin=14.11 me=Anu ve=Anu ma=Cit ju=Has sa=Svā su=Jye mo=Viś
25.10.-2907 dmax=53.93 emin=15.60 me=Anu ve=Anu ma=Cit ju=Has sa=Svā su=Jye mo=Anu

27.12.-2845 dmax=69.88 emin=17.60 me=UĀṣ ve=PĀṣ ma=Viś ju=Mūl sa=Jye su=Dha mo=UĀṣ

22.02.-2806 dmax=22.64 emin=23.51 me=PBh ve=Śat ma=Śat ju=PBh sa=PBh su=Rev mo=Dha
23.02.-2806 dmax=23.17 emin=22.97 me=PBh ve=Śat ma=Śat ju=PBh sa=PBh su=Rev mo=Śat
24.02.-2806 dmax=23.73 emin=22.39 me=PBh ve=Śat ma=Śat ju=PBh sa=PBh su=Rev mo=PBh
25.02.-2806 dmax=34.65 emin=11.44 me=UBh ve=Śat ma=Śat ju=PBh sa=PBh su=Rev mo=UBh

17.07.-2768 dmax=64.10 emin=9.85 me=Mag ve=Pun ma=Puṣ ju=Mṛg sa=Pun su=Mag mo=Mṛg
18.07.-2768 dmax=65.87 emin=8.92 me=Mag ve=Pun ma=Puṣ ju=Mṛg sa=Pun su=PPh mo=Ārd
19.07.-2768 dmax=67.67 emin=7.97 me=Mag ve=Pun ma=Puṣ ju=Mṛg sa=Pun su=PPh mo=Pun
20.07.-2768 dmax=69.47 emin=7.02 me=Mag ve=Pun ma=Puṣ ju=Mṛg sa=Pun su=PPh mo=Puṣ
21.07.-2768 dmax=71.27 emin=6.08 me=Mag ve=Pun ma=Puṣ ju=Mṛg sa=Pun su=PPh mo=Āśl

05.11.-2762 dmax=60.76 emin=10.88 me=Anu ve=Svā ma=Viś ju=Jye sa=Has su=Mūl mo=Has
06.11.-2762 dmax=60.93 emin=11.67 me=Anu ve=Svā ma=Viś ju=Jye sa=Has su=Mūl mo=Cit
07.11.-2762 dmax=61.10 emin=12.47 me=Anu ve=Viś ma=Viś ju=Jye sa=Has su=Mūl mo=Svā
08.11.-2762 dmax=61.26 emin=13.27 me=Anu ve=Viś ma=Viś ju=Jye sa=Has su=Mūl mo=Viś
09.11.-2762 dmax=61.43 emin=14.07 me=Jye ve=Viś ma=Viś ju=Jye sa=Has su=Mūl mo=Anu
10.11.-2762 dmax=61.61 emin=14.86 me=Jye ve=Viś ma=Anu ju=Jye sa=Has su=Mūl mo=Jye
11.11.-2762 dmax=66.75 emin=10.69 me=Jye ve=Viś ma=Anu ju=Jye sa=Has su=Mūl mo=Jye

19.09.-2706 dmax=54.50 emin=11.83 me=Cit ve=Has ma=Mag ju=PPh sa=PPh su=Svā mo=Mag
20.09.-2706 dmax=55.56 emin=11.22 me=Cit ve=Has ma=Mag ju=PPh sa=PPh su=Svā mo=PPh
21.09.-2706 dmax=56.63 emin=10.61 me=Svā ve=Has ma=Mag ju=PPh sa=PPh su=Svā mo=UPh
22.09.-2706 dmax=57.71 emin=9.99 me=Svā ve=Has ma=Mag ju=PPh sa=PPh su=Svā mo=Has

27.12.-2666 dmax=17.57 emin=23.24 me=UĀṣ ve=PĀṣ ma=PĀṣ ju=UĀṣ sa=PĀṣ su=Dha mo=PĀṣ
28.12.-2666 dmax=17.83 emin=23.89 me=UĀṣ ve=PĀṣ ma=PĀṣ ju=UĀṣ sa=PĀṣ su=Dha mo=UĀṣ
29.12.-2666 dmax=26.36 emin=16.27 me=UĀṣ ve=PĀṣ ma=PĀṣ ju=UĀṣ sa=PĀṣ su=Dha mo=Śra

05.11.-2610 dmax=62.37 emin=15.59 me=Jye ve=Svā ma=Has ju=Cit sa=Anu su=Mūl mo=Has
06.11.-2610 dmax=63.33 emin=15.13 me=Jye ve=Svā ma=Has ju=Cit sa=Anu su=Mūl mo=Cit
07.11.-2610 dmax=64.29 emin=14.66 me=Jye ve=Viś ma=Has ju=Cit sa=Anu su=Mūl mo=Svā
08.11.-2610 dmax=65.27 emin=14.18 me=Jye ve=Viś ma=Has ju=Cit sa=Anu su=Mūl mo=Viś
09.11.-2610 dmax=66.25 emin=13.70 me=Jye ve=Viś ma=Has ju=Cit sa=Anu su=Mūl mo=Anu
10.11.-2610 dmax=68.10 emin=12.36 me=Jye ve=Viś ma=Has ju=Cit sa=Anu su=Mūl mo=Jye

22.07.-2565 dmax=66.31 emin=17.41 me=Āśl ve=Pun ma=Pun ju=Puṣ sa=Roh su=PPh mo=Roh
23.07.-2565 dmax=67.65 emin=17.00 me=Āśl ve=Pun ma=Pun ju=Puṣ sa=Roh su=PPh mo=Mṛg
24.07.-2565 dmax=69.08 emin=16.50 me=Mag ve=Pun ma=Pun ju=Puṣ sa=Roh su=PPh mo=Ārd
25.07.-2565 dmax=70.58 emin=15.93 me=Mag ve=Pun ma=Pun ju=Puṣ sa=Roh su=PPh mo=Pun
26.07.-2565 dmax=72.15 emin=15.29 me=Mag ve=Puṣ ma=Pun ju=Puṣ sa=Roh su=PPh mo=Puṣ
27.07.-2565 dmax=73.79 emin=14.59 me=Mag ve=Puṣ ma=Pun ju=Puṣ sa=Roh su=PPh mo=Āśl

11.07.-2531 dmax=62.36 emin=12.59 me=Āśl ve=Āśl ma=Puṣ ju=Roh sa=Āśl su=Mag mo=Āśl

18.11.-2527 dmax=73.59 emin=15.52 me=Mūl ve=Viś ma=Viś ju=Cit sa=Has su=PĀṣ mo=Cit

29.10.-2525 dmax=37.76 emin=10.03 me=Viś ve=Viś ma=Viś ju=Anu sa=Svā su=Jye mo=Cit
30.10.-2525 dmax=37.89 emin=10.83 me=Anu ve=Viś ma=Viś ju=Anu sa=Svā su=Jye mo=Svā
31.10.-2525 dmax=38.02 emin=11.63 me=Anu ve=Viś ma=Viś ju=Anu sa=Svā su=Jye mo=Viś
01.11.-2525 dmax=38.16 emin=12.42 me=Anu ve=Viś ma=Viś ju=Anu sa=Svā su=Jye mo=Anu

10.09.-2469 dmax=44.38 emin=14.97 me=Has ve=UPh ma=Mag ju=Mag sa=UPh su=Cit mo=Mag
11.09.-2469 dmax=45.39 emin=14.38 me=Has ve=UPh ma=Mag ju=PPh sa=UPh su=Cit mo=PPh
12.09.-2469 dmax=46.42 emin=13.78 me=Has ve=UPh ma=Mag ju=PPh sa=UPh su=Cit mo=Has
13.09.-2469 dmax=47.46 emin=13.17 me=Cit ve=UPh ma=Mag ju=PPh sa=UPh su=Svā mo=Cit

03.01.-2430 dmax=70.23 emin=18.83 me=Śra ve=PĀṣ ma=Mūl ju=Viś sa=Mūl su=Dha mo=Viś
04.01.-2430 dmax=69.92 emin=20.06 me=Śra ve=PĀṣ ma=Mūl ju=Viś sa=Mūl su=Dha mo=Jye

13.07.-2328 dmax=38.76 emin=18.08 me=Āśl ve=Puṣ ma=Pun ju=Pun sa=Ārd su=Mag mo=Ārd
14.07.-2328 dmax=39.54 emin=18.18 me=Āśl ve=Āśl ma=Pun ju=Pun sa=Ārd su=Mag mo=Pun
15.07.-2328 dmax=40.43 emin=18.17 me=Āśl ve=Āśl ma=Pun ju=Pun sa=Ārd su=Mag mo=Puṣ
16.07.-2328 dmax=41.44 emin=18.04 me=Āśl ve=Āśl ma=Pun ju=Pun sa=Ārd su=Mag mo=Āśl
17.07.-2328 dmax=54.70 emin=5.66 me=Āśl ve=Āśl ma=Pun ju=Pun sa=Ārd su=Mag mo=Mag

12.03.-2189 dmax=29.60 emin=25.40 me=UBh ve=PBh ma=UBh ju=PBh sa=Śat su=Aśv mo=Śat
13.03.-2189 dmax=30.89 emin=24.99 me=UBh ve=PBh ma=UBh ju=PBh sa=Śat su=Aśv mo=PBh
14.03.-2189 dmax=33.51 emin=23.25 me=UBh ve=PBh ma=UBh ju=PBh sa=Śat su=Aśv mo=UBh

03.08.-2151 dmax=65.34 emin=13.86 me=Mag ve=Puṣ ma=Āśl ju=Mṛg sa=Ārd su=PPh mo=Mṛg
04.08.-2151 dmax=66.97 emin=13.09 me=Mag ve=Puṣ ma=Āśl ju=Mṛg sa=Ārd su=PPh mo=Ārd
05.08.-2151 dmax=68.65 emin=12.29 me=PPh ve=Puṣ ma=Āśl ju=Mṛg sa=Ārd su=UPh mo=Pun
06.08.-2151 dmax=70.34 emin=11.47 me=PPh ve=Puṣ ma=Āśl ju=Mṛg sa=Ārd su=UPh mo=Puṣ
07.08.-2151 dmax=72.06 emin=10.63 me=PPh ve=Puṣ ma=Āśl ju=Mṛg sa=Ārd su=UPh mo=Āśl
08.08.-2151 dmax=73.78 emin=9.79 me=PPh ve=Puṣ ma=Āśl ju=Mṛg sa=Ārd su=UPh mo=Mag

20.01.-2133 dmax=68.38 emin=20.64 me=Dha ve=Śra ma=Jye ju=Jye sa=UĀṣ su=Śat mo=Jye

19.09.-2055 dmax=74.39 emin=13.41 me=Cit ve=UPh ma=UPh ju=Puṣ sa=Has su=Svā mo=Puṣ
20.09.-2055 dmax=75.92 emin=12.80 me=Cit ve=UPh ma=UPh ju=Puṣ sa=Has su=Svā mo=Āśl
21.09.-2055 dmax=77.46 emin=12.19 me=Cit ve=UPh ma=UPh ju=Puṣ sa=Has su=Svā mo=Mag

12.01.-2048 dmax=41.22 emin=26.68 me=Śra ve=PĀṣ ma=UĀṣ ju=Śra sa=Jye su=Śat mo=Jye
13.01.-2048 dmax=42.24 emin=26.59 me=Śra ve=PĀṣ ma=UĀṣ ju=Śra sa=Jye su=Śat mo=Mūl
14.01.-2048 dmax=43.30 emin=26.47 me=Śra ve=UĀṣ ma=Śra ju=Śra sa=Jye su=Śat mo=PĀṣ
15.01.-2048 dmax=44.40 emin=26.31 me=Śra ve=UĀṣ ma=Śra ju=Śra sa=Jye su=Śat mo=Śra
16.01.-2048 dmax=55.21 emin=16.45 me=Śra ve=UĀṣ ma=Śra ju=Śra sa=Jye su=Śat mo=Dha

30.10.-1993 dmax=45.87 emin=14.74 me=Anu ve=Cit ma=Has ju=Cit sa=Viś su=Jye mo=Anu

24.11.-1993 dmax=54.18 emin=19.01 me=Jye ve=Viś ma=Cit ju=Cit sa=Viś su=PĀṣ mo=Svā
25.11.-1993 dmax=55.47 emin=18.62 me=Jye ve=Viś ma=Svā ju=Cit sa=Viś su=PĀṣ mo=Svā
26.11.-1993 dmax=56.78 emin=18.21 me=Mūl ve=Viś ma=Svā ju=Cit sa=Viś su=PĀṣ mo=Viś
27.11.-1993 dmax=58.10 emin=17.79 me=Mūl ve=Anu ma=Svā ju=Cit sa=Viś su=PĀṣ mo=Anu
28.11.-1993 dmax=59.42 emin=17.37 me=Mūl ve=Anu ma=Svā ju=Cit sa=Viś su=PĀṣ mo=Jye
29.11.-1993 dmax=62.16 emin=15.54 me=Mūl ve=Anu ma=Svā ju=Cit sa=Viś su=PĀṣ mo=Mūl

02.03.-1952 dmax=8.39 emin=26.24 me=PBh ve=PBh ma=PBh ju=PBh sa=PBh su=Rev mo=PBh
03.03.-1952 dmax=11.76 emin=23.63 me=PBh ve=PBh ma=PBh ju=PBh sa=PBh su=Rev mo=UBh
04.03.-1952 dmax=24.06 emin=12.09 me=PBh ve=PBh ma=PBh ju=PBh sa=PBh su=Rev mo=UBh

24.07.-1914 dmax=58.04 emin=17.75 me=Āśl ve=Āśl ma=Āśl ju=Mṛg sa=Pun su=PPh mo=Mṛg
25.07.-1914 dmax=59.22 emin=17.42 me=Āśl ve=Āśl ma=Āśl ju=Mṛg sa=Pun su=PPh mo=Ārd
26.07.-1914 dmax=60.50 emin=16.99 me=Āśl ve=Āśl ma=Āśl ju=Mṛg sa=Pun su=PPh mo=Pun
27.07.-1914 dmax=61.85 emin=16.49 me=Mag ve=Āśl ma=Āśl ju=Mṛg sa=Pun su=PPh mo=Pun
28.07.-1914 dmax=63.29 emin=15.91 me=Mag ve=Āśl ma=Āśl ju=Mṛg sa=Pun su=PPh mo=Puṣ
29.07.-1914 dmax=64.80 emin=15.26 me=Mag ve=Āśl ma=Āśl ju=Mṛg sa=Pun su=PPh mo=Āśl
30.07.-1914 dmax=71.34 emin=9.59 me=Mag ve=Āśl ma=Āśl ju=Mṛg sa=Pun su=PPh mo=Mag

14.11.-1908 dmax=63.14 emin=15.02 me=Anu ve=Anu ma=Anu ju=Jye sa=Has su=Mūl mo=Has
15.11.-1908 dmax=63.31 emin=15.82 me=Anu ve=Anu ma=Jye ju=Jye sa=Has su=Mūl mo=Cit
16.11.-1908 dmax=63.49 emin=16.62 me=Jye ve=Anu ma=Jye ju=Jye sa=Has su=Mūl mo=Svā
17.11.-1908 dmax=63.66 emin=17.42 me=Jye ve=Anu ma=Jye ju=Jye sa=Has su=Mūl mo=Anu
18.11.-1908 dmax=63.84 emin=18.22 me=Jye ve=Anu ma=Jye ju=Jye sa=Has su=Mūl mo=Jye
19.11.-1908 dmax=75.69 emin=7.34 me=Jye ve=Anu ma=Jye ju=Jye sa=Has su=Mūl mo=Mūl

11.01.-1896 dmax=68.26 emin=17.43 me=Śra ve=UĀṣ ma=Anu ju=Anu sa=Śra su=Dha mo=Anu
12.01.-1896 dmax=68.28 emin=18.32 me=Śra ve=UĀṣ ma=Jye ju=Anu sa=Śra su=Dha mo=Jye
13.01.-1896 dmax=68.30 emin=19.21 me=Śra ve=UĀṣ ma=Jye ju=Anu sa=Śra su=Śat mo=Mūl
14.01.-1896 dmax=68.33 emin=20.10 me=Śra ve=UĀṣ ma=Jye ju=Anu sa=Śra su=Śat mo=PĀṣ
15.01.-1896 dmax=68.36 emin=20.99 me=Śra ve=UĀṣ ma=Jye ju=Anu sa=Śra su=Śat mo=UĀṣ

26.09.-1852 dmax=46.87 emin=18.06 me=Cit ve=UPh ma=PPh ju=PPh sa=Mag su=Svā mo=Mag
27.09.-1852 dmax=48.15 emin=17.72 me=Cit ve=Has ma=PPh ju=PPh sa=Mag su=Svā mo=PPh
28.09.-1852 dmax=49.48 emin=17.33 me=Cit ve=Has ma=PPh ju=PPh sa=Mag su=Svā mo=UPh
29.09.-1852 dmax=50.83 emin=16.91 me=Cit ve=Has ma=PPh ju=PPh sa=Mag su=Viś mo=Has
30.09.-1852 dmax=52.23 emin=16.46 me=Cit ve=Has ma=PPh ju=PPh sa=Mag su=Viś mo=Cit
01.10.-1852 dmax=54.88 emin=14.75 me=Cit ve=Has ma=PPh ju=PPh sa=Mag su=Viś mo=Svā

03.01.-1811 dmax=32.92 emin=11.83 me=UĀṣ ve=Śra ma=UĀṣ ju=UĀṣ sa=Mūl su=Dha mo=PĀṣ
04.01.-1811 dmax=34.07 emin=11.59 me=UĀṣ ve=Śra ma=UĀṣ ju=UĀṣ sa=Mūl su=Dha mo=UĀṣ
05.01.-1811 dmax=35.23 emin=11.35 me=UĀṣ ve=Śra ma=UĀṣ ju=UĀṣ sa=Mūl su=Dha mo=Śra

14.11.-1756 dmax=50.59 emin=19.34 me=Anu ve=Jye ma=Cit ju=Cit sa=Anu su=Mūl mo=Cit
15.11.-1756 dmax=51.72 emin=19.10 me=Jye ve=Jye ma=Cit ju=Cit sa=Anu su=Mūl mo=Svā
16.11.-1756 dmax=52.85 emin=18.87 me=Jye ve=Jye ma=Cit ju=Cit sa=Anu su=Mūl mo=Viś
17.11.-1756 dmax=53.98 emin=18.63 me=Jye ve=Jye ma=Cit ju=Cit sa=Anu su=Mūl mo=Anu
18.11.-1756 dmax=55.11 emin=18.40 me=Jye ve=Jye ma=Cit ju=Cit sa=Anu su=Mūl mo=Jye

28.07.-1711 dmax=76.40 emin=13.06 me=Mag ve=Āśl ma=Puṣ ju=Puṣ sa=Roh su=PPh mo=Roh

06.11.-1579 dmax=71.16 emin=15.47 me=Anu ve=Svā ma=Viś ju=UPh sa=Anu su=Jye mo=UPh
07.11.-1579 dmax=71.19 emin=16.38 me=Anu ve=Svā ma=Viś ju=UPh sa=Anu su=Jye mo=Has
08.11.-1579 dmax=71.22 emin=17.29 me=Anu ve=Svā ma=Viś ju=UPh sa=Anu su=Jye mo=Cit
09.11.-1579 dmax=71.25 emin=18.20 me=Anu ve=Svā ma=Viś ju=UPh sa=Anu su=Jye mo=Svā

17.05.-1476 dmax=24.66 emin=21.88 me=Roh ve=Bha ma=Roh ju=Bha sa=Kṛt su=Mṛg mo=Bha
18.05.-1476 dmax=25.65 emin=21.64 me=Roh ve=Bha ma=Roh ju=Bha sa=Kṛt su=Ārd mo=Kṛt
19.05.-1476 dmax=26.72 emin=21.33 me=Roh ve=Kṛt ma=Roh ju=Bha sa=Kṛt su=Ārd mo=Roh
20.05.-1476 dmax=38.67 emin=10.14 me=Roh ve=Kṛt ma=Roh ju=Bha sa=Kṛt su=Ārd mo=Mṛg

20.07.-1414 dmax=33.80 emin=18.25 me=Āśl ve=Pun ma=Ārd ju=Puṣ sa=Ārd su=Mag mo=Ārd
21.07.-1414 dmax=34.22 emin=18.17 me=Āśl ve=Pun ma=Ārd ju=Puṣ sa=Ārd su=Mag mo=Puṣ
22.07.-1414 dmax=34.76 emin=17.98 me=Āśl ve=Pun ma=Ārd ju=Puṣ sa=Ārd su=Mag mo=Āśl

12.12.-1376 dmax=59.79 emin=22.03 me=Mūl ve=Anu ma=Viś ju=Svā sa=Svā su=UĀṣ mo=Svā
13.12.-1376 dmax=61.00 emin=21.73 me=Mūl ve=Anu ma=Viś ju=Svā sa=Svā su=UĀṣ mo=Viś
14.12.-1376 dmax=62.24 emin=21.41 me=Mūl ve=Jye ma=Viś ju=Svā sa=Svā su=UĀṣ mo=Anu
15.12.-1376 dmax=63.52 emin=21.06 me=PĀṣ ve=Jye ma=Viś ju=Svā sa=Svā su=UĀṣ mo=Jye
16.12.-1376 dmax=64.80 emin=20.70 me=PĀṣ ve=Jye ma=Viś ju=Svā sa=Svā su=UĀṣ mo=PĀṣ
17.12.-1376 dmax=77.68 emin=8.75 me=PĀṣ ve=Jye ma=Viś ju=Svā sa=Svā su=UĀṣ mo=UĀṣ

23.11.-1374 dmax=30.12 emin=11.67 me=Mūl ve=Jye ma=Viś ju=Jye sa=Viś su=Mūl mo=Viś
24.11.-1374 dmax=31.08 emin=11.16 me=Mūl ve=Jye ma=Viś ju=Jye sa=Viś su=PĀṣ mo=Anu

12.08.-1297 dmax=65.30 emin=17.90 me=Mag ve=Mag ma=Mag ju=Mṛg sa=Ārd su=UPh mo=Ārd
13.08.-1297 dmax=66.19 emin=17.88 me=Mag ve=Mag ma=Mag ju=Mṛg sa=Ārd su=UPh mo=Ārd
14.08.-1297 dmax=67.22 emin=17.74 me=Mag ve=Mag ma=Mag ju=Mṛg sa=Ārd su=UPh mo=Pun
15.08.-1297 dmax=68.35 emin=17.49 me=PPh ve=Mag ma=Mag ju=Mṛg sa=Ārd su=UPh mo=Puṣ
16.08.-1297 dmax=69.58 emin=17.15 me=PPh ve=Mag ma=Mag ju=Mṛg sa=Ārd su=UPh mo=Āśl
17.08.-1297 dmax=70.89 emin=16.73 me=PPh ve=Mag ma=Mag ju=Mṛg sa=Ārd su=UPh mo=Mag
18.08.-1297 dmax=76.76 emin=11.76 me=PPh ve=Mag ma=PPh ju=Mṛg sa=Ārd su=UPh mo=PPh

03.01.-1279 dmax=53.49 emin=17.25 me=UĀṣ ve=Mūl ma=Jye ju=Anu sa=UĀṣ su=Dha mo=UĀṣ
04.01.-1279 dmax=63.39 emin=8.23 me=UĀṣ ve=Mūl ma=Jye ju=Anu sa=UĀṣ su=Dha mo=Śra

*18.11.-1197 dmax=18.69 emin=14.74 me=Anu ve=Anu ma=Jye ju=Anu sa=Viś su=Mūl mo=Anu*
*19.11.-1197 dmax=22.10 emin=12.25 me=Jye ve=Anu ma=Jye ju=Anu sa=Viś su=Mūl mo=Jye*

02.12.-1139 dmax=54.06 emin=22.90 me=Jye ve=Jye ma=Viś ju=Cit sa=Viś su=PĀṣ mo=Svā
03.12.-1139 dmax=55.10 emin=22.77 me=Jye ve=Jye ma=Viś ju=Cit sa=Viś su=PĀṣ mo=Viś
04.12.-1139 dmax=56.18 emin=22.60 me=Jye ve=Jye ma=Viś ju=Cit sa=Viś su=PĀṣ mo=Anu
05.12.-1139 dmax=57.29 emin=22.40 me=Mūl ve=Mūl ma=Viś ju=Cit sa=Viś su=PĀṣ mo=Jye
06.12.-1139 dmax=61.93 emin=18.67 me=Mūl ve=Mūl ma=Viś ju=Cit sa=Viś su=PĀṣ mo=Mūl

31.07.-1000 dmax=41.62 emin=16.74 me=Āśl ve=Pun ma=Puṣ ju=Ārd sa=Puṣ su=PPh mo=Ārd
01.08.-1000 dmax=42.98 emin=16.19 me=Āśl ve=Pun ma=Puṣ ju=Ārd sa=Puṣ su=PPh mo=Pun
02.08.-1000 dmax=44.41 emin=15.57 me=Mag ve=Puṣ ma=Puṣ ju=Ārd sa=Puṣ su=PPh mo=Āśl
03.08.-1000 dmax=45.91 emin=14.88 me=Mag ve=Puṣ ma=Puṣ ju=Ārd sa=Puṣ su=PPh mo=Mag

06.10.-998 dmax=64.02 emin=8.14 me=Cit ve=Svā ma=UPh ju=PPh sa=Mag su=Viś mo=PPh
07.10.-998 dmax=65.21 emin=7.89 me=Cit ve=Svā ma=UPh ju=PPh sa=Mag su=Viś mo=UPh
08.10.-998 dmax=66.41 emin=7.64 me=Cit ve=Svā ma=UPh ju=PPh sa=Mag su=Viś mo=Has
09.10.-998 dmax=67.61 emin=7.39 me=Cit ve=Svā ma=Has ju=PPh sa=Mag su=Viś mo=Cit
10.10.-998 dmax=68.81 emin=7.14 me=Cit ve=Svā ma=Has ju=PPh sa=Mag su=Viś mo=Svā

06.02.-897 dmax=44.28 emin=16.45 me=Śat ve=Śra ma=Śra ju=Dha sa=PĀṣ su=PBh mo=PĀṣ

18.11.-842 dmax=56.50 emin=16.38 me=Anu ve=Svā ma=Has ju=Svā sa=Jye su=Mūl mo=Has
19.11.-842 dmax=56.06 emin=17.29 me=Anu ve=Svā ma=Has ju=Svā sa=Jye su=Mūl mo=Cit
20.11.-842 dmax=55.63 emin=18.20 me=Anu ve=Svā ma=Has ju=Svā sa=Jye su=Mūl mo=Svā
21.11.-842 dmax=55.19 emin=19.11 me=Jye ve=Viś ma=Has ju=Svā sa=Jye su=Mūl mo=Viś
22.11.-842 dmax=55.59 emin=19.19 me=Jye ve=Viś ma=Has ju=Svā sa=Jye su=Mūl mo=Anu
23.11.-842 dmax=56.58 emin=18.68 me=Jye ve=Viś ma=Cit ju=Svā sa=Jye su=Mūl mo=Jye

05.08.-797 dmax=64.54 emin=15.73 me=Mag ve=Puṣ ma=Pun ju=Āśl sa=Mṛg su=PPh mo=Mṛg
06.08.-797 dmax=64.73 emin=16.46 me=Mag ve=Puṣ ma=Pun ju=Āśl sa=Mṛg su=PPh mo=Pun
07.08.-797 dmax=65.09 emin=17.03 me=Mag ve=Puṣ ma=Puṣ ju=Āśl sa=Mṛg su=PPh mo=Puṣ
08.08.-797 dmax=65.58 emin=17.46 me=Mag ve=Puṣ ma=Puṣ ju=Āśl sa=Mṛg su=PPh mo=Āśl
09.08.-797 dmax=66.22 emin=17.75 me=Mag ve=Puṣ ma=Puṣ ju=Āśl sa=Mṛg su=PPh mo=Mag

10.12.-757 dmax=53.68 emin=16.41 me=Mūl ve=Jye ma=Jye ju=Mūl sa=Svā su=PĀṣ mo=Svā
11.12.-757 dmax=55.09 emin=15.95 me=Mūl ve=Jye ma=Jye ju=Mūl sa=Svā su=PĀṣ mo=Anu
12.12.-757 dmax=56.52 emin=15.48 me=Mūl ve=Jye ma=Jye ju=Mūl sa=Svā su=UĀṣ mo=Jye
13.12.-757 dmax=57.96 emin=15.00 me=PĀṣ ve=Jye ma=Jye ju=Mūl sa=Svā su=UĀṣ mo=Mūl
14.12.-757 dmax=62.90 emin=11.03 me=PĀṣ ve=Mūl ma=Jye ju=Mūl sa=Svā su=UĀṣ mo=PĀṣ

23.09.-701 dmax=36.54 emin=18.42 me=Has ve=PPh ma=Mag ju=UPh sa=UPh su=Cit mo=PPh
24.09.-701 dmax=36.91 emin=18.47 me=Has ve=PPh ma=Mag ju=UPh sa=UPh su=Svā mo=UPh
25.09.-701 dmax=37.38 emin=18.41 me=Has ve=PPh ma=Mag ju=UPh sa=UPh su=Svā mo=UPh
26.09.-701 dmax=38.46 emin=17.75 me=Has ve=UPh ma=Mag ju=UPh sa=UPh su=Svā mo=Has
27.09.-701 dmax=49.71 emin=6.91 me=Has ve=UPh ma=Mag ju=UPh sa=UPh su=Svā mo=Cit

<u>29.01.-660 dmax=25.92 emin=10.92 me=Dha ve=Dha ma=UĀṣ ju=Śra sa=UĀṣ su=Śat mo=Śra</u>
<u>30.01.-660 dmax=27.05 emin=10.67 me=Dha ve=Dha ma=UĀṣ ju=Śra sa=UĀṣ su=Śat mo=Dha</u>

26.07.-560 dmax=42.79 emin=8.99 me=Āśl ve=Puṣ ma=Pun ju=Puṣ sa=Ārd su=Mag mo=Ārd
27.07.-560 dmax=42.18 emin=10.47 me=Āśl ve=Puṣ ma=Pun ju=Puṣ sa=Ārd su=Mag mo=Pun
28.07.-560 dmax=41.68 emin=11.84 me=Āśl ve=Puṣ ma=Pun ju=Puṣ sa=Ārd su=Mag mo=Puṣ
29.07.-560 dmax=41.32 emin=13.07 me=Āśl ve=Puṣ ma=Pun ju=Puṣ sa=Ārd su=Mag mo=Āśl
30.07.-560 dmax=47.15 emin=8.12 me=Āśl ve=Puṣ ma=Pun ju=Puṣ sa=Ārd su=Mag mo=Mag

19.12.-522 dmax=59.78 emin=24.16 me=Mūl ve=Mūl ma=Anu ju=Svā sa=Svā su=UĀṣ mo=Svā
20.12.-522 dmax=60.57 emin=24.34 me=Mūl ve=Mūl ma=Anu ju=Svā sa=Svā su=UĀṣ mo=Viś
21.12.-522 dmax=61.44 emin=24.45 me=Mūl ve=Mūl ma=Anu ju=Svā sa=Svā su=UĀṣ mo=Anu
22.12.-522 dmax=62.36 emin=24.51 me=Mūl ve=Mūl ma=Anu ju=Svā sa=Svā su=UĀṣ mo=Jye
23.12.-522 dmax=63.34 emin=24.52 me=Mūl ve=Mūl ma=Anu ju=Svā sa=Svā su=UĀṣ mo=Mūl
24.12.-522 dmax=65.06 emin=23.78 me=PĀṣ ve=Mūl ma=Jye ju=Svā sa=Svā su=UĀṣ mo=PĀṣ
25.12.-522 dmax=76.95 emin=12.87 me=PĀṣ ve=Mūl ma=Jye ju=Svā sa=Svā su=UĀṣ mo=PĀṣ

<u>25.03.-421 dmax=28.80 emin=19.66 me=UBh ve=Rev ma=UBh ju=Rev sa=Śat su=Aśv mo=PBh</u>
<u>26.03.-421 dmax=28.39 emin=20.94 me=UBh ve=Rev ma=UBh ju=Rev sa=Śat su=Aśv mo=UBh</u>
<u>27.03.-421 dmax=28.04 emin=22.17 me=UBh ve=Rev ma=UBh ju=Rev sa=Śat su=Aśv mo=Rev</u>

17.08.-383 dmax=49.58 emin=17.90 me=Mag ve=Āśl ma=Mag ju=Pun sa=Pun su=UPh mo=Pun
18.08.-383 dmax=50.59 emin=17.80 me=Mag ve=Āśl ma=Mag ju=Pun sa=Pun su=UPh mo=Puṣ
19.08.-383 dmax=51.70 emin=17.59 me=Mag ve=Āśl ma=Mag ju=Pun sa=Pun su=UPh mo=Āśl
20.08.-383 dmax=52.91 emin=17.29 me=Mag ve=Āśl ma=Mag ju=Pun sa=Pun su=UPh mo=Āśl
21.08.-383 dmax=54.22 emin=16.89 me=PPh ve=Āśl ma=Mag ju=Pun sa=Pun su=UPh mo=Mag
22.08.-383 dmax=62.76 emin=9.26 me=PPh ve=Āśl ma=Mag ju=Pun sa=Pun su=UPh mo=PPh

04.10.-287 dmax=55.87 emin=17.85 me=Cit ve=UPh ma=Has ju=Mag sa=Cit su=Svā mo=Mag
05.10.-287 dmax=57.11 emin=17.50 me=Cit ve=UPh ma=Has ju=Mag sa=Cit su=Svā mo=PPh
06.10.-287 dmax=58.38 emin=17.11 me=Cit ve=UPh ma=Has ju=Mag sa=Cit su=Svā mo=UPh
07.10.-287 dmax=59.71 emin=16.67 me=Cit ve=UPh ma=Has ju=Mag sa=Cit su=Svā mo=UPh
08.10.-287 dmax=61.08 emin=16.20 me=Cit ve=UPh ma=Has ju=Mag sa=Cit su=Svā mo=Has
09.10.-287 dmax=62.79 emin=15.38 me=Cit ve=UPh ma=Has ju=Mag sa=Cit su=Svā mo=Cit

25.01.-280 dmax=48.96 emin=12.45 me=Śra ve=PĀṣ ma=Śra ju=Dha sa=Mūl su=Śat mo=Mūl
26.01.-280 dmax=49.12 emin=13.22 me=Śra ve=PĀṣ ma=Śra ju=Dha sa=Mūl su=Śat mo=PĀṣ
27.01.-280 dmax=49.29 emin=13.99 me=Śra ve=PĀṣ ma=Śra ju=Dha sa=Mūl su=Śat mo=UĀṣ
28.01.-280 dmax=49.45 emin=14.76 me=Śra ve=PĀṣ ma=Śra ju=Dha sa=Mūl su=Śat mo=Śra
29.01.-280 dmax=51.02 emin=14.12 me=Śra ve=PĀṣ ma=Śra ju=Dha sa=Mūl su=Śat mo=Dha

22.02.-280 dmax=66.61 emin=21.18 me=Śat ve=Śra ma=Dha ju=Dha sa=Mūl su=UBh mo=PĀṣ
23.02.-280 dmax=68.14 emin=20.60 me=Śat ve=Śra ma=Dha ju=Dha sa=Mūl su=UBh mo=UĀṣ
24.02.-280 dmax=69.70 emin=20.00 me=Śat ve=Dha ma=Śat ju=Dha sa=Mūl su=UBh mo=Śra

08.12.-225 dmax=44.58 emin=22.54 me=Jye ve=Anu ma=Svā ju=Viś sa=Viś su=PĀṣ mo=Svā
09.12.-225 dmax=45.17 emin=22.38 me=Jye ve=Anu ma=Svā ju=Viś sa=Anu su=PĀṣ mo=Viś
10.12.-225 dmax=45.80 emin=22.18 me=Jye ve=Anu ma=Svā ju=Viś sa=Anu su=PĀṣ mo=Anu
11.12.-225 dmax=46.44 emin=21.96 me=Mūl ve=Anu ma=Svā ju=Viś sa=Anu su=PĀṣ mo=Jye
12.12.-225 dmax=50.49 emin=18.34 me=Mūl ve=Anu ma=Svā ju=Viś sa=Anu su=PĀṣ mo=Mūl

11.02.-222 dmax=75.98 emin=11.39 me=Dha ve=Śat ma=Mūl ju=PĀṣ sa=Jye su=PBh mo=Mūl
12.02.-222 dmax=77.19 emin=11.14 me=Dha ve=Śat ma=Mūl ju=PĀṣ sa=Jye su=PBh mo=PĀṣ
13.02.-222 dmax=78.40 emin=10.90 me=Dha ve=Śat ma=Mūl ju=PĀṣ sa=Jye su=PBh mo=UĀṣ

<u>15.03.-184 dmax=16.52 emin=19.27 me=PBh ve=PBh ma=PBh ju=UBh sa=PBh su=Rev mo=Śat</u>
<u>16.03.-184 dmax=15.56 emin=20.02 me=PBh ve=PBh ma=UBh ju=UBh sa=PBh su=Rev mo=PBh</u>
<u>17.03.-184 dmax=16.71 emin=18.65 me=PBh ve=PBh ma=UBh ju=UBh sa=PBh su=Rev mo=UBh</u>
<u>18.03.-184 dmax=27.50 emin=7.65 me=UBh ve=PBh ma=UBh ju=UBh sa=PBh su=Aśv mo=Rev</u>

08.08.-146 dmax=45.28 emin=15.89 me=Mag ve=Puṣ ma=Āśl ju=Ārd sa=Puṣ su=PPh mo=Ārd
09.08.-146 dmax=45.39 emin=16.59 me=Mag ve=Puṣ ma=Āśl ju=Ārd sa=Puṣ su=PPh mo=Pun
10.08.-146 dmax=45.66 emin=17.14 me=Mag ve=Āśl ma=Āśl ju=Ārd sa=Puṣ su=PPh mo=Puṣ
11.08.-146 dmax=46.07 emin=17.54 me=Mag ve=Āśl ma=Āśl ju=Ārd sa=Puṣ su=PPh mo=Āśl
12.08.-146 dmax=47.55 emin=16.89 me=Mag ve=Āśl ma=Āśl ju=Ārd sa=Puṣ su=PPh mo=Mag

15.06.-122 dmax=53.44 emin=12.54 me=Ārd ve=Roh ma=Kṛt ju=Ārd sa=Bha su=Pun mo=Bha
16.06.-122 dmax=53.59 emin=13.27 me=Ārd ve=Roh ma=Kṛt ju=Ārd sa=Bha su=Pun mo=Kṛt
17.06.-122 dmax=54.90 emin=12.84 me=Ārd ve=Roh ma=Kṛt ju=Ārd sa=Bha su=Pun mo=Roh
18.06.-122 dmax=56.80 emin=11.82 me=Ārd ve=Roh ma=Kṛt ju=Ārd sa=Bha su=Pun mo=Mṛg
19.06.-122 dmax=58.74 emin=10.76 me=Ārd ve=Roh ma=Kṛt ju=Ārd sa=Bha su=Pun mo=Ārd

11.10.-84 dmax=43.62 emin=18.31 me=Cit ve=UPh ma=UPh ju=UPh sa=PPh su=Viś mo=PPh
12.10.-84 dmax=44.15 emin=18.71 me=Cit ve=UPh ma=UPh ju=UPh sa=PPh su=Viś mo=UPh
13.10.-84 dmax=44.81 emin=18.98 me=Cit ve=UPh ma=UPh ju=UPh sa=PPh su=Viś mo=Has
14.10.-84 dmax=45.60 emin=19.13 me=Cit ve=UPh ma=UPh ju=UPh sa=PPh su=Viś mo=Cit
15.10.-84 dmax=58.03 emin=7.63 me=Cit ve=Has ma=UPh ju=UPh sa=PPh su=Viś mo=Svā

17.01.-43 dmax=28.04 emin=11.85 me=UĀṣ ve=UĀṣ ma=UĀṣ ju=Śra sa=PĀṣ su=Dha mo=UĀṣ
18.01.-43 dmax=28.17 emin=12.63 me=UĀṣ ve=UĀṣ ma=UĀṣ ju=Śra sa=PĀṣ su=Dha mo=Śra

13.02.-43 dmax=48.89 emin=15.75 me=Dha ve=Śat ma=Dha ju=Dha sa=PĀṣ su=PBh mo=UĀṣ
14.02.-43 dmax=50.07 emin=15.50 me=Dha ve=Śat ma=Dha ju=Dha sa=PĀṣ su=PBh mo=UĀṣ
15.02.-43 dmax=51.23 emin=15.26 me=Dha ve=Śat ma=Dha ju=Dha sa=PĀṣ su=PBh mo=Śra
16.02.-43 dmax=52.41 emin=15.01 me=Śat ve=Śat ma=Dha ju=Dha sa=PĀṣ su=PBh mo=Dha
17.02.-43 dmax=53.58 emin=14.77 me=Śat ve=Śat ma=Dha ju=Dha sa=PĀṣ su=PBh mo=Śat

06.08.-26 dmax=54.29 emin=5.23 me=Mag ve=Āśl ma=Ārd ju=Āśl sa=Mag su=PPh mo=Mag

# F: All Planets Near the Moon in the Evening Sky

This list shows clusters of planets around the new moon crescent that were visible in the evening sky between 3500 BCE and 1 BCE.

Very good visibility is assumed (extinction coefficient 0.15).

Data provided:
- date with astronomical year count;
- distribution range of the planets in degrees (*dmax*);
- minimum elongation (*emin*);
- positions of the celestial bodies in the lunar mansions (Lahiri).

Clusters with smallest possible *dmax* and greatest possible *emin* are most eye-catching. The most spectacular clusters are underlined.

The rare clusterings that are immediately followed by super-conjunctions are listed in italics.

09.05.-3499 dmax=74.07 emin=15.26 me=Pun ve=Āśl ma=Mag ju=Has sa=UPh su=Ārd mo=Puṣ
10.05.-3499 dmax=72.31 emin=16.15 me=Pun ve=Āśl ma=Mag ju=Has sa=UPh su=Ārd mo=Āśl
11.05.-3499 dmax=70.58 emin=17.01 me=Pun ve=Āśl ma=Mag ju=Has sa=UPh su=Ārd mo=Mag
12.05.-3499 dmax=68.90 emin=17.83 me=Pun ve=Āśl ma=Mag ju=Has sa=UPh su=Ārd mo=PPh

06.06.-3499 dmax=49.29 emin=16.51 me=Mag ve=PPh ma=PPh ju=Has sa=UPh su=Puṣ mo=Āśl
07.06.-3499 dmax=38.28 emin=26.71 me=Mag ve=PPh ma=PPh ju=Has sa=UPh su=Puṣ mo=Mag
08.06.-3499 dmax=37.73 emin=26.45 me=Mag ve=PPh ma=PPh ju=Has sa=UPh su=Puṣ mo=PPh
09.06.-3499 dmax=37.24 emin=26.13 me=Mag ve=PPh ma=PPh ju=Has sa=UPh su=Puṣ mo=UPh
10.06.-3499 dmax=36.82 emin=25.74 me=Mag ve=PPh ma=PPh ju=Has sa=UPh su=Puṣ mo=Has

21.03.-3443 dmax=69.66 emin=18.86 me=Roh ve=Mṛg ma=Roh ju=Mṛg sa=Āśl su=Bha mo=Roh
22.03.-3443 dmax=68.09 emin=19.51 me=Roh ve=Mṛg ma=Roh ju=Mṛg sa=Āśl su=Bha mo=Ārd
23.03.-3443 dmax=66.58 emin=20.10 me=Roh ve=Mṛg ma=Roh ju=Mṛg sa=Āśl su=Bha mo=Pun
24.03.-3443 dmax=65.12 emin=20.64 me=Roh ve=Mṛg ma=Roh ju=Mṛg sa=Āśl su=Kṛt mo=Puṣ
25.03.-3443 dmax=63.73 emin=21.12 me=Roh ve=Mṛg ma=Roh ju=Mṛg sa=Āśl su=Kṛt mo=Āśl

09.04.-3358 dmax=65.34 emin=13.32 me=Mṛg ve=Pun ma=Puṣ ju=Mag sa=Ārd su=Roh mo=Mṛg
10.04.-3358 dmax=54.24 emin=23.57 me=Mṛg ve=Pun ma=Puṣ ju=Mag sa=Ārd su=Roh mo=Ārd
11.04.-3358 dmax=53.36 emin=23.61 me=Ārd ve=Pun ma=Puṣ ju=Mag sa=Ārd su=Roh mo=Ārd
12.04.-3358 dmax=52.55 emin=23.59 me=Ārd ve=Pun ma=Puṣ ju=Mag sa=Ārd su=Roh mo=Pun
13.04.-3358 dmax=51.79 emin=23.51 me=Ārd ve=Pun ma=Puṣ ju=Mag sa=Ārd su=Roh mo=Puṣ
14.04.-3358 dmax=51.10 emin=23.37 me=Ārd ve=Pun ma=Puṣ ju=Mag sa=Ārd su=Roh mo=Āśl

08.08.-3320 dmax=52.08 emin=15.09 me=Cit ve=Viś ma=Anu ju=Viś sa=Cit su=UPh mo=Viś
09.08.-3320 dmax=51.26 emin=15.64 me=Cit ve=Viś ma=Anu ju=Viś sa=Cit su=UPh mo=Anu

22.01.-3302 dmax=51.75 emin=7.21 me=UBh ve=Aśv ma=Aśv ju=Bha sa=Bha su=PBh mo=UBh
23.01.-3302 dmax=49.85 emin=8.21 me=UBh ve=Aśv ma=Aśv ju=Bha sa=Bha su=PBh mo=Aśv
24.01.-3302 dmax=47.95 emin=9.21 me=UBh ve=Aśv ma=Aśv ju=Bha sa=Bha su=PBh mo=Bha
25.01.-3302 dmax=46.08 emin=10.19 me=UBh ve=Aśv ma=Aśv ju=Bha sa=Bha su=PBh mo=Kṛt

06.12.-3220 dmax=71.86 emin=17.56 me=Dha ve=Dha ma=Aśv ju=Aśv sa=Śat su=UĀṣ mo=Dha
07.12.-3220 dmax=71.54 emin=16.96 me=Dha ve=Dha ma=Aśv ju=Aśv sa=Śat su=Śra mo=Śat
08.12.-3220 dmax=71.39 emin=16.18 me=Dha ve=Dha ma=Aśv ju=Aśv sa=Śat su=Śra mo=PBh
09.12.-3220 dmax=71.44 emin=15.22 me=Dha ve=Dha ma=Aśv ju=Aśv sa=Śat su=Śra mo=UBh

29.05.-3202 dmax=75.54 emin=13.76 me=Āśl ve=Puṣ ma=Āśl ju=Cit sa=Cit su=Pun mo=Has

30.07.-3200 dmax=67.98 emin=21.44 me=Cit ve=Cit ma=Has ju=Jye sa=Viś su=UPh mo=Has
31.07.-3200 dmax=67.38 emin=21.14 me=Cit ve=Cit ma=Has ju=Jye sa=Viś su=UPh mo=Svā
01.08.-3200 dmax=66.78 emin=20.85 me=Cit ve=Cit ma=Has ju=Jye sa=Viś su=UPh mo=Viś
02.08.-3200 dmax=66.19 emin=20.55 me=Cit ve=Cit ma=Has ju=Jye sa=Viś su=UPh mo=Anu
03.08.-3200 dmax=65.60 emin=20.25 me=Cit ve=Cit ma=Has ju=Jye sa=Viś su=UPh mo=Jye

03.04.-3181 dmax=71.13 emin=14.83 me=Roh ve=Roh ma=Mag ju=Puṣ sa=Ārd su=Kṛt mo=Mṛg
04.04.-3181 dmax=69.71 emin=15.76 me=Roh ve=Mṛg ma=Mag ju=Puṣ sa=Ārd su=Kṛt mo=Mṛg
05.04.-3181 dmax=68.35 emin=16.64 me=Roh ve=Mṛg ma=Mag ju=Puṣ sa=Ārd su=Kṛt mo=Ārd
06.04.-3181 dmax=67.03 emin=17.48 me=Mṛg ve=Mṛg ma=Mag ju=Puṣ sa=Ārd su=Kṛt mo=Pun
07.04.-3181 dmax=65.76 emin=18.28 me=Mṛg ve=Mṛg ma=Mag ju=Puṣ sa=Ārd su=Kṛt mo=Puṣ
08.04.-3181 dmax=64.55 emin=19.02 me=Mṛg ve=Mṛg ma=Mag ju=Puṣ sa=Ārd su=Kṛt mo=Āśl

02.05.-3181 dmax=60.81 emin=12.45 me=Pun ve=Pun ma=PPh ju=Puṣ sa=Ārd su=Mṛg mo=Ārd
03.05.-3181 dmax=58.76 emin=14.10 me=Pun ve=Pun ma=PPh ju=Puṣ sa=Ārd su=Mṛg mo=Pun
04.05.-3181 dmax=59.19 emin=13.28 me=Pun ve=Pun ma=PPh ju=Puṣ sa=Ārd su=Mṛg mo=Puṣ
05.05.-3181 dmax=59.63 emin=12.45 me=Pun ve=Pun ma=PPh ju=Puṣ sa=Ārd su=Mṛg mo=Āśl

18.10.-3164 dmax=33.91 emin=12.77 me=Mūl ve=Mūl ma=PĀṣ ju=PĀṣ sa=UĀṣ su=Jye mo=Mūl
19.10.-3164 dmax=34.78 emin=10.98 me=Mūl ve=Mūl ma=PĀṣ ju=PĀṣ sa=UĀṣ su=Jye mo=PĀṣ
20.10.-3164 dmax=35.82 emin=9.01 me=Mūl ve=Mūl ma=PĀṣ ju=PĀṣ sa=UĀṣ su=Jye mo=UĀṣ

23.01.-3123 dmax=73.68 emin=14.78 me=UBh ve=Aśv ma=Roh ju=Roh sa=Mṛg su=PBh mo=UBh

21.04.-3123 dmax=29.70 emin=11.89 me=Mṛg ve=Pun ma=Puṣ ju=Mṛg sa=Mṛg su=Roh mo=Ārd

21.05.-3085 dmax=72.56 emin=15.26 me=Puṣ ve=Āśl ma=UPh ju=Mag sa=Has su=Ārd mo=Puṣ
22.05.-3085 dmax=66.84 emin=20.07 me=Puṣ ve=Āśl ma=UPh ju=Mag sa=Has su=Pun mo=Āśl
23.05.-3085 dmax=65.23 emin=20.76 me=Puṣ ve=Āśl ma=UPh ju=Mag sa=Has su=Pun mo=Mag
24.05.-3085 dmax=63.67 emin=21.41 me=Puṣ ve=Mag ma=UPh ju=Mag sa=Has su=Pun mo=PPh
25.05.-3085 dmax=62.13 emin=22.04 me=Puṣ ve=Mag ma=UPh ju=Mag sa=Has su=Pun mo=UPh
26.05.-3085 dmax=60.63 emin=22.63 me=Āśl ve=Mag ma=UPh ju=Mag sa=Has su=Pun mo=Has

20.06.-3085 dmax=44.87 emin=21.87 me=Mag ve=UPh ma=Cit ju=PPh sa=Has su=Āśl mo=Mag
21.06.-3085 dmax=42.62 emin=23.80 me=Mag ve=UPh ma=Cit ju=PPh sa=Has su=Āśl mo=PPh
22.06.-3085 dmax=43.04 emin=23.06 me=PPh ve=UPh ma=Cit ju=PPh sa=Has su=Āśl mo=UPh
23.06.-3085 dmax=43.55 emin=22.23 me=PPh ve=UPh ma=Cit ju=PPh sa=Has su=Āśl mo=Has

23.07.-3023 dmax=53.34 emin=17.23 me=UPh ve=Has ma=Svā ju=Viś sa=Viś su=PPh mo=UPh
24.07.-3023 dmax=51.88 emin=17.85 me=UPh ve=Has ma=Svā ju=Viś sa=Viś su=PPh mo=Has
25.07.-3023 dmax=50.48 emin=18.41 me=Has ve=Has ma=Svā ju=Viś sa=Viś su=PPh mo=Cit
26.07.-3023 dmax=49.10 emin=18.95 me=Has ve=Has ma=Svā ju=Viś sa=Viś su=PPh mo=Viś
27.07.-3023 dmax=47.75 emin=19.47 me=Has ve=Has ma=Svā ju=Viś sa=Viś su=PPh mo=Anu

21.08.-3023 dmax=34.75 emin=11.95 me=Svā ve=Svā ma=Viś ju=Anu sa=Viś su=Has mo=Cit
22.08.-3023 dmax=21.69 emin=24.20 me=Svā ve=Viś ma=Viś ju=Anu sa=Viś su=Has mo=Svā
23.08.-3023 dmax=21.30 emin=23.78 me=Svā ve=Viś ma=Viś ju=Anu sa=Viś su=Has mo=Viś

04.06.-2967 dmax=61.95 emin=14.73 me=Āśl ve=Āśl ma=Āśl ju=Āśl sa=Has su=Pun mo=Āśl
05.06.-2967 dmax=60.78 emin=15.00 me=Āśl ve=Āśl ma=Āśl ju=Āśl sa=Has su=Puṣ mo=Mag

22.04.-2944 dmax=64.22 emin=16.03 me=Ārd ve=Puṣ ma=Mag ju=Pun sa=Pun su=Roh mo=Ārd
23.04.-2944 dmax=56.76 emin=23.05 me=Ārd ve=Puṣ ma=Mag ju=Pun sa=Pun su=Roh mo=Pun
24.04.-2944 dmax=56.70 emin=22.68 me=Ārd ve=Puṣ ma=PPh ju=Pun sa=Pun su=Mṛg mo=Puṣ
25.04.-2944 dmax=56.71 emin=22.24 me=Ārd ve=Puṣ ma=PPh ju=Pun sa=Pun su=Mṛg mo=Puṣ
26.04.-2944 dmax=56.81 emin=21.72 me=Ārd ve=Puṣ ma=PPh ju=Pun sa=Pun su=Mṛg mo=Āśl
27.04.-2944 dmax=56.96 emin=21.14 me=Ārd ve=Puṣ ma=PPh ju=Pun sa=Pun su=Mṛg mo=PPh

08.10.-2927 dmax=51.78 emin=20.15 me=Jye ve=PĀṣ ma=PĀṣ ju=PĀṣ sa=Śra su=Anu mo=Jye
09.10.-2927 dmax=51.11 emin=19.86 me=Jye ve=PĀṣ ma=PĀṣ ju=PĀṣ sa=Śra su=Anu mo=Mūl
10.10.-2927 dmax=50.89 emin=19.13 me=Jye ve=PĀṣ ma=PĀṣ ju=PĀṣ sa=Śra su=Anu mo=PĀṣ
11.10.-2927 dmax=50.82 emin=18.25 me=Jye ve=PĀṣ ma=PĀṣ ju=PĀṣ sa=Śra su=Anu mo=UĀṣ
12.10.-2927 dmax=50.91 emin=17.20 me=Jye ve=UĀṣ ma=PĀṣ ju=PĀṣ sa=Śra su=Anu mo=Śra

04.02.-2888 dmax=58.53 emin=10.39 me=Rev ve=Bha ma=Kṛt ju=Rev sa=Roh su=UBh mo=Rev

26.05.-2882 dmax=73.28 emin=10.89 me=Puṣ ve=Āśl ma=PPh ju=Has sa=Mag su=Pun mo=Puṣ
27.05.-2882 dmax=71.45 emin=11.87 me=Puṣ ve=Mag ma=PPh ju=Has sa=Mag su=Pun mo=Āśl
28.05.-2882 dmax=69.64 emin=12.82 me=Puṣ ve=Mag ma=PPh ju=Has sa=Mag su=Pun mo=Mag
29.05.-2882 dmax=67.86 emin=13.75 me=Puṣ ve=Mag ma=PPh ju=Has sa=Mag su=Pun mo=PPh
30.05.-2882 dmax=66.11 emin=14.65 me=Puṣ ve=Mag ma=PPh ju=Has sa=Mag su=Pun mo=UPh
31.05.-2882 dmax=64.40 emin=15.51 me=Puṣ ve=Mag ma=PPh ju=Has sa=Mag su=Pun mo=Has

07.04.-2826 dmax=43.10 emin=11.56 me=Roh ve=Mṛg ma=Mṛg ju=Ārd sa=Pun su=Kṛt mo=Roh
08.04.-2826 dmax=37.15 emin=16.65 me=Mṛg ve=Mṛg ma=Mṛg ju=Ārd sa=Pun su=Kṛt mo=Mṛg
09.04.-2826 dmax=35.45 emin=17.49 me=Mṛg ve=Mṛg ma=Ārd ju=Ārd sa=Pun su=Kṛt mo=Ārd
10.04.-2826 dmax=33.79 emin=18.29 me=Mṛg ve=Ārd ma=Ārd ju=Ārd sa=Pun su=Kṛt mo=Pun

07.05.-2826 dmax=20.37 emin=14.41 me=Pun ve=Puṣ ma=Pun ju=Ārd sa=Puṣ su=Mṛg mo=Pun
08.05.-2826 dmax=21.33 emin=13.68 me=Pun ve=Puṣ ma=Pun ju=Ārd sa=Puṣ su=Mṛg mo=Puṣ
09.05.-2826 dmax=22.29 emin=12.95 me=Pun ve=Puṣ ma=Pun ju=Ārd sa=Puṣ su=Ārd mo=Puṣ

13.07.-2786 dmax=74.79 emin=13.15 me=PPh ve=Cit ma=Cit ju=Viś sa=Anu su=Mag mo=UPh
14.07.-2786 dmax=73.13 emin=13.87 me=PPh ve=Cit ma=Cit ju=Viś sa=Anu su=Mag mo=Has
15.07.-2786 dmax=71.49 emin=14.58 me=PPh ve=Cit ma=Cit ju=Viś sa=Anu su=Mag mo=Cit
16.07.-2786 dmax=69.87 emin=15.26 me=UPh ve=Cit ma=Cit ju=Viś sa=Anu su=Mag mo=Svā
17.07.-2786 dmax=68.27 emin=15.93 me=UPh ve=Cit ma=Cit ju=Viś sa=Anu su=Mag mo=Viś
18.07.-2786 dmax=66.70 emin=16.57 me=UPh ve=Cit ma=Cit ju=Viś sa=Anu su=PPh mo=Anu

11.08.-2786 dmax=45.52 emin=15.61 me=Cit ve=Svā ma=Viś ju=Viś sa=Anu su=UPh mo=Has
12.08.-2786 dmax=34.55 emin=25.67 me=Cit ve=Svā ma=Viś ju=Viś sa=Anu su=UPh mo=Svā
13.08.-2786 dmax=33.65 emin=25.65 me=Cit ve=Viś ma=Viś ju=Viś sa=Anu su=UPh mo=Viś
14.08.-2786 dmax=32.80 emin=25.59 me=Cit ve=Viś ma=Viś ju=Viś sa=Anu su=Has mo=Anu

11.02.-2685 dmax=37.49 emin=5.49 me=Rev ve=Bha ma=Bha ju=Bha sa=Aśv su=UBh mo=Bha

08.04.-2647 dmax=72.32 emin=11.52 me=Mṛg ve=Mṛg ma=Puṣ ju=Puṣ sa=Mag su=Kṛt mo=Roh
09.04.-2647 dmax=64.55 emin=18.38 me=Mṛg ve=Mṛg ma=Puṣ ju=Puṣ sa=Mag su=Kṛt mo=Mṛg
10.04.-2647 dmax=64.43 emin=17.59 me=Mṛg ve=Mṛg ma=Puṣ ju=Puṣ sa=Mag su=Kṛt mo=Ārd
11.04.-2647 dmax=64.38 emin=16.73 me=Mṛg ve=Mṛg ma=Puṣ ju=Puṣ sa=Mag su=Kṛt mo=Pun
12.04.-2647 dmax=64.42 emin=15.79 me=Mṛg ve=Mṛg ma=Puṣ ju=Puṣ sa=Mag su=Roh mo=Puṣ
13.04.-2647 dmax=64.53 emin=14.78 me=Mṛg ve=Mṛg ma=Puṣ ju=Puṣ sa=Mag su=Roh mo=Āśl

18.05.-2645 dmax=80.33 emin=5.48 me=Ārd ve=Pun ma=PPh ju=Has sa=PPh su=Ārd mo=Āśl
19.05.-2645 dmax=78.34 emin=6.61 me=Pun ve=Pun ma=PPh ju=Has sa=PPh su=Ārd mo=Mag
20.05.-2645 dmax=76.37 emin=7.72 me=Pun ve=Pun ma=PPh ju=Has sa=PPh su=Ārd mo=PPh
21.05.-2645 dmax=74.42 emin=8.81 me=Pun ve=Pun ma=PPh ju=Has sa=PPh su=Ārd mo=UPh

05.08.-2609 dmax=57.78 emin=20.11 me=Has ve=Has ma=Jye ju=Cit sa=Anu su=UPh mo=Has
06.08.-2609 dmax=57.02 emin=20.58 me=Has ve=Has ma=Jye ju=Cit sa=Anu su=UPh mo=Svā
07.08.-2609 dmax=56.27 emin=21.03 me=Has ve=Cit ma=Jye ju=Cit sa=Anu su=UPh mo=Viś
08.08.-2609 dmax=55.56 emin=21.45 me=Cit ve=Cit ma=Jye ju=Cit sa=Anu su=UPh mo=Anu
09.08.-2609 dmax=54.86 emin=21.86 me=Cit ve=Cit ma=Jye ju=Cit sa=Anu su=UPh mo=Jye

29.03.-2589 dmax=73.17 emin=9.47 me=Kṛt ve=Ārd ma=Mṛg ju=Mṛg sa=Āśl su=Bha mo=Roh
30.03.-2589 dmax=71.15 emin=10.58 me=Kṛt ve=Ārd ma=Mṛg ju=Mṛg sa=Āśl su=Kṛt mo=Mṛg
31.03.-2589 dmax=69.16 emin=11.66 me=Kṛt ve=Ārd ma=Mṛg ju=Mṛg sa=Āśl su=Kṛt mo=Mṛg
01.04.-2589 dmax=67.20 emin=12.71 me=Roh ve=Ārd ma=Mṛg ju=Mṛg sa=Āśl su=Kṛt mo=Ārd
02.04.-2589 dmax=65.29 emin=13.72 me=Roh ve=Ārd ma=Mṛg ju=Mṛg sa=Āśl su=Kṛt mo=Pun
03.04.-2589 dmax=63.41 emin=14.69 me=Roh ve=Ārd ma=Mṛg ju=Mṛg sa=Āśl su=Kṛt mo=Puṣ

27.04.-2589 dmax=48.15 emin=8.80 me=Ārd ve=Ārd ma=Ārd ju=Ārd sa=Āśl su=Mṛg mo=Mṛg
28.04.-2589 dmax=40.24 emin=15.84 me=Ārd ve=Ārd ma=Ārd ju=Ārd sa=Āśl su=Mṛg mo=Ārd
29.04.-2589 dmax=40.11 emin=15.11 me=Ārd ve=Ārd ma=Pun ju=Ārd sa=Āśl su=Mṛg mo=Pun
30.04.-2589 dmax=39.98 emin=14.38 me=Ārd ve=Ārd ma=Pun ju=Ārd sa=Āśl su=Mṛg mo=Puṣ
01.05.-2589 dmax=39.85 emin=13.65 me=Ārd ve=Ārd ma=Pun ju=Ārd sa=Āśl su=Mṛg mo=Āśl

11.06.-2585 dmax=76.19 emin=8.29 me=Mag ve=Puṣ ma=Mag ju=Cit sa=Has su=Puṣ mo=Āśl
12.06.-2585 dmax=75.05 emin=8.57 me=Mag ve=Puṣ ma=Mag ju=Cit sa=Has su=Puṣ mo=Mag
13.06.-2585 dmax=73.91 emin=8.85 me=Mag ve=Āśl ma=PPh ju=Cit sa=Has su=Puṣ mo=PPh
14.06.-2585 dmax=72.78 emin=9.13 me=Mag ve=Āśl ma=PPh ju=Cit sa=Has su=Puṣ mo=UPh
15.06.-2585 dmax=71.65 emin=9.40 me=Mag ve=Āśl ma=PPh ju=Cit sa=Has su=Puṣ mo=Has
16.06.-2585 dmax=70.52 emin=9.68 me=Mag ve=Āśl ma=PPh ju=Cit sa=Has su=Puṣ mo=Cit

16.08.-2583 dmax=71.08 emin=12.49 me=Cit ve=Viś ma=Svā ju=Mūl sa=Svā su=Has mo=Cit
17.08.-2583 dmax=60.10 emin=22.58 me=Cit ve=Viś ma=Svā ju=Mūl sa=Svā su=Has mo=Svā
18.08.-2583 dmax=58.90 emin=22.90 me=Cit ve=Viś ma=Svā ju=Mūl sa=Svā su=Has mo=Viś
19.08.-2583 dmax=57.71 emin=23.21 me=Svā ve=Viś ma=Svā ju=Mūl sa=Svā su=Has mo=Anu
20.08.-2583 dmax=57.16 emin=22.88 me=Svā ve=Viś ma=Svā ju=Mūl sa=Svā su=Has mo=Jye
21.08.-2583 dmax=57.17 emin=22.00 me=Svā ve=Viś ma=Svā ju=Mūl sa=Svā su=Has mo=Mūl

05.11.-2547 dmax=31.77 emin=11.50 me=PĀṣ ve=PĀṣ ma=Śra ju=UĀṣ sa=PĀṣ su=Mūl mo=PĀṣ
06.11.-2547 dmax=31.29 emin=11.73 me=PĀṣ ve=PĀṣ ma=Śra ju=UĀṣ sa=PĀṣ su=Mūl mo=UĀṣ

10.02.-2506 dmax=65.46 emin=17.51 me=Rev ve=Bha ma=Mṛg ju=Mṛg sa=Kṛt su=UBh mo=Rev
11.02.-2506 dmax=64.68 emin=17.79 me=Rev ve=Bha ma=Mṛg ju=Mṛg sa=Kṛt su=UBh mo=Aśv
12.02.-2506 dmax=64.70 emin=17.27 me=Rev ve=Bha ma=Mṛg ju=Mṛg sa=Kṛt su=UBh mo=Kṛt
13.02.-2506 dmax=64.86 emin=16.62 me=Rev ve=Bha ma=Mṛg ju=Mṛg sa=Kṛt su=UBh mo=Roh
14.02.-2506 dmax=65.12 emin=15.86 me=Aśv ve=Bha ma=Mṛg ju=Mṛg sa=Kṛt su=UBh mo=Mṛg

07.06.-2468 dmax=73.29 emin=13.66 me=Āśl ve=Mag ma=Cit ju=PPh sa=UPh su=Pun mo=Puṣ
08.06.-2468 dmax=69.45 emin=17.09 me=Āśl ve=Mag ma=Cit ju=PPh sa=UPh su=Puṣ mo=Mag
09.06.-2468 dmax=68.29 emin=17.86 me=Āśl ve=Mag ma=Cit ju=PPh sa=UPh su=Puṣ mo=PPh
10.06.-2468 dmax=67.14 emin=18.61 me=Āśl ve=Mag ma=Cit ju=PPh sa=UPh su=Puṣ mo=UPh
11.06.-2468 dmax=66.04 emin=19.32 me=Āśl ve=Mag ma=Cit ju=PPh sa=UPh su=Puṣ mo=Has
12.06.-2468 dmax=64.96 emin=20.01 me=Āśl ve=Mag ma=Cit ju=PPh sa=UPh su=Puṣ mo=Cit

23.12.-2451 dmax=53.32 emin=8.39 me=Dha ve=PBh ma=PBh ju=Śat sa=Rev su=Śra mo=Dha
24.12.-2451 dmax=53.00 emin=7.79 me=Dha ve=PBh ma=UBh ju=Śat sa=Rev su=Śra mo=Śat
25.12.-2451 dmax=54.00 emin=5.86 me=Dha ve=PBh ma=UBh ju=Śat sa=Rev su=Śra mo=PBh

23.08.-2372 dmax=62.55 emin=13.35 me=Svā ve=Viś ma=Mūl ju=Cit sa=Jye su=Has mo=Cit
24.08.-2372 dmax=63.04 emin=12.57 me=Svā ve=Viś ma=Mūl ju=Cit sa=Jye su=Has mo=Svā

*31.05.-2348 dmax=78.07 emin=11.75 me=Āśl ve=Mag ma=Mag ju=Cit sa=Cit su=Pun mo=Puṣ*
*01.06.-2348 dmax=65.88 emin=23.02 me=Āśl ve=Mag ma=Mag ju=Cit sa=Cit su=Pun mo=Āśl*
*02.06.-2348 dmax=61.15 emin=26.83 me=Āśl ve=Mag ma=Mag ju=Cit sa=Cit su=Pun mo=Mag*
*03.06.-2348 dmax=60.18 emin=26.88 me=Āśl ve=Mag ma=Mag ju=Cit sa=Cit su=Pun mo=PPh*
*04.06.-2348 dmax=59.26 emin=26.88 me=Āśl ve=Mag ma=Mag ju=Cit sa=Cit su=Pun mo=PPh*
*05.06.-2348 dmax=58.41 emin=26.82 me=Āśl ve=Mag ma=Mag ju=Cit sa=Cit su=Pun mo=UPh*

27.10.-2310 dmax=28.07 emin=20.29 me=Mūl ve=UĀṣ ma=Śra ju=PĀṣ sa=UĀṣ su=Jye mo=Mūl
28.10.-2310 dmax=27.88 emin=20.23 me=Mūl ve=UĀṣ ma=Śra ju=PĀṣ sa=UĀṣ su=Jye mo=PĀṣ
29.10.-2310 dmax=27.97 emin=19.89 me=PĀṣ ve=UĀṣ ma=Śra ju=PĀṣ sa=UĀṣ su=Jye mo=UĀṣ

04.02.-2269 dmax=83.20 emin=6.77 me=Rev ve=UBh ma=Mṛg ju=Roh sa=Roh su=PBh mo=Roh

13.06.-2265 dmax=69.95 emin=7.17 me=Puṣ ve=Mag ma=Has ju=Cit sa=Āśl su=Puṣ mo=Āśl
14.06.-2265 dmax=68.09 emin=8.19 me=Puṣ ve=Mag ma=Has ju=Cit sa=Āśl su=Puṣ mo=Mag
15.06.-2265 dmax=66.26 emin=9.18 me=Āśl ve=Mag ma=Has ju=Cit sa=Āśl su=Puṣ mo=PPh
16.06.-2265 dmax=64.45 emin=10.15 me=Āśl ve=Mag ma=Has ju=Cit sa=Āśl su=Puṣ mo=UPh
17.06.-2265 dmax=62.68 emin=11.09 me=Āśl ve=PPh ma=Has ju=Cit sa=Āśl su=Puṣ mo=Has

29.12.-2248 dmax=41.16 emin=13.62 me=Śat ve=PBh ma=Śat ju=Rev sa=Śat su=Dha mo=Śat
30.12.-2248 dmax=36.79 emin=17.17 me=Śat ve=PBh ma=PBh ju=Rev sa=Śat su=Dha mo=PBh
31.12.-2248 dmax=36.85 emin=16.28 me=Śat ve=PBh ma=PBh ju=Rev sa=Śat su=Dha mo=UBh

14.12.-2214 dmax=74.02 emin=14.46 me=Dha ve=PBh ma=PBh ju=Dha sa=Aśv su=Śra mo=Dha
15.12.-2214 dmax=71.34 emin=16.17 me=Dha ve=PBh ma=PBh ju=Dha sa=Aśv su=Śra mo=Śat
16.12.-2214 dmax=71.34 emin=15.19 me=Dha ve=PBh ma=PBh ju=Dha sa=Aśv su=Śra mo=PBh
17.12.-2214 dmax=71.53 emin=14.03 me=Dha ve=PBh ma=PBh ju=Dha sa=Aśv su=Śra mo=UBh
18.12.-2214 dmax=71.90 emin=12.69 me=Dha ve=PBh ma=PBh ju=Dha sa=Aśv su=Śra mo=Rev

26.04.-2209 dmax=25.25 emin=9.22 me=Mṛg ve=Ārd ma=Pun ju=Pun sa=Ārd su=Roh mo=Mṛg
27.04.-2209 dmax=19.36 emin=14.78 me=Mṛg ve=Ārd ma=Pun ju=Pun sa=Ārd su=Roh mo=Ārd
28.04.-2209 dmax=18.10 emin=15.71 me=Ārd ve=Ārd ma=Pun ju=Pun sa=Ārd su=Roh mo=Pun

28.06.-2171 dmax=60.51 emin=7.32 me=Mag ve=Āśl ma=Has ju=UPh sa=Cit su=Āśl mo=Cit

29.08.-2169 dmax=44.78 emin=9.45 me=Svā ve=Anu ma=Anu ju=Anu sa=Viś su=Has mo=Cit
30.08.-2169 dmax=33.17 emin=20.80 me=Svā ve=Anu ma=Anu ju=Anu sa=Viś su=Has mo=Svā
31.08.-2169 dmax=29.67 emin=24.04 me=Svā ve=Anu ma=Anu ju=Anu sa=Viś su=Has mo=Viś
01.09.-2169 dmax=29.26 emin=24.19 me=Svā ve=Anu ma=Jye ju=Anu sa=Viś su=Cit mo=Anu
02.09.-2169 dmax=28.88 emin=24.31 me=Svā ve=Anu ma=Jye ju=Anu sa=Viś su=Cit mo=Jye

15.02.-2151 dmax=55.55 emin=15.29 me=Aśv ve=Bha ma=Aśv ju=Kṛt sa=Mṛg su=UBh mo=Rev
16.02.-2151 dmax=53.30 emin=16.63 me=Aśv ve=Kṛt ma=Aśv ju=Kṛt sa=Mṛg su=UBh mo=Aśv
17.02.-2151 dmax=53.15 emin=15.87 me=Aśv ve=Kṛt ma=Aśv ju=Kṛt sa=Mṛg su=UBh mo=Kṛt
18.02.-2151 dmax=53.11 emin=15.00 me=Aśv ve=Kṛt ma=Aśv ju=Kṛt sa=Mṛg su=UBh mo=Roh

13.06.-2113 dmax=59.79 emin=11.99 me=Āśl ve=PPh ma=Mag ju=Āśl sa=Has su=Puṣ mo=Āśl
14.06.-2113 dmax=52.28 emin=18.61 me=Āśl ve=PPh ma=Mag ju=Āśl sa=Has su=Puṣ mo=Mag
15.06.-2113 dmax=50.66 emin=19.33 me=Āśl ve=PPh ma=Mag ju=Āśl sa=Has su=Puṣ mo=PPh
16.06.-2113 dmax=49.09 emin=20.01 me=Āśl ve=PPh ma=Mag ju=Āśl sa=Has su=Puṣ mo=UPh
17.06.-2113 dmax=48.40 emin=19.81 me=Mag ve=PPh ma=Mag ju=Āśl sa=Has su=Puṣ mo=Has

28.03.-2030 dmax=78.00 emin=6.44 me=Kṛt ve=Kṛt ma=Puṣ ju=Puṣ sa=Puṣ su=Bha mo=Kṛt
29.03.-2030 dmax=76.33 emin=7.62 me=Kṛt ve=Kṛt ma=Āśl ju=Puṣ sa=Puṣ su=Bha mo=Roh
30.03.-2030 dmax=74.69 emin=8.77 me=Kṛt ve=Kṛt ma=Āśl ju=Puṣ sa=Puṣ su=Bha mo=Mṛg
31.03.-2030 dmax=73.07 emin=9.90 me=Kṛt ve=Kṛt ma=Āśl ju=Puṣ sa=Puṣ su=Bha mo=Ārd
01.04.-2030 dmax=71.48 emin=11.00 me=Kṛt ve=Kṛt ma=Āśl ju=Puṣ sa=Puṣ su=Bha mo=Pun
02.04.-2030 dmax=69.93 emin=12.07 me=Kṛt ve=Kṛt ma=Āśl ju=Puṣ sa=Puṣ su=Kṛt mo=Puṣ

26.04.-2030 dmax=64.18 emin=7.19 me=Ārd ve=Ārd ma=Mag ju=Āśl sa=Puṣ su=Roh mo=Mṛg
27.04.-2030 dmax=52.23 emin=18.73 me=Ārd ve=Ārd ma=Mag ju=Āśl sa=Puṣ su=Roh mo=Ārd
28.04.-2030 dmax=50.81 emin=19.74 me=Ārd ve=Ārd ma=Mag ju=Āśl sa=Puṣ su=Roh mo=Pun
29.04.-2030 dmax=50.13 emin=20.01 me=Ārd ve=Ārd ma=Mag ju=Āśl sa=Puṣ su=Roh mo=Puṣ
30.04.-2030 dmax=49.46 emin=20.28 me=Ārd ve=Ārd ma=Mag ju=Āśl sa=Puṣ su=Mṛg mo=Puṣ
01.05.-2030 dmax=48.80 emin=20.54 me=Ārd ve=Ārd ma=Mag ju=Āśl sa=Puṣ su=Mṛg mo=Āśl

07.06.-2028 dmax=71.95 emin=5.08 me=Puṣ ve=Mag ma=Has ju=Has sa=Mag su=Pun mo=Has

17.10.-2013 dmax=69.19 emin=10.49 me=Jye ve=Jye ma=Mūl ju=UĀṣ sa=Dha su=Anu mo=UĀṣ
18.10.-2013 dmax=67.99 emin=10.72 me=Jye ve=Jye ma=Mūl ju=UĀṣ sa=Dha su=Anu mo=Śra

19.12.-2011 dmax=47.32 emin=10.75 me=Dha ve=PBh ma=Śat ju=UBh sa=PBh su=Śra mo=Dha
20.12.-2011 dmax=39.84 emin=17.39 me=Dha ve=PBh ma=Śat ju=UBh sa=PBh su=Śra mo=Śat
21.12.-2011 dmax=38.66 emin=17.74 me=Dha ve=PBh ma=Śat ju=UBh sa=PBh su=Śra mo=PBh
22.12.-2011 dmax=37.55 emin=18.01 me=Dha ve=PBh ma=Śat ju=UBh sa=PBh su=Śra mo=UBh

*15.05.-1972 dmax=23.73 emin=11.31 me=Puṣ ve=Puṣ ma=Puṣ ju=Ārd sa=Pun su=Ārd mo=Pun*
*16.05.-1972 dmax=23.78 emin=10.58 me=Puṣ ve=Puṣ ma=Puṣ ju=Ārd sa=Pun su=Ārd mo=Puṣ*

02.03.-1889 dmax=70.96 emin=18.50 me=Bha ve=Kṛt ma=Pun ju=Mṛg sa=Bha su=Rev mo=Kṛt
03.03.-1889 dmax=71.25 emin=17.66 me=Bha ve=Kṛt ma=Pun ju=Mṛg sa=Bha su=Rev mo=Roh
04.03.-1889 dmax=71.56 emin=16.81 me=Bha ve=Kṛt ma=Pun ju=Mṛg sa=Bha su=Rev mo=Mṛg

16.08.-1872 dmax=56.41 emin=14.34 me=Cit ve=Cit ma=Svā ju=Anu sa=Jye su=UPh mo=Has
17.08.-1872 dmax=45.08 emin=24.75 me=Cit ve=Cit ma=Svā ju=Anu sa=Jye su=UPh mo=Cit
18.08.-1872 dmax=43.90 emin=25.00 me=Cit ve=Cit ma=Svā ju=Anu sa=Jye su=UPh mo=Svā
19.08.-1872 dmax=42.73 emin=25.25 me=Cit ve=Cit ma=Svā ju=Anu sa=Jye su=UPh mo=Viś
20.08.-1872 dmax=41.57 emin=25.49 me=Cit ve=Cit ma=Svā ju=Anu sa=Jye su=Has mo=Jye

17.04.-1793 dmax=67.70 emin=10.75 me=Mṛg ve=Pun ma=Āśl ju=Puṣ sa=Āśl su=Kṛt mo=Roh
18.04.-1793 dmax=56.35 emin=21.65 me=Mṛg ve=Pun ma=Āśl ju=Puṣ sa=Āśl su=Roh mo=Mṛg
19.04.-1793 dmax=54.37 emin=23.18 me=Mṛg ve=Pun ma=Āśl ju=Puṣ sa=Āśl su=Roh mo=Ārd
20.04.-1793 dmax=53.96 emin=23.15 me=Mṛg ve=Pun ma=Āśl ju=Puṣ sa=Āśl su=Roh mo=Pun
21.04.-1793 dmax=53.62 emin=23.05 me=Mṛg ve=Pun ma=Āśl ju=Puṣ sa=Āśl su=Roh mo=Puṣ
22.04.-1793 dmax=53.34 emin=22.89 me=Ārd ve=Pun ma=Mag ju=Puṣ sa=Āśl su=Roh mo=Āśl

19.06.-1731 dmax=71.27 emin=9.63 me=Mag ve=PPh ma=PPh ju=Cit sa=UPh su=Puṣ mo=Āśl
20.06.-1731 dmax=58.63 emin=21.42 me=Mag ve=PPh ma=UPh ju=Cit sa=UPh su=Puṣ mo=Mag
21.06.-1731 dmax=52.55 emin=26.66 me=Mag ve=PPh ma=UPh ju=Cit sa=UPh su=Puṣ mo=PPh
22.06.-1731 dmax=51.48 emin=26.88 me=Mag ve=PPh ma=UPh ju=Cit sa=UPh su=Puṣ mo=UPh
23.06.-1731 dmax=50.45 emin=27.06 me=Mag ve=PPh ma=UPh ju=Cit sa=UPh su=Puṣ mo=Has
24.06.-1731 dmax=49.47 emin=27.20 me=Mag ve=PPh ma=UPh ju=Cit sa=UPh su=Puṣ mo=Cit

07.04.-1675 dmax=75.16 emin=14.13 me=Roh ve=Roh ma=Mṛg ju=Pun sa=Āśl su=Kṛt mo=Puṣ

01.05.-1675 dmax=57.71 emin=9.96 me=Ārd ve=Pun ma=Ārd ju=Pun sa=Mag su=Roh mo=Mṛg
02.05.-1675 dmax=48.86 emin=17.93 me=Ārd ve=Pun ma=Ārd ju=Pun sa=Mag su=Mṛg mo=Ārd
03.05.-1675 dmax=48.29 emin=17.62 me=Ārd ve=Pun ma=Ārd ju=Pun sa=Mag su=Mṛg mo=Pun
04.05.-1675 dmax=47.72 emin=17.31 me=Ārd ve=Pun ma=Ārd ju=Pun sa=Mag su=Mṛg mo=Puṣ
05.05.-1675 dmax=47.15 emin=17.00 me=Ārd ve=Pun ma=Ārd ju=Pun sa=Mag su=Mṛg mo=Āśl

01.01.-1596 dmax=42.39 emin=14.27 me=Śat ve=UBh ma=Rev ju=Śat sa=Rev su=Dha mo=Śat
02.01.-1596 dmax=40.68 emin=15.66 me=Śat ve=UBh ma=Rev ju=Śat sa=Rev su=Dha mo=PBh
03.01.-1596 dmax=41.14 emin=14.88 me=Śat ve=UBh ma=Rev ju=Śat sa=Rev su=Dha mo=UBh
04.01.-1596 dmax=41.59 emin=14.11 me=Śat ve=UBh ma=Rev ju=Śat sa=Rev su=Dha mo=Rev

28.04.-1590 dmax=66.40 emin=22.98 me=Ārd ve=Puṣ ma=Āśl ju=PPh sa=Ārd su=Roh mo=Mag

05.03.-1534 dmax=25.98 emin=16.76 me=Bha ve=Krt ma=Bha ju=Krt sa=Krt su=Rev mo=Aśv
06.03.-1534 dmax=22.53 emin=19.44 me=Bha ve=Kṛt ma=Bha ju=Kṛt sa=Kṛt su=Rev mo=Kṛt
07.03.-1534 dmax=21.94 emin=19.25 me=Bha ve=Krt ma=Krt ju=Krt sa=Krt su=Rev mo=Roh

30.06.-1496 dmax=29.67 emin=13.65 me=Mag ve=UPh ma=PPh ju=Mag sa=UPh su=Āśl mo=Mag
01.07.-1496 dmax=27.17 emin=15.29 me=Mag ve=UPh ma=PPh ju=Mag sa=UPh su=Āśl mo=PPh
02.07.-1496 dmax=26.32 emin=15.28 me=Mag ve=UPh ma=PPh ju=Mag sa=UPh su=Āśl mo=UPh

09.06.-1494 dmax=76.19 emin=8.33 me=Āśl ve=Puṣ ma=PPh ju=Has sa=Has su=Pun mo=Puṣ
10.06.-1494 dmax=72.32 emin=11.29 me=Āśl ve=Puṣ ma=PPh ju=Has sa=Has su=Pun mo=Āśl
11.06.-1494 dmax=72.88 emin=9.81 me=Āśl ve=Puṣ ma=PPh ju=Has sa=Has su=Pun mo=Mag

29.08.-1458 dmax=61.46 emin=18.49 me=Svā ve=Svā ma=Jye ju=Svā sa=Mūl su=Has mo=Cit
30.08.-1458 dmax=56.64 emin=22.37 me=Svā ve=Svā ma=Jye ju=Svā sa=Mūl su=Has mo=Viś
31.08.-1458 dmax=55.45 emin=22.61 me=Svā ve=Svā ma=Jye ju=Svā sa=Mūl su=Has mo=Anu
01.09.-1458 dmax=54.26 emin=22.86 me=Svā ve=Svā ma=Jye ju=Svā sa=Mūl su=Has mo=Jye

16.05.-1413 dmax=61.79 emin=15.78 me=Pun ve=Pun ma=PPh ju=Āśl sa=Pun su=Mṛg mo=Pun
17.05.-1413 dmax=61.11 emin=16.05 me=Pun ve=Pun ma=PPh ju=Āśl sa=Pun su=Mṛg mo=Puṣ
18.05.-1413 dmax=60.42 emin=16.32 me=Pun ve=Pun ma=PPh ju=Āśl sa=Pun su=Mṛg mo=Puṣ
19.05.-1413 dmax=59.74 emin=16.59 me=Pun ve=Pun ma=PPh ju=Āśl sa=Pun su=Ārd mo=Āśl
20.05.-1413 dmax=59.95 emin=15.97 me=Puṣ ve=Pun ma=PPh ju=Āśl sa=Pun su=Ārd mo=Mag
21.05.-1413 dmax=60.36 emin=15.15 me=Puṣ ve=Pun ma=PPh ju=Āśl sa=Pun su=Ārd mo=PPh

08.06.-1317 dmax=74.06 emin=15.20 me=Puṣ ve=Āśl ma=Has ju=UPh sa=Cit su=Pun mo=Has

02.07.-1317 dmax=60.71 emin=10.49 me=PPh ve=PPh ma=Cit ju=UPh sa=Cit su=Āśl mo=Āśl
03.07.-1317 dmax=46.28 emin=24.58 me=PPh ve=PPh ma=Cit ju=UPh sa=Cit su=Āśl mo=PPh
04.07.-1317 dmax=43.13 emin=27.39 me=PPh ve=PPh ma=Cit ju=UPh sa=Cit su=Āśl mo=UPh
05.07.-1317 dmax=42.83 emin=27.36 me=PPh ve=UPh ma=Cit ju=UPh sa=Cit su=Āśl mo=Has
06.07.-1317 dmax=42.56 emin=27.29 me=PPh ve=UPh ma=Cit ju=UPh sa=Cit su=Āśl mo=Cit

03.09.-1255 dmax=45.26 emin=15.79 me=Svā ve=Svā ma=Anu ju=Jye sa=Anu su=Has mo=Cit
04.09.-1255 dmax=39.61 emin=20.61 me=Svā ve=Svā ma=Anu ju=Jye sa=Anu su=Has mo=Viś
05.09.-1255 dmax=38.53 emin=20.86 me=Svā ve=Svā ma=Anu ju=Jye sa=Anu su=Has mo=Anu
06.09.-1255 dmax=37.46 emin=21.10 me=Svā ve=Svā ma=Anu ju=Jye sa=Anu su=Cit mo=Jye

05.05.-1176 dmax=70.06 emin=15.40 me=Ārd ve=Puṣ ma=PPh ju=Āśl sa=Puṣ su=Mṛg mo=Ārd
06.05.-1176 dmax=61.12 emin=23.87 me=Ārd ve=Puṣ ma=PPh ju=Āśl sa=Puṣ su=Mṛg mo=Pun
07.05.-1176 dmax=60.36 emin=24.16 me=Ārd ve=Puṣ ma=PPh ju=Āśl sa=Puṣ su=Mṛg mo=Puṣ
08.05.-1176 dmax=59.67 emin=24.39 me=Pun ve=Puṣ ma=PPh ju=Āśl sa=Puṣ su=Mṛg mo=Āśl
09.05.-1176 dmax=59.02 emin=24.58 me=Pun ve=Puṣ ma=PPh ju=Āśl sa=Puṣ su=Mṛg mo=Mag
10.05.-1176 dmax=58.43 emin=24.71 me=Pun ve=Puṣ ma=PPh ju=Āśl sa=Puṣ su=Mṛg mo=PPh

21.10.-1159 dmax=61.64 emin=16.93 me=Jye ve=PĀṣ ma=PĀṣ ju=UĀṣ sa=Dha su=Anu mo=Jye
22.10.-1159 dmax=56.83 emin=20.78 me=Jye ve=PĀṣ ma=PĀṣ ju=UĀṣ sa=Dha su=Anu mo=Mūl
23.10.-1159 dmax=55.68 emin=20.96 me=Mūl ve=PĀṣ ma=PĀṣ ju=UĀṣ sa=Dha su=Anu mo=PĀṣ
24.10.-1159 dmax=54.59 emin=21.09 me=Mūl ve=PĀṣ ma=PĀṣ ju=UĀṣ sa=Dha su=Anu mo=UĀṣ
25.10.-1159 dmax=53.55 emin=21.17 me=Mūl ve=PĀṣ ma=PĀṣ ju=UĀṣ sa=Dha su=Anu mo=Śra

19.02.-1120 dmax=67.67 emin=5.06 me=UBh ve=Aśv ma=Roh ju=Aśv sa=Roh su=UBh mo=Bha
20.02.-1120 dmax=65.69 emin=6.12 me=Rev ve=Bha ma=Roh ju=Aśv sa=Roh su=UBh mo=Kṛt

08.07.-1114 dmax=51.31 emin=22.37 me=PPh ve=UPh ma=Has ju=Svā sa=PPh su=Āśl mo=PPh

24.12.-1097 dmax=69.01 emin=10.26 me=Dha ve=Dha ma=Dha ju=Aśv sa=UBh su=Śra mo=Śra
25.12.-1097 dmax=61.08 emin=17.30 me=Dha ve=Dha ma=Dha ju=Aśv sa=UBh su=Śra mo=Dha
26.12.-1097 dmax=59.85 emin=17.64 me=Dha ve=Dha ma=Dha ju=Aśv sa=UBh su=Śra mo=Śat
27.12.-1097 dmax=59.19 emin=17.41 me=Dha ve=Śat ma=Dha ju=Aśv sa=UBh su=Śra mo=PBh
28.12.-1097 dmax=58.54 emin=17.18 me=Dha ve=Śat ma=Dha ju=Aśv sa=UBh su=Śra mo=UBh

24.06.-1080 dmax=67.81 emin=21.37 me=Mag ve=Mag ma=Cit ju=PPh sa=Svā su=Puṣ mo=UPh
25.06.-1080 dmax=68.11 emin=20.14 me=Mag ve=Mag ma=Cit ju=PPh sa=Svā su=Puṣ mo=Has
26.06.-1080 dmax=68.46 emin=18.87 me=Mag ve=Mag ma=Cit ju=PPh sa=Svā su=Puṣ mo=Cit

25.04.-1058 dmax=44.09 emin=11.05 me=Mṛg ve=Mṛg ma=Ārd ju=Pun sa=Puṣ su=Roh mo=Puṣ

20.05.-1058 dmax=24.82 emin=9.10 me=Pun ve=Pun ma=Pun ju=Puṣ sa=Puṣ su=Mṛg mo=Ārd
21.05.-1058 dmax=13.07 emin=20.01 me=Pun ve=Pun ma=Pun ju=Puṣ sa=Puṣ su=Ārd mo=Pun
22.05.-1058 dmax=9.48 emin=22.76 me=Puṣ ve=Puṣ ma=Pun ju=Puṣ sa=Puṣ su=Ārd mo=Puṣ

24.08.-1018 dmax=51.15 emin=15.70 me=Cit ve=Viś ma=Viś ju=Anu sa=Anu su=UPh mo=Cit
25.08.-1018 dmax=43.00 emin=22.93 me=Cit ve=Viś ma=Viś ju=Anu sa=Anu su=UPh mo=Svā
26.08.-1018 dmax=41.75 emin=23.26 me=Cit ve=Viś ma=Viś ju=Anu sa=Anu su=Has mo=Viś
27.08.-1018 dmax=40.53 emin=23.56 me=Cit ve=Viś ma=Viś ju=Anu sa=Anu su=Has mo=Viś
28.08.-1018 dmax=39.33 emin=23.84 me=Cit ve=Viś ma=Viś ju=Anu sa=Anu su=Has mo=Anu

18.01.-979 dmax=54.97 emin=10.43 me=PBh ve=Rev ma=Aśv ju=Śat sa=PBh su=Śat mo=Śat
19.01.-979 dmax=54.21 emin=10.83 me=PBh ve=Rev ma=Bha ju=Śat sa=PBh su=Śat mo=PBh
20.01.-979 dmax=54.61 emin=10.06 me=PBh ve=Rev ma=Bha ju=Śat sa=PBh su=Śat mo=UBh

21.04.-879 dmax=75.79 emin=12.38 me=Mṛg ve=Roh ma=Āśl ju=Āśl sa=Mag su=Kṛt mo=Roh
22.04.-879 dmax=74.46 emin=12.79 me=Mṛg ve=Roh ma=Āśl ju=Āśl sa=Mag su=Kṛt mo=Mṛg
23.04.-879 dmax=73.27 emin=13.06 me=Mṛg ve=Roh ma=Āśl ju=Āśl sa=Mag su=Kṛt mo=Ārd
24.04.-879 dmax=72.09 emin=13.33 me=Mṛg ve=Mṛg ma=Āśl ju=Āśl sa=Mag su=Roh mo=Pun
25.04.-879 dmax=70.90 emin=13.60 me=Mṛg ve=Mṛg ma=Āśl ju=Āśl sa=Mag su=Roh mo=Puṣ
26.04.-879 dmax=69.73 emin=13.86 me=Mṛg ve=Mṛg ma=Āśl ju=Āśl sa=Mag su=Roh mo=Āśl

27.06.-877 dmax=67.61 emin=10.54 me=Mag ve=Mag ma=Has ju=Cit sa=UPh su=Puṣ mo=Āśl
28.06.-877 dmax=55.99 emin=21.32 me=Mag ve=Mag ma=Has ju=Cit sa=UPh su=Puṣ mo=Mag
29.06.-877 dmax=54.55 emin=21.92 me=Mag ve=Mag ma=Has ju=Cit sa=UPh su=Puṣ mo=PPh
30.06.-877 dmax=53.13 emin=22.50 me=Mag ve=Mag ma=Has ju=Cit sa=UPh su=Puṣ mo=UPh
01.07.-877 dmax=51.75 emin=23.04 me=Mag ve=Mag ma=Has ju=Cit sa=UPh su=Puṣ mo=Has
02.07.-877 dmax=50.40 emin=23.55 me=Mag ve=Mag ma=Has ju=Cit sa=UPh su=Puṣ mo=Cit

14.12.-860 dmax=68.72 emin=13.80 me=Śra ve=Śat ma=Dha ju=Rev sa=Rev su=UĀṣ mo=Śra
15.12.-860 dmax=67.13 emin=14.42 me=Śra ve=Śat ma=Dha ju=Rev sa=Rev su=UĀṣ mo=Dha
16.12.-860 dmax=65.57 emin=15.02 me=Śra ve=PBh ma=Dha ju=Rev sa=Rev su=UĀṣ mo=Śat
17.12.-860 dmax=64.03 emin=15.59 me=Śra ve=PBh ma=Dha ju=Rev sa=Rev su=UĀṣ mo=PBh
18.12.-860 dmax=62.53 emin=16.13 me=Śra ve=PBh ma=Dha ju=Rev sa=Rev su=UĀṣ mo=UBh

16.09.-841 dmax=59.14 emin=14.77 me=Viś ve=Svā ma=PĀṣ ju=Viś sa=Jye su=Cit mo=Svā
17.09.-841 dmax=55.50 emin=18.13 me=Viś ve=Svā ma=PĀṣ ju=Viś sa=Jye su=Cit mo=Viś
18.09.-841 dmax=54.98 emin=18.38 me=Viś ve=Viś ma=PĀṣ ju=Viś sa=Jye su=Cit mo=Anu
19.09.-841 dmax=54.45 emin=18.63 me=Viś ve=Viś ma=PĀṣ ju=Viś sa=Jye su=Cit mo=Jye
20.09.-841 dmax=53.94 emin=18.87 me=Viś ve=Viś ma=PĀṣ ju=Viś sa=Jye su=Cit mo=Mūl
21.09.-841 dmax=53.42 emin=19.12 me=Viś ve=Viś ma=PĀṣ ju=Viś sa=Jye su=Cit mo=PĀṣ

*11.05.-821 dmax=44.52 emin=15.51 me=Pun ve=Puṣ ma=Pun ju=Pun sa=Āśl su=Mṛg mo=Ārd*
*12.05.-821 dmax=34.73 emin=24.43 me=Pun ve=Puṣ ma=Pun ju=Pun sa=Āśl su=Mṛg mo=Pun*
*13.05.-821 dmax=33.67 emin=24.62 me=Pun ve=Puṣ ma=Pun ju=Pun sa=Āśl su=Mṛg mo=Puṣ*
*14.05.-821 dmax=32.68 emin=24.75 me=Pun ve=Puṣ ma=Pun ju=Pun sa=Āśl su=Mṛg mo=Āśl*

04.11.-745 dmax=75.70 emin=12.54 me=Mūl ve=PĀṣ ma=Dha ju=Mūl sa=Śat su=Jye mo=Mūl

26.02.-738 dmax=71.56 emin=18.15 me=Aśv ve=Aśv ma=Ārd ju=Ārd sa=Roh su=UBh mo=Roh
27.02.-738 dmax=70.29 emin=18.52 me=Aśv ve=Aśv ma=Ārd ju=Ārd sa=Roh su=UBh mo=Mṛg

06.01.-682 dmax=51.45 emin=14.99 me=Śat ve=Śat ma=UBh ju=PBh sa=Rev su=Śra mo=Śat
07.01.-682 dmax=47.72 emin=17.78 me=Śat ve=Śat ma=UBh ju=PBh sa=Rev su=Dha mo=PBh
08.01.-682 dmax=47.22 emin=17.35 me=Śat ve=Śat ma=UBh ju=PBh sa=Rev su=Dha mo=UBh
09.01.-682 dmax=46.89 emin=16.75 me=Śat ve=Śat ma=UBh ju=PBh sa=Rev su=Dha mo=Rev
10.01.-682 dmax=46.72 emin=15.99 me=Śat ve=Śat ma=UBh ju=PBh sa=Aśv su=Dha mo=Aśv

03.05.-644 dmax=62.26 emin=9.32 me=Mṛg ve=Mṛg ma=Puṣ ju=Mṛg sa=Āśl su=Roh mo=Mṛg
04.05.-644 dmax=58.77 emin=11.92 me=Mṛg ve=Mṛg ma=Puṣ ju=Mṛg sa=Āśl su=Roh mo=Ārd
05.05.-644 dmax=58.62 emin=11.19 me=Mṛg ve=Mṛg ma=Puṣ ju=Mṛg sa=Āśl su=Roh mo=Pun
06.05.-644 dmax=58.46 emin=10.46 me=Ārd ve=Ārd ma=Puṣ ju=Mṛg sa=Mag su=Roh mo=Puṣ

05.09.-604 dmax=72.16 emin=8.15 me=Svā ve=Anu ma=Mūl ju=Svā sa=Mūl su=Has mo=Cit
06.09.-604 dmax=61.00 emin=19.02 me=Svā ve=Anu ma=Mūl ju=Svā sa=Mūl su=Has mo=Svā
07.09.-604 dmax=55.31 emin=24.41 me=Svā ve=Anu ma=Mūl ju=Svā sa=Mūl su=Has mo=Viś
08.09.-604 dmax=55.06 emin=24.37 me=Svā ve=Anu ma=Mūl ju=Svā sa=Mūl su=Has mo=Viś
09.09.-604 dmax=55.54 emin=23.59 me=Svā ve=Anu ma=Mūl ju=Svā sa=Mūl su=Has mo=Anu
10.09.-604 dmax=56.03 emin=22.81 me=Svā ve=Anu ma=Mūl ju=Svā sa=Mūl su=Cit mo=Jye

09.11.-542 dmax=38.16 emin=13.87 me=Mūl ve=UĀṣ ma=Śra ju=UĀṣ sa=Śra su=Jye mo=Mūl
<u>10.11.-542 dmax=33.25 emin=18.54 me=Mūl ve=UĀṣ ma=Śra ju=UĀṣ sa=Śra su=Jye mo=PĀṣ</u>
<u>11.11.-542 dmax=32.66 emin=18.88 me=PĀṣ ve=UĀṣ ma=Śra ju=UĀṣ sa=Śra su=Jye mo=UĀṣ</u>
<u>12.11.-542 dmax=32.09 emin=19.20 me=PĀṣ ve=UĀṣ ma=Śra ju=UĀṣ sa=Śra su=Jye mo=Śra</u>

11.01.-479 dmax=60.16 emin=11.46 me=Śat ve=Śat ma=PBh ju=Aśv sa=PBh su=Dha mo=Śat
12.01.-479 dmax=55.20 emin=15.56 me=Śat ve=Śat ma=PBh ju=Aśv sa=PBh su=Dha mo=PBh
13.01.-479 dmax=53.74 emin=16.15 me=Śat ve=Śat ma=PBh ju=Aśv sa=PBh su=Dha mo=UBh
14.01.-479 dmax=52.36 emin=16.67 me=Śat ve=Śat ma=PBh ju=Aśv sa=PBh su=Dha mo=Rev
15.01.-479 dmax=51.04 emin=17.13 me=Śat ve=Śat ma=PBh ju=Aśv sa=PBh su=Dha mo=Aśv

10.07.-463 dmax=70.63 emin=17.34 me=PPh ve=UPh ma=Svā ju=UPh sa=Cit su=Āśl mo=Mag
11.07.-463 dmax=62.76 emin=24.82 me=PPh ve=UPh ma=Viś ju=UPh sa=Cit su=Āśl mo=PPh
12.07.-463 dmax=61.98 emin=25.21 me=PPh ve=UPh ma=Viś ju=UPh sa=Cit su=Āśl mo=UPh
13.07.-463 dmax=61.22 emin=25.58 me=PPh ve=UPh ma=Viś ju=UPh sa=Cit su=Āśl mo=Has
14.07.-463 dmax=60.51 emin=25.91 me=PPh ve=UPh ma=Viś ju=UPh sa=Cit su=Āśl mo=Cit
15.07.-463 dmax=59.84 emin=26.21 me=PPh ve=UPh ma=Viś ju=UPh sa=Cit su=Āśl mo=Svā

18.05.-439 dmax=71.02 emin=18.79 me=Ārd ve=Puṣ ma=Āśl ju=UPh sa=Puṣ su=Mṛg mo=Pun

12.09.-401 dmax=44.23 emin=13.33 me=Svā ve=Anu ma=Jye ju=Jye sa=Viś su=Has mo=Cit
13.09.-401 dmax=37.23 emin=20.07 me=Svā ve=Anu ma=Jye ju=Jye sa=Viś su=Cit mo=Svā
14.09.-401 dmax=36.57 emin=20.47 me=Svā ve=Anu ma=Jye ju=Jye sa=Viś su=Cit mo=Viś
15.09.-401 dmax=35.93 emin=20.85 me=Svā ve=Anu ma=Jye ju=Jye sa=Viś su=Cit mo=Anu
16.09.-401 dmax=35.30 emin=21.21 me=Svā ve=Anu ma=Jye ju=Jye sa=Viś su=Cit mo=Jye

28.02.-383 dmax=59.22 emin=17.74 me=Aśv ve=Bha ma=Aśv ju=Roh sa=Mṛg su=UBh mo=Aśv
01.03.-383 dmax=57.84 emin=18.19 me=Aśv ve=Bha ma=Aśv ju=Roh sa=Mṛg su=UBh mo=Bha
02.03.-383 dmax=56.56 emin=18.55 me=Aśv ve=Bha ma=Aśv ju=Roh sa=Mṛg su=UBh mo=Kṛt
03.03.-383 dmax=55.36 emin=18.83 me=Aśv ve=Bha ma=Aśv ju=Roh sa=Mṛg su=Rev mo=Roh
04.03.-383 dmax=54.26 emin=19.01 me=Aśv ve=Bha ma=Aśv ju=Roh sa=Mṛg su=Rev mo=Mṛg

26.06.-345 dmax=68.62 emin=8.94 me=Puṣ ve=Mag ma=Mag ju=PPh sa=Cit su=Puṣ mo=Āśl
27.06.-345 dmax=66.73 emin=9.93 me=Āśl ve=Mag ma=Mag ju=PPh sa=Cit su=Puṣ mo=Mag
28.06.-345 dmax=64.85 emin=10.90 me=Āśl ve=Mag ma=Mag ju=PPh sa=Cit su=Puṣ mo=PPh
29.06.-345 dmax=63.02 emin=11.83 me=Āśl ve=PPh ma=Mag ju=PPh sa=Cit su=Puṣ mo=UPh
30.06.-345 dmax=61.21 emin=12.75 me=Āśl ve=PPh ma=Mag ju=PPh sa=Cit su=Puṣ mo=Has

03.11.-305 dmax=52.46 emin=17.56 me=Mūl ve=Mūl ma=Śra ju=UĀṣ sa=Dha su=Anu mo=Śra

10.05.-262 dmax=66.93 emin=8.72 me=Ārd ve=Mṛg ma=Mag ju=Mag sa=Āśl su=Roh mo=Mṛg
11.05.-262 dmax=66.23 emin=8.99 me=Ārd ve=Mṛg ma=Mag ju=Mag sa=Āśl su=Roh mo=Ārd
12.05.-262 dmax=65.53 emin=9.26 me=Ārd ve=Mṛg ma=Mag ju=Mag sa=Āśl su=Mṛg mo=Pun
13.05.-262 dmax=64.82 emin=9.54 me=Ārd ve=Mṛg ma=Mag ju=Mag sa=Āśl su=Mṛg mo=Puṣ
14.05.-262 dmax=64.13 emin=9.81 me=Pun ve=Mṛg ma=Mag ju=Mag sa=Āśl su=Mṛg mo=Āśl
15.05.-262 dmax=63.43 emin=10.08 me=Pun ve=Ārd ma=Mag ju=Mag sa=Āśl su=Mṛg mo=Mag

15.07.-260 dmax=58.95 emin=11.68 me=PPh ve=UPh ma=Cit ju=Cit sa=PPh su=Āśl mo=Mag
16.07.-260 dmax=50.85 emin=18.95 me=PPh ve=UPh ma=Cit ju=Cit sa=PPh su=Āśl mo=PPh
17.07.-260 dmax=49.37 emin=19.60 me=PPh ve=UPh ma=Cit ju=Cit sa=PPh su=Āśl mo=UPh
18.07.-260 dmax=48.09 emin=20.05 me=PPh ve=UPh ma=Cit ju=Cit sa=PPh su=Āśl mo=Has
19.07.-260 dmax=48.11 emin=19.21 me=PPh ve=UPh ma=Cit ju=Svā sa=PPh su=Āśl mo=Cit
20.07.-260 dmax=48.12 emin=18.37 me=PPh ve=UPh ma=Cit ju=Svā sa=PPh su=Mag mo=Svā

*01.01.-242 dmax=64.92 emin=10.20 me=Dha ve=PBh ma=Śat ju=Aśv sa=UBh su=Śra mo=Dha*
*02.01.-242 dmax=63.30 emin=10.94 me=Dha ve=PBh ma=Śat ju=Aśv sa=UBh su=Śra mo=Śat*
*03.01.-242 dmax=61.68 emin=11.68 me=Dha ve=PBh ma=Śat ju=Aśv sa=UBh su=Śra mo=PBh*
*04.01.-242 dmax=60.08 emin=12.41 me=Dha ve=UBh ma=Śat ju=Aśv sa=UBh su=Śra mo=UBh*
*05.01.-242 dmax=58.50 emin=13.12 me=Dha ve=UBh ma=PBh ju=Aśv sa=UBh su=Śra mo=Rev*

05.10.-224 dmax=73.21 emin=14.02 me=Anu ve=Viś ma=Śra ju=Viś sa=Anu su=Svā mo=Anu
06.10.-224 dmax=72.63 emin=14.27 me=Anu ve=Viś ma=Śra ju=Viś sa=Anu su=Svā mo=Jye
07.10.-224 dmax=72.29 emin=14.28 me=Anu ve=Viś ma=Śra ju=Viś sa=Anu su=Svā mo=Mūl
08.10.-224 dmax=72.75 emin=13.49 me=Anu ve=Anu ma=Śra ju=Viś sa=Anu su=Svā mo=PĀṣ

28.05.-204 dmax=27.69 emin=17.63 me=Pun ve=Āśl ma=Puṣ ju=Puṣ sa=Puṣ su=Ārd mo=Pun
29.05.-204 dmax=21.29 emin=24.04 me=Puṣ ve=Āśl ma=Puṣ ju=Puṣ sa=Puṣ su=Ārd mo=Puṣ
30.05.-204 dmax=21.41 emin=23.93 me=Puṣ ve=Āśl ma=Puṣ ju=Puṣ sa=Puṣ su=Ārd mo=Āśl

29.08.-104 dmax=69.29 emin=13.80 me=Cit ve=Has ma=Svā ju=Mūl sa=Jye su=UPh mo=Cit
30.08.-104 dmax=68.15 emin=14.06 me=Cit ve=Cit ma=Svā ju=Mūl sa=Jye su=UPh mo=Svā
31.08.-104 dmax=67.02 emin=14.32 me=Cit ve=Cit ma=Svā ju=Mūl sa=Jye su=Has mo=Viś
01.09.-104 dmax=65.88 emin=14.58 me=Cit ve=Cit ma=Svā ju=Mūl sa=Jye su=Has mo=Anu
02.09.-104 dmax=64.75 emin=14.84 me=Cit ve=Cit ma=Viś ju=Mūl sa=Jye su=Has mo=Jye

24.01.-65 dmax=39.63 emin=15.04 me=PBh ve=PBh ma=Aśv ju=UBh sa=UBh su=Śat mo=PBh
25.01.-65 dmax=39.08 emin=15.27 me=PBh ve=PBh ma=Aśv ju=UBh sa=UBh su=Śat mo=UBh
26.01.-65 dmax=38.53 emin=15.51 me=PBh ve=PBh ma=Aśv ju=UBh sa=UBh su=Śat mo=Rev
27.01.-65 dmax=37.97 emin=15.75 me=PBh ve=PBh ma=Aśv ju=UBh sa=UBh su=Śat mo=Aśv

01.05.-25 dmax=64.68 emin=18.45 me=Mṛg ve=Pun ma=Mag ju=Āśl sa=Mag su=Roh mo=Mṛg
02.05.-25 dmax=61.98 emin=20.67 me=Mṛg ve=Pun ma=Mag ju=Āśl sa=Mag su=Roh mo=Ārd
03.05.-25 dmax=60.93 emin=21.24 me=Mṛg ve=Pun ma=Mag ju=Āśl sa=Mag su=Roh mo=Pun
04.05.-25 dmax=59.94 emin=21.76 me=Mṛg ve=Pun ma=Mag ju=Āśl sa=Mag su=Roh mo=Puṣ
05.05.-25 dmax=59.00 emin=22.23 me=Ārd ve=Pun ma=Mag ju=Āśl sa=Mag su=Roh mo=Āśl
06.05.-25 dmax=58.11 emin=22.65 me=Ārd ve=Pun ma=Mag ju=Āśl sa=Mag su=Roh mo=Mag

# G: Total Solar Eclipses at Sunrise

This is a list of *total* and near-total solar eclipses that were possibly observable at *sunrise* from Kurukṣetra (76.85E, 30.00N) between 3500 BCE and 1 BCE. The calculations are extremely sensitive to the uncertainty of ΔT. The model Morrison/Stephenson 2004 was used. Standard error of ΔT was taken into consideration according to Huber 2000 (http://eclipse.gsfc.nasa.gov/SEcat5/uncertainty.html).

More eclipses are listed for the more remote past than for the more recent past, because the uncertainty of ΔT grows with time distance from present. However, the likelihood of observability is considerably smaller for more ancient eclipses. Calculations that are marked by a "+" are made for the geographic latitude 30.5N, those marked by a "–" for the geographic latitude 29.5N.

The table contains the following values:
The date of the eclipse in astronomical year count;
the magnitude (fr);
geographic longitude at which the eclipse could be observed at sunrise at the latitude of Kurukṣetra (lon);
the offset in geographic longitude from Kurukṣetra (dl);
the estimated standard error in longitude (si=sigma);
the proportion z = |dl| / si;
the lunar mansion where the eclipse took place.

The value z shows the probability that an eclipse was locally observable:

z > 1: The probability is smaller than 31.7%
z > 2: The probability is smaller than 4.6%
z > 3: The probability is smaller than 0.3%

Only eclipses with z < 3 are listed.

27. 9.-3344 fr=0.98 lon= 99.33 dl= 22.48 si=46.923 z=0.479 Viś
7. 5.-3309 fr=1.00 lon=168.12 dl= 91.27 si=45.909 z=1.988 Ārd
+26. 1.-3099 fr=1.01 lon= 3.47 dl=–73.38 si=40.042 z=1.832 PBh 30.5N
26. 1.-3099 fr=0.99 lon= 3.47 dl=–73.38 si=40.042 z=1.832 PBh
17. 2.-3063 fr=1.01 lon=114.88 dl= 38.03 si=39.074 z=0.973 Rev
28. 2.-3045 fr=1.00 lon= –6.68 dl=–83.53 si=38.594 z=2.164 Aśv
–24. 4.-2833 fr=0.99 lon= 49.14 dl=–27.71 si=33.155 z=0.836 Roh 29.5N
21.12.-2809 fr=1.00 lon= –6.84 dl=–83.69 si=32.563 z=2.570 Śra
+17. 5.-2770 fr=0.98 lon= 62.01 dl=–14.84 si=31.613 z=0.469 Ārd 29.5N
21. 7.-2643 fr=1.00 lon=100.02 dl= 23.17 si=28.608 z=0.810 PPh
28. 3.-2627 fr=0.99 lon= 11.88 dl=–64.97 si=28.240 z=2.301 Bha
26. 2.-2551 fr=0.98 lon=124.54 dl= 47.69 si=26.519 z=1.798 Rev
1. 4.-2470 fr=1.01 lon= 5.88 dl=–70.97 si=24.741 z=2.869 Kṛt
–16. 8.-2328 fr=0.98 lon=117.07 dl= 40.22 si=21.761 z=1.848 UPh 29.5N
17. 7.-2298 fr=1.00 lon= 63.89 dl=–12.96 si=21.153 z=0.613 Mag
– 3.10.-2042 fr=0.99 lon= 80.22 dl= 3.37 si=16.292 z=0.207 Viś 29.5N
+23. 2.-1761 fr=1.00 lon= 97.23 dl= 20.38 si=11.622 z=1.754 Rev 30.5N
23. 2.-1761 fr=0.98 lon= 97.23 dl= 20.38 si=11.622 z=1.754 Rev
+19. 4.-1549 fr=0.98 lon= 97.15 dl= 20.30 si= 8.566 z=2.370 Kṛt 30.5N
4.11.-1467 fr=1.00 lon= 63.62 dl=–13.23 si= 7.493 z=1.766 Jye
27. 3.-1186 fr=1.00 lon= 76.97 dl= 0.12 si= 4.292 z=0.029 Bha
27. 3.-1186 fr=1.01 lon= 77.22 dl= 0.37 si= 4.292 z=0.087 Bha

# H: Total Solar Eclipses at Sunset

This is a list of *total* and near-total solar eclipses that were possibly observable at *sunset* from Kurukṣetra (76.85E, 30.00N) between 3500 BCE and 1 BCE. Explanation of data is given in Appendix G.

+24. 4.-3373 fr=0.99 lon=192.53 dl= 115.68 si=47.772 z=2.422 Mṛg 30.5N
– 2. 2.-3257 fr=0.99 lon=–42.66 dl=–119.51 si=44.421 z=2.690 UBh 29.5N
+13. 2.-3239 fr=0.99 lon=199.62 dl= 122.77 si=43.911 z=2.796 Rev 30.5N
–28. 3.-3167 fr=0.99 lon=114.65 dl= 37.80 si=41.900 z=0.902 Kṛt 29.5N
+ 8. 5.-3160 fr=0.99 lon=128.23 dl= 51.38 si=41.707 z=1.232 Ārd 30.5N
+26. 1.-3099 fr=1.00 lon=111.47 dl= 34.62 si=40.042 z=0.865 PBh 30.5N
26. 1.-3099 fr=0.99 lon=111.72 dl= 34.87 si=40.042 z=0.871 PBh
+14. 8.-2998 fr=0.99 lon=168.53 dl= 91.68 si=37.355 z=2.454 Has 30.5N
+24. 8.-2980 fr=1.00 lon= 41.94 dl= –34.91 si=36.885 z=0.946 Has 30.5N
24. 8.-2980 fr=0.99 lon= 41.69 dl= –35.16 si=36.885 z=0.953 Has
+ 1. 4.-2972 fr=1.00 lon=179.82 dl= 102.97 si=36.678 z=2.807 Kṛt 30.5N
15. 9.-2944 fr=1.01 lon=139.24 dl= 62.39 si=35.955 z=1.735 Svā
+23. 5.-2928 fr=1.01 lon= 49.72 dl= –27.13 si=35.544 z=0.763 Pun 30.5N
23. 5.-2928 fr=0.99 lon= 49.72 dl= –27.13 si=35.544 z=0.763 Pun
26. 9.-2926 fr=1.01 lon= 4.62 dl= –72.23 si=35.493 z=2.035 Viś
18.10.-2890 fr=1.01 lon= 90.11 dl= 13.26 si=34.579 z=0.384 Anu
13. 3.-2878 fr=1.02 lon=168.27 dl= 91.42 si=34.277 z=2.667 Aśv
+ 9.11.-2854 fr=0.99 lon=172.32 dl= 95.47 si=33.676 z=2.835 Mūl 30.5N
9.11.-2854 fr=0.98 lon=172.07 dl= 95.22 si=33.676 z=2.828 Mūl
8. 3.-2552 fr=0.99 lon=102.47 dl= 25.62 si=26.542 z=0.965 Aśv
– 8. 3.-2552 fr=1.00 lon=102.72 dl= 25.87 si=26.542 z=0.975 Aśv 29.5N
23. 3.-2339 fr=1.01 lon= 50.39 dl= –26.46 si=21.985 z=1.203 Bha
20.12.-2288 fr=1.00 lon=126.74 dl= 49.89 si=20.953 z=2.381 Śra
27. 7.-2280 fr=1.00 lon=115.22 dl= 38.37 si=20.793 z=1.845 PPh
29. 4.-2071 fr=1.02 lon=123.41 dl= 46.56 si=16.814 z=2.769 Roh
–14. 5.-1858 fr=0.99 lon= 59.63 dl= –17.22 si=13.155 z=1.309 Mṛg 29.5N
15. 6.-1804 fr=1.01 lon= 90.48 dl= 13.63 si=12.291 z=1.109 Puṣ
10. 2.-1304 fr=1.00 lon= 88.96 dl= 12.11 si= 5.546 z=2.184 PBh
14. 3.-1250 fr=1.01 lon= 90.73 dl= 13.88 si= 4.956 z=2.802 Aśv
23.10.-1067 fr=1.00 lon= 70.11 dl= –6.74 si= 3.164 z=2.131 Anu

# I: Annular Solar Eclipses at Sunrise

This is a list of *annular* solar eclipses that were possibly observable at *sunrise* from Kurukṣetra (76.85E, 30.00N) between 3500 BCE and 1 BCE. There are more candidates for the more remote past than for the more recent past, but the likelihood of observability is higher for the more recent past. The calculations were made for geographic latitudes between 29°N and 31°N. Information on the data is given in Appendix G.

15. 5.-3421 fr=0.96 lon=120.77 dl= 43.92 si=49.193 z=0.893 Ārd
19.12.-3414 fr=0.94 lon=–18.10 dl= –94.95 si=48.984 z=1.938 Śra
27. 9.-3344 fr=0.98 lon= 99.33 dl= 22.48 si=46.923 z=0.479 Viś
18. 7.-3294 fr=0.94 lon=122.42 dl= 45.57 si=45.477 z=1.002 PPh
22.12.-3284 fr=0.93 lon= 12.78 dl= –64.07 si=45.191 z=1.418 Dha
9.11.-3272 fr=0.99 lon=–57.19 dl=–134.04 si=44.848 z=2.989 Mūl
19. 3.-3139 fr=0.96 lon=194.96 dl= 118.11 si=41.130 z=2.872 Bha
13. 9.-3055 fr=0.93 lon=181.02 dl= 104.17 si=38.861 z=2.681 Svā
24. 9.-3037 fr=0.91 lon= 65.20 dl= –11.65 si=38.382 z=0.303 Viś
11. 6.-3003 fr=0.94 lon= 37.89 dl= –38.96 si=37.486 z=1.039 Puṣ
28.11.-2929 fr=0.92 lon= 67.89 dl= –8.96 si=35.570 z=0.252 UĀṣ
15. 8.-2895 fr=0.97 lon=129.48 dl= 52.63 si=34.705 z=1.517 Has
20. 1.-2884 fr=0.96 lon= –6.43 dl= –83.28 si=34.428 z=2.419 PBh
19. 8.-2765 fr=0.95 lon=163.37 dl= 86.52 si=31.492 z=2.748 Has
29. 8.-2747 fr=0.96 lon= 46.43 dl= –30.42 si=31.058 z=0.980 Cit
1.12.-2715 fr=0.96 lon= –9.03 dl= –85.88 si=30.295 z=2.835 UĀṣ
28. 3.-2627 fr=0.99 lon= 11.88 dl= –64.97 si=28.240 z=2.301 Bha
31. 1.-2345 fr=0.98 lon=120.53 dl= 43.68 si=22.108 z=1.976 PBh
16. 8.-2328 fr=0.97 lon=117.07 dl= 40.22 si=21.761 z=1.848 UPh
12.12.-2176 fr=0.93 lon=115.80 dl= 38.95 si=18.765 z=2.076 UĀṣ
7. 5.-2164 fr=0.97 lon= 84.99 dl= 8.14 si=18.537 z=0.439 Mṛg
9. 5.-2137 fr=0.96 lon= 56.26 dl= –20.59 si=18.029 z=1.142 Mṛg
7. 1.-1963 fr=0.92 lon= 92.87 dl= 16.02 si=14.909 z=1.075 Dha
21. 1.-1815 fr=0.99 lon=106.45 dl= 29.60 si=12.465 z=2.375 Śat
23. 2.-1761 fr=0.99 lon= 98.48 dl= 21.63 si=11.622 z=1.861 Rev
20. 8.-1677 fr=0.97 lon= 47.76 dl= –29.09 si=10.363 z=2.807 UPh
3. 1.-1618 fr=0.91 lon= 76.80 dl= –0.05 si= 9.516 z=0.005 Dha

# J: Annular Solar Eclipses at Sunset

This is a list of *annular* solar eclipses that were possibly observable at *sunset* from Kurukṣetra (76.85E, 30.00N) between 3500 BCE and 1 BCE. There are more candidates for the more remote past than for the more recent past, but the likelihood of observability is higher for the more recent past. The calculations were made for geographic latitudes between 29°N and 31°N. Information on the data is given in Appendix G.

13. 7.-3470 fr=0.98 lon= 18.86 dl=–57.99 si=50.663 z=1.145 PPh
29.12.-3442 fr=0.95 lon=133.14 dl= 56.29 si=49.820 z=1.130 Dha
8. 1.-3423 fr=0.92 lon= 15.59 dl=–61.26 si=49.252 z=1.244 Śat
3. 2.-3211 fr=0.94 lon= 11.23 dl=–65.62 si=43.124 z=1.522 UBh
8. 4.-3084 fr=0.95 lon= 12.44 dl=–64.41 si=39.637 z=1.625 Kṛt
22. 9.-3083 fr=0.97 lon= 43.52 dl=–33.33 si=39.610 z=0.841 Viś
14.10.-3047 fr=0.94 lon=145.41 dl= 68.56 si=38.648 z=1.774 Anu
25.10.-3029 fr=0.95 lon= 15.09 dl=–61.76 si=38.170 z=1.618 Jye
16.11.-2993 fr=0.94 lon=112.18 dl= 35.33 si=37.224 z=0.949 PĀṣ
1. 4.-2972 fr=0.99 lon=178.32 dl=101.47 si=36.678 z=2.766 Kṛt
24. 7.-2931 fr=0.94 lon=149.49 dl= 72.64 si=35.621 z=2.039 PPh
9.12.-2930 fr=0.95 lon=168.56 dl= 91.71 si=35.596 z=2.577 UĀṣ
22. 2.-2784 fr=0.96 lon=–17.76 dl=–94.61 si=31.952 z=2.961 Rev
15. 8.-2374 fr=0.93 lon=123.98 dl= 47.13 si=22.707 z=2.076 UPh
5. 3.-2245 fr=0.93 lon= 63.55 dl=–13.30 si=20.100 z=0.662 Āśv
30. 6.-2074 fr=0.94 lon=119.24 dl= 42.39 si=16.869 z=2.513 Āśl
10. 4.-1977 fr=0.99 lon= 70.90 dl= –5.95 si=15.150 z=0.393 Kṛt
18. 1.-1945 fr=0.91 lon= 79.30 dl= 2.45 si=14.601 z=0.168 Śat
6. 9.-1817 fr=0.95 lon= 81.36 dl= 4.51 si=12.497 z=0.361 Cit
7. 9.-1790 fr=0.95 lon= 48.89 dl=–27.96 si=12.072 z=2.317 Cit
26. 3.-1688 fr=0.96 lon= 47.78 dl=–29.07 si=10.524 z=2.762 Bha
12.12.-1655 fr=0.91 lon= 56.72 dl=–20.13 si=10.043 z=2.004 UĀṣ
17. 4.-1131 fr=0.98 lon= 73.59 dl= –3.26 si= 3.754 z=0.869 Kṛt

# K: Total and Annular Solar Eclipses Observable in Kurukṣetra

This is a list of total, near-total (m > 99%), and annular solar eclipses that could have been observed from Kurukṣetra (76E51, 30N00) between 3500 BCE and 1 BCE. Because of the uncertainty of ΔT there are more candidates for the more remote past, but the likelihood of observability is higher for more recent eclipses. The calculation examines the geographic latitudes 29°N – 31°N.

Data:

1. line: type of eclipse; date; moment of greatest eclipse in LMT, magnitude values (proportion of diameters Moon : Sun; fraction of solar diameter that is occulted; fraction of the solar disc that is occulted).
2. line: duration and four contacts.
3. line: altitude above the horizon (alt), geographic longitude where the eclipse was observable at Kurukṣetra latitude (lon); offset from the geographic longitude of Kurukṣetra (dlon), assuming the ΔT model Morrison/Stephenson 2004; the estimated standard error in geographic longitude (s=sigma); the proportion z = |dlon| / sigma.

The value z shows the probability that an eclipse was locally observable:

z > 1: The probability is smaller than 31.7%
z > 2: The probability is smaller than 4.6%
z > 3: The probability is smaller than 0.3%

Only eclipses with z < 3 are listed.

In some cases, the central line of the eclipse path does not cross the latitude of Kurukṣetra but only approaches it. In this case, two calculations are made, one for the maximum approximation to the latitude, and another one for the true latitude of Kurukṣetra.

annular 14.08.-3500 05:40:48.7 0.9754/0.9876/0.9514
1 min 34.39 sec - 05:40:01.3 05:41:35.7 06:45:31.0
alt=7.033, lon=54.873, dlon=-21.977, s=51.573, z=0.426

annular 14.08.-3500 13:23:52.3 0.9896/0.9946/0.9794
1 min 2.19 sec 11:46:42.8 13:23:21.4 13:24:23.6 14:50:18.5
alt=69.481, lon=136.838, dlon=59.988, s=51.573, z=1.163

total 6.02.-3499 15:23:56.6 1.0164/1.0082/1.0331
1 min 8.69 sec 14:04:58.9 15:23:22.5 15:24:31.2 16:33:46.1
alt=20.890, lon=-129.487, dlon=153.663, s=51.543, z=2.981

annular 26.11.-3496 10:43:32.4 0.9167/0.9582/0.8403
9 min 49.77 sec 08:59:56.0 10:38:38.0 10:48:27.7 12:40:37.2
alt=42.068, lon=70.456, dlon=-6.394, s=51.452, z=0.124

total 13.09.-3492 14:09:49.5 1.0398/1.0198/1.0812
3 min 2.08 sec 12:46:23.3 14:08:18.5 14:11:20.6 15:25:04.3
alt=56.733, lon=-174.977, dlon=108.173, s=51.330, z=2.107

annular 2.07.-3488 07:33:02.2 0.9847/0.9921/0.9696
1 min 9.09 sec 06:26:17.0 07:32:27.5 07:33:36.6 08:48:58.6
alt=33.594, lon=4.602, dlon=-72.248, s=51.208, z=1.411

annular 6.11.-3486 09:25:33.8 0.9307/0.9650/0.8662
6 min 30.43 sec 08:01:05.8 09:22:18.7 09:28:49.1 10:59:59.1
alt=38.335, lon=149.623, dlon=72.773, s=51.148, z=1.423

annular 25.08.-3482 13:10:48.7 0.9834/0.9915/0.9670
1 min 38.01 sec 11:33:49.4 13:09:59.9 13:11:37.9 14:38:14.7
alt=71.371, lon=14.849, dlon=-62.001, s=51.026, z=1.215

total 18.02.-3481 15:14:39.0 1.0237/1.0118/1.0481
1 min 40.15 sec 13:56:25.9 15:13:49.1 15:15:29.3 16:24:24.0
alt=24.194, lon=111.002, dlon=34.152, s=50.996, z=0.670

annular 7.12.-3478 09:43:39.1 0.9157/0.9578/0.8384
9 min 11.53 sec 08:09:10.7 09:39:03.9 09:48:15.4 11:35:54.3
alt=32.350, lon=-60.083, dlon=-136.933, s=50.905, z=2.690

annular 12.04.-3475 12:36:51.0 0.9656/0.9827/0.9324
3 min 49.85 sec 10:49:35.7 12:34:56.4 12:38:46.2 14:19:30.0
alt=56.480, lon=134.753, dlon=57.903, s=50.814, z=1.140

total 25.09.-3474 13:07:54.9 1.0370/1.0184/1.0753
3 min 1.38 sec 11:40:31.3 13:06:24.4 13:09:25.8 14:29:35.5
alt=64.720, lon=43.168, dlon=-33.682, s=50.784, z=0.663

+annular 13.07.-3470 18:50:49.7 0.9750/0.9822/0.9505
1 min 20.79 sec 17:51:51.1 18:50:09.5 18:51:30.3 -
alt=-0.0699 lat=31.2031, lon=18.1981, dlon=-58.6519, s=50.663, z=1.158
at lat=31:
annular 13.07.-3470 18:51:00.5 0.9749/0.9776/0.9505
0 min 57.64 sec 17:52:03.6 18:50:31.8 18:51:29.5 -

annular 16.11.-3468 08:49:14.7 0.9318/0.9655/0.8682
6 min 0.51 sec 07:30:13.4 08:46:14.5 08:52:15.1 10:18:44.4
alt=29.276, lon=18.244, dlon=-58.606, s=50.603, z=1.158

total 13.05.-3467 14:40:12.9 1.0276/1.0131/1.0560
2 min 8.02 sec 13:15:59.2 14:39:08.9 14:41:17.0 15:57:16.2
alt=45.389, lon=137.257, dlon=60.407, s=50.572, z=1.194

total 28.02.-3463 15:08:54.6 1.0308/1.0152/1.0625
2 min 9.38 sec 13:51:42.9 15:07:50.0 15:09:59.4 16:18:20.7
alt=27.201, lon=-5.796, dlon=-82.646, s=50.452, z=1.638

total 23.06.-3460 10:44:55.0 1.0631/1.0312/1.1302
5 min 16.64 sec 09:21:31.4 10:42:17.0 10:47:33.6 12:14:35.3
alt=73.989, lon=112.988, dlon=36.138, s=50.361, z=0.718

total 23.06.-3460 14:53:05.1 1.0584/1.0287/1.1201
4 min 14.68 sec 13:32:14.3 14:50:57.4 14:55:12.1 16:04:26.9
alt=46.892, lon=152.589, dlon=75.739, s=50.361, z=1.504

annular 18.12.-3460 08:42:23.5 0.9146/0.9572/0.8365
8 min 20.47 sec 07:17:39.4 08:38:13.8 08:46:34.2 10:24:33.7
alt=20.794, lon=169.920, dlon=93.070, s=50.361, z=1.848

annular 23.04.-3457 10:26:56.9 0.9632/0.9814/0.9278
3 min 56.36 sec 08:50:27.2 10:24:58.7 10:28:55.0 12:13:34.3
alt=54.070, lon=16.784, dlon=-60.066, s=50.271, z=1.195

annular 24.07.-3452 07:26:48.3 0.9849/0.9924/0.9700
1 min 8.50 sec 06:20:06.3 07:26:13.9 07:27:22.4 08:43:18.0
alt=31.344, lon=139.711, dlon=62.861, s=50.120, z=1.254

-total 24.05.-3449 16:08:16.4 1.0188/1.0088/1.0379
1 min 17.64 sec 14:50:41.0 16:07:37.7 16:08:55.3 17:16:58.3
alt=27.7738 lat=28.5946, lon=46.4027, dlon=-30.4473, s=50.030, z=0.609
at lat=29:
partial 24.05.-3449 16:08:16.6 0.9968/0.9968/0.9980
0 min 0.00 sec 14:50:50.5 - - 17:16:53.8

annular 12.05.-3448 06:45:28.8 0.9631/0.9809/0.9276
2 min 36.21 sec 05:41:00.8 06:44:10.6 06:46:46.8 07:57:14.7
alt=16.381, lon=-176.111, dlon=107.039, s=50.000, z=2.141

annular 16.09.-3446 12:26:59.4 0.9715/0.9856/0.9439
2 min 48.98 sec 10:50:26.7 12:25:35.1 12:28:24.1 13:58:06.8
alt=72.263, lon=122.694, dlon=45.844, s=49.940, z=0.918

total 4.07.-3442 08:43:29.0 1.0586/1.0292/1.1207
4 min 11.26 sec 07:33:22.2 08:41:23.7 08:45:35.0 10:02:57.5
alt=48.761, lon=-23.944, dlon=-100.794, s=49.820, z=2.023

total 4.07.-3442 15:24:39.1 1.0563/1.0278/1.1157
3 min 49.40 sec 14:08:55.9 15:22:44.2 15:26:33.6 16:31:26.8
alt=41.114, lon=41.894, dlon=-34.956, s=49.820, z=0.702

annular 29.12.-3442 07:40:28.9 0.9136/0.9567/0.8346
7 min 27.31 sec - 07:36:45.6 07:44:12.9 09:10:20.9
alt=8.151, lon=40.229, dlon=-36.621, s=49.820, z=0.735

annular 29.12.-3442 17:03:51.9 0.9118/0.9552/0.8314
7 min 3.94 sec 15:41:00.8 17:00:19.6 17:07:23.6 -
alt=0.180, lon=132.636, dlon=55.786, s=49.820, z=1.120

total 17.10.-3438 11:12:54.5 1.0294/1.0145/1.0596
2 min 27.41 sec 09:47:57.4 11:11:40.8 11:14:08.2 12:40:54.3
alt=58.925, lon=117.929, dlon=41.079, s=49.700, z=0.827

annular 4.08.-3434 07:19:28.9 0.9844/0.9921/0.9691
1 min 10.06 sec 06:13:14.9 07:18:53.7 07:20:03.8 08:35:30.5
alt=28.729, lon=22.322, dlon=-54.528, s=49.581, z=1.100

annular 4.08.-3434 16:29:30.8 0.9833/0.9915/0.9669
1 min 15.37 sec 15:12:59.2 16:28:53.4 16:30:08.8 17:36:12.1
alt=29.519, lon=115.049, dlon=38.199, s=49.581, z=0.770

annular 8.12.-3432 07:36:47.8 0.9352/0.9673/0.8747
4 min 57.82 sec - 07:34:18.9 07:39:16.8 08:55:09.2
alt=11.153, lon=115.203, dlon=38.353, s=49.521, z=0.774

annular 24.05.-3430 07:19:24.1 0.9619/0.9804/0.9252
2 min 50.62 sec 06:11:35.0 07:17:58.8 07:20:49.4 08:35:34.0
alt=26.281, lon=92.752, dlon=15.902, s=49.461, z=0.321

annular 26.09.-3428 11:58:49.6 0.9660/0.9829/0.9332
3 min 22.48 sec 10:23:17.6 11:57:08.6 12:00:31.0 13:31:52.4
alt=69.027, lon=-6.707, dlon=-83.557, s=49.401, z=1.691

total 22.03.-3427 15:08:49.6 1.0432/1.0212/1.0882
2 min 58.12 sec 13:53:48.2 15:07:20.5 15:10:18.6 16:17:16.3
alt=31.633, lon=127.334, dlon=50.484, s=49.372, z=1.023

total 14.07.-3424 07:10:27.0 1.0523/1.0261/1.1074
3 min 11.15 sec 06:10:15.1 07:08:51.6 07:12:02.7 08:17:59.4
alt=28.483, lon=-160.832, dlon=122.318, s=49.282, z=2.482

annular 8.01.-3423 16:40:31.7 0.9154/0.9576/0.8379
7 min 1.83 sec 15:14:15.4 16:37:00.7 16:44:02.5 -
alt=4.863, lon=12.023, dlon=-64.827, s=49.252, z=1.316

annular 15.05.-3421 05:28:01.5 0.9460/0.9603/0.8949
3 min 5.22 sec - 05:26:28.9 05:29:34.1 06:33:21.8
alt=-0.029, lon=121.522, dlon=44.672, s=49.193, z=0.908

total 27.10.-3420 10:19:17.0 1.0250/1.0123/1.0507
2 min 0.52 sec 08:58:55.7 10:18:16.8 10:20:17.4 11:46:09.4
alt=49.086, lon=-25.252, dlon=-102.102, s=49.163, z=2.077

annular 14.08.-3416 15:11:27.3 0.9873/0.9936/0.9747
1 min 6.88 sec 13:43:10.4 15:10:54.2 15:12:01.0 16:27:28.0
alt=46.453, lon=-18.877, dlon=-95.727, s=49.044, z=1.952

annular 19.12.-3414 06:53:26.5 0.9372/0.9655/0.8784
4 min 24.54 sec - 06:51:14.4 06:55:38.9 08:05:17.0
alt=0.0622 lat=30.7757, lon=-17.6785, dlon=-94.5285, s=48.984, z=1.930
at lat=30:
annular 19.12.-3414 06:53:19.2 0.9373/0.9447/0.8785
2 min 54.35 sec - 06:51:52.0 06:54:46.4 08:05:12.5

annular 3.06.-3412 07:36:56.4 0.9591/0.9791/0.9199
3 min 9.14 sec 06:27:03.7 07:35:21.8 07:38:30.9 08:56:04.5
alt=32.100, lon=-2.518, dlon=-79.368, s=48.925, z=1.622

annular 7.10.-3410 11:28:07.5 0.9608/0.9803/0.9232
3 min 52.84 sec 09:54:24.7 11:26:11.3 11:30:04.1 13:02:36.0
alt=63.533, lon=-137.407, dlon=145.743, s=48.865, z=2.983

total 2.04.-3409 15:16:43.6 1.0481/1.0236/1.0986
3 min 15.96 sec 14:02:48.4 15:15:05.5 15:18:21.5 16:24:24.3
alt=32.241, lon=17.059, dlon=-59.791, s=48.836, z=1.224

total 26.07.-3406 05:52:28.3 1.0456/1.0226/1.0932
2 min 25.99 sec 04:59:06.9 05:51:15.4 05:53:41.4 06:51:01.6
alt=11.588, lon=60.529, dlon=-16.321, s=48.747, z=0.335

total 26.07.-3406 15:27:26.1 1.0537/1.0268/1.1104
3 min 32.08 sec 14:14:26.1 15:25:40.0 15:29:12.1 16:32:18.6
alt=42.336, lon=163.446, dlon=86.596, s=48.747, z=1.776

total 7.11.-3402 09:28:22.8 1.0204/1.0100/1.0413
1 min 32.22 sec 08:13:22.0 09:27:36.8 09:29:09.0 10:51:41.6
alt=38.171, lon=-168.699, dlon=114.451, s=48.628, z=2.354

total 13.03.-3399 16:08:05.8 1.0635/1.0314/1.1311
3 min 59.58 sec 14:58:35.4 16:06:05.8 16:10:05.4 17:10:32.3
alt=19.298, lon=133.752, dlon=56.902, s=48.539, z=1.172

annular 26.08.-3398 06:54:48.7 0.9826/0.9911/0.9654
1 min 15.09 sec 05:50:52.9 06:54:11.1 06:55:26.2 08:07:41.3
alt=20.661, lon=136.566, dlon=59.716, s=48.509, z=1.231

annular 25.08.-3398 13:52:13.4 0.9904/0.9951/0.9810
0 min 57.78 sec 12:14:39.2 13:51:44.9 13:52:42.6 15:18:14.3
alt=62.989, lon=-153.742, dlon=129.408, s=48.509, z=2.668

annular 18.10.-3392 10:54:42.6 0.9560/0.9778/0.9139
4 min 18.50 sec 09:23:41.9 10:52:33.2 10:56:51.7 12:29:45.2
alt=56.508, lon=90.298, dlon=13.448, s=48.332, z=0.278

total 2.04.-3390 07:54:40.5 1.0691/1.0338/1.1430
4 min 18.04 sec 06:52:22.0 07:52:32.0 07:56:50.1 09:02:59.7
alt=19.258, lon=-65.247, dlon=-142.097, s=48.273, z=2.944

total 5.08.-3388 15:15:52.3 1.0526/1.0263/1.1080
3 min 29.07 sec 14:02:34.4 15:14:07.7 15:17:36.8 16:21:17.3
alt=45.368, lon=38.524, dlon=-38.326, s=48.214, z=0.795

annular 30.01.-3387 16:08:58.5 0.9230/0.9614/0.8518
6 min 37.23 sec 14:39:43.5 16:05:39.8 16:12:17.0 -
alt=12.458, lon=142.169, dlon=65.319, s=48.184, z=1.356

-annular 24.05.-3384 14:57:52.5 0.9496/0.9743/0.9017
5 min 4.71 sec 13:12:33.4 14:55:20.2 15:00:24.9 16:26:09.6
alt=43.3740 lat=28.1634, lon=18.3737, dlon=-58.4763, s=48.096, z=1.216
at lat=29:
annular 24.05.-3384 14:57:35.8 0.9496/0.9503/0.9017
1 min 28.90 sec 13:12:56.7 14:56:51.8 14:58:20.7 16:25:36.8

total 18.11.-3384 08:38:51.4 1.0161/1.0077/1.0324
1 min 6.61 sec 07:29:19.2 08:38:18.1 08:39:24.8 09:56:59.3
alt=26.877, lon=47.815, dlon=-29.035, s=48.096, z=0.604

total 24.03.-3381 14:23:05.5 1.0706/1.0350/1.1461
5 min 10.77 sec 13:02:37.7 14:20:29.9 14:25:40.6 15:36:14.2
alt=39.540, lon=-1.625, dlon=-78.475, s=48.007, z=1.635

annular 5.09.-3380 06:36:27.4 0.9814/0.9904/0.9631
1 min 17.33 sec 05:34:27.9 06:35:48.6 06:37:06.0 07:46:33.7
alt=15.123, lon=8.134, dlon=-68.716, s=47.978, z=1.432

annular 5.09.-3380 12:32:04.2 0.9923/0.9959/0.9846
0 min 50.95 sec 10:51:59.9 12:31:39.0 12:32:29.9 14:06:33.7
alt=74.894, lon=69.924, dlon=-6.926, s=47.978, z=0.144

annular 25.06.-3376 07:53:40.3 0.9514/0.9755/0.9051
3 min 57.62 sec 06:40:36.7 07:51:41.5 07:55:39.1 09:18:06.8
alt=37.844, lon=160.287, dlon=83.437, s=47.860, z=1.743

annular 29.10.-3374 10:20:00.1 0.9514/0.9755/0.9052
4 min 38.23 sec 08:52:25.5 10:17:40.9 10:22:19.1 11:54:27.1
alt=48.599, lon=-42.585, dlon=-119.435, s=47.801, z=2.499

total 24.04.-3373 16:20:45.4 1.0529/1.0258/1.1085
3 min 18.42 sec 15:12:16.8 16:19:06.0 16:22:24.5 17:23:09.9
alt=22.286, lon=168.236, dlon=91.386, s=47.772, z=1.913

total 12.04.-3372 08:48:42.7 1.0742/1.0364/1.1540
4 min 53.97 sec 07:42:18.3 08:46:16.2 08:51:10.2 10:00:46.9
alt=33.544, lon=-167.966, dlon=115.184, s=47.743, z=2.413

annular 10.02.-3369 15:59:43.4 0.9269/0.9632/0.8591
6 min 18.13 sec 14:30:29.5 15:56:34.4 16:02:52.5 17:16:07.9
alt=15.622, lon=32.504, dlon=-44.346, s=47.655, z=0.931

annular 4.06.-3366 16:41:20.3 0.9448/0.9721/0.8927
4 min 25.82 sec 15:17:24.0 16:39:07.6 16:43:33.4 17:52:50.3
alt=21.823, lon=-59.494, dlon=-136.344, s=47.567, z=2.866

annular 16.09.-3362 11:30:47.2 0.9929/0.9961/0.9858
0 min 47.43 sec 09:53:55.3 11:30:23.5 11:31:10.9 13:08:47.8
alt=72.0073 lat=29.0604, lon=-65.4738, dlon=-142.3238, s=47.449, z=2.999
at lat=30:
partial 16.09.-3362 11:29:50.8 0.9699/0.9699/0.9589
0 min 0.00 sec 09:53:41.6 - - 13:07:16.0

annular 6.07.-3358 07:57:11.3 0.9468/0.9733/0.8964
4 min 26.84 sec 06:42:39.4 07:54:57.8 07:59:24.6 09:24:17.3
alt=38.709, lon=58.488, dlon=-18.362, s=47.332, z=0.388

annular 8.11.-3356 09:44:09.3 0.9473/0.9734/0.8973
4 min 51.27 sec 08:20:33.7 09:41:43.6 09:46:34.9 11:16:42.2
alt=40.134, lon=-175.919, dlon=107.231, s=47.274, z=2.268

total 24.04.-3354 09:10:05.0 1.0765/1.0377/1.1588
5 min 7.09 sec 08:02:33.7 09:07:32.0 09:12:39.1 10:23:01.1
alt=41.351, lon=83.301, dlon=6.451, s=47.215, z=0.137

total 27.08.-3352 14:37:39.4 1.0502/1.0250/1.1029
3 min 27.35 sec 13:22:08.6 14:35:55.7 14:39:23.1 15:45:56.3
alt=53.203, lon=139.642, dlon=62.792, s=47.157, z=1.332

annular 15.06.-3348 09:17:06.5 0.9516/0.9758/0.9056
4 min 54.64 sec 07:47:51.7 09:14:39.2 09:19:33.9 11:03:12.4
alt=55.235, lon=130.204, dlon=53.354, s=47.040, z=1.134

annular 14.06.-3348 17:21:13.1 0.9426/0.9711/0.8884
4 min 12.16 sec 16:05:33.4 17:19:07.3 17:23:19.4 18:27:01.0
alt=14.495, lon=-149.813, dlon=133.337, s=47.040, z=2.835

total 10.12.-3348 07:02:02.4 1.0078/1.0035/1.0157
0 min 26.00 sec - 07:01:49.5 07:02:15.5 08:08:26.5
alt=4.013, lon=121.397, dlon=44.547, s=47.040, z=0.947

total 15.04.-3345 10:29:46.8 1.0732/1.0363/1.1518
5 min 41.55 sec 09:11:27.2 10:26:56.4 10:32:38.0 11:53:26.0
alt=51.600, lon=93.044, dlon=16.194, s=46.953, z=0.345

annular 27.09.-3344 05:42:12.5 0.9786/0.9872/0.9577
1 min 18.21 sec - 05:41:33.4 05:42:51.7 06:44:34.8
alt=-0.025, lon=99.656, dlon=22.806, s=46.923, z=0.486

annular 27.09.-3344 09:55:18.8 0.9917/0.9954/0.9834
0 min 49.92 sec 08:29:40.3 09:54:53.9 09:55:43.8 11:29:56.8
alt=53.463, lon=151.324, dlon=74.474, s=46.923, z=1.587

annular 16.07.-3340 07:58:44.8 0.9419/0.9709/0.8873
4 min 58.30 sec 06:42:48.3 07:56:15.6 08:01:13.9 09:28:25.8
alt=38.612, lon=-45.725, dlon=-122.575, s=46.807, z=2.619

annular 16.07.-3340 18:05:03.7 0.9355/0.9676/0.8752
4 min 22.99 sec 16:55:36.0 18:02:52.4 18:07:15.4 -
alt=8.789, lon=58.488, dlon=-18.362, s=46.807, z=0.392

annular 20.11.-3338 09:08:11.5 0.9435/0.9715/0.8902
4 min 58.18 sec 07:48:48.3 09:05:42.3 09:10:40.5 10:37:40.8
alt=31.453, lon=50.997, dlon=-25.853, s=46.749, z=0.553

total 4.05.-3336 09:22:57.5 1.0771/1.0381/1.1602
5 min 12.49 sec 08:14:49.2 09:20:21.7 09:25:34.2 10:36:33.1
alt=47.418, lon=-26.268, dlon=-103.118, s=46.691, z=2.209

total 7.09.-3334 14:12:26.6 1.0489/1.0243/1.1003
3 min 27.59 sec 12:55:26.2 14:10:42.8 14:14:10.4 15:22:50.5
alt=57.207, lon=6.002, dlon=-70.848, s=46.632, z=1.519

annular 3.03.-3333 15:56:17.3 0.9341/0.9667/0.8726
5 min 35.47 sec 14:29:06.2 15:53:29.6 15:59:05.1 17:12:15.1
alt=19.936, lon=-175.989, dlon=107.161, s=46.603, z=2.299

annular 26.06.-3330 07:28:07.0 0.9469/0.9733/0.8967
4 min 21.75 sec 06:14:55.9 07:25:56.2 07:30:17.9 08:54:13.5
alt=32.386, lon=9.424, dlon=-67.426, s=46.516, z=1.450

annular 26.06.-3330 17:37:55.5 0.9414/0.9707/0.8862
4 min 6.02 sec 16:26:02.6 17:35:52.8 17:39:58.8 18:41:11.1
alt=12.236, lon=113.406, dlon=36.556, s=46.516, z=0.786

total 25.04.-3327 08:15:46.8 1.0668/1.0329/1.1381
4 min 21.90 sec 07:10:51.2 08:13:36.3 08:17:58.2 09:27:59.1
alt=30.951, lon=-43.580, dlon=-120.430, s=46.429, z=2.594

annular 8.10.-3326 08:45:30.2 0.9900/0.9945/0.9801
0 min 52.67 sec 07:29:35.3 08:45:03.9 08:45:56.6 10:11:36.4
alt=37.393, lon=9.161, dlon=-67.689, s=46.400, z=1.459

annular 27.07.-3322 08:00:00.5 0.9370/0.9684/0.8780
5 min 31.82 sec 06:42:35.6 07:57:14.6 08:02:46.4 09:32:17.1
alt=38.042, lon=-151.838, dlon=131.312, s=46.284, z=2.837

annular 14.03.-3315 16:03:43.3 0.9371/0.9681/0.8782
5 min 14.94 sec 14:38:14.6 16:01:05.9 16:06:20.9 17:18:45.3
alt=20.437, lon=84.880, dlon=8.030, s=46.082, z=0.174

annular 6.07.-3312 17:43:13.9 0.9405/0.9701/0.8846
4 min 4.36 sec 16:33:09.4 17:41:12.0 17:45:16.4 18:45:19.6
alt=12.310, lon=11.796, dlon=-65.054, s=45.995, z=1.414

total 7.05.-3309 05:37:48.6 1.0553/1.0047/1.1136
1 min 30.27 sec - 05:37:03.7 05:38:34.0 06:33:00.7
alt=-0.021, lon=168.962, dlon=92.112, s=45.909, z=2.006

+annular 18.10.-3308 06:52:23.5 0.9852/0.9921/0.9707
1 min 1.63 sec - 06:51:52.6 06:52:54.3 08:01:52.5
alt=11.4399 lat=31.3828, lon=-145.5821, dlon=137.5679, s=45.880, z=2.998
at lat=31:
partial 18.10.-3308 06:52:15.1 0.9804/0.9804/0.9670
0 min 0.00 sec - - - 08:01:46.9

annular 22.02.-3305 16:09:12.4 0.9763/0.9879/0.9531
1 min 54.33 sec 14:46:30.0 16:08:15.5 16:10:09.8 17:20:49.1
alt=15.978, lon=95.497, dlon=18.647, s=45.794, z=0.407

annular 7.08.-3304 08:00:26.6 0.9322/0.9659/0.8689
6 min 5.29 sec 06:41:41.9 07:57:24.1 08:03:29.4 09:34:56.3
alt=36.990, lon=99.338, dlon=22.488, s=45.765, z=0.491

annular 7.08.-3304 15:15:52.3 0.9342/0.9671/0.8727
6 min 18.58 sec 13:34:46.2 15:12:43.0 15:19:01.6 16:39:39.3
alt=45.433, lon=166.703, dlon=89.853, s=45.765, z=1.963

annular 12.12.-3302 07:57:59.1 0.9375/0.9685/0.8790
4 min 57.07 sec 06:46:42.9 07:55:30.6 08:00:27.6 09:19:19.3
alt=14.267, lon=147.089, dlon=70.239, s=45.707, z=1.537

total 26.05.-3300 09:36:26.3 1.0750/1.0373/1.1556
5 min 11.12 sec 08:27:00.8 09:33:51.1 09:39:02.3 10:52:04.5
alt=56.103, lon=111.904, dlon=35.054, s=45.650, z=0.768

total 29.09.-3298 13:13:06.0 1.0465/1.0231/1.0951
3 min 27.76 sec 11:53:41.9 13:11:22.2 13:14:50.0 14:28:18.1
alt=62.228, lon=92.287, dlon=15.437, s=45.592, z=0.339

annular 25.03.-3297 16:21:57.7 0.9395/0.9692/0.8827
4 min 54.44 sec 14:59:05.3 16:19:30.6 16:24:25.1 17:35:06.1
alt=18.564, lon=-10.087, dlon=-86.937, s=45.563, z=1.908

+annular 18.07.-3294 04:49:06.5 0.9373/0.9501/0.8786
3 min 8.25 sec - 04:47:32.4 04:50:40.7 05:51:18.2
alt=-0.0704 lat=31.1844, lon=122.8630, dlon=46.0130, s=45.477, z=1.012
at lat=31:
annular 18.07.-3294 04:48:55.3 0.9373/0.9463/0.8786
2 min 45.08 sec - 04:47:32.8 04:50:17.8 05:51:04.7

annular 30.10.-3290 06:57:47.3 0.9876/0.9933/0.9753
0 min 52.25 sec - 06:57:21.2 06:58:13.4 08:07:09.4
alt=10.878, lon=83.438, dlon=6.588, s=45.362, z=0.145

annular 4.03.-3287 14:34:41.0 0.9871/0.9934/0.9744
1 min 14.04 sec 12:59:17.2 14:34:04.3 14:35:18.4 15:57:55.5
alt=33.521, lon=-31.906, dlon=-108.756, s=45.276, z=2.402

annular 18.08.-3286 08:02:43.6 0.9275/0.9635/0.8603
6 min 39.20 sec 06:42:29.6 07:59:24.3 08:06:03.5 09:39:24.3
alt=36.146, lon=-11.358, dlon=-88.208, s=45.248, z=1.949

annular 18.08.-3286 13:43:36.2 0.9325/0.9661/0.8695
7 min 40.37 sec 11:47:30.2 13:39:45.8 13:47:26.2 15:22:43.2
alt=65.193, lon=40.442, dlon=-36.408, s=45.248, z=0.805

annular 22.12.-3284 07:25:45.2 0.9354/0.9674/0.8749
4 min 52.21 sec - 07:23:19.0 07:28:11.3 08:42:59.8
alt=6.319, lon=17.638, dlon=-59.212, s=45.191, z=1.310

total 6.06.-3282 09:41:12.2 1.0725/1.0362/1.1502
5 min 6.62 sec 08:30:42.2 09:38:39.3 09:43:45.9 10:58:30.3
alt=59.183, lon=0.041, dlon=-76.809, s=45.133, z=1.702

total 9.10.-3280 12:40:07.0 1.0453/1.0225/1.0927
3 min 26.38 sec 11:20:20.8 12:38:24.0 12:41:50.3 13:57:33.3
alt=61.713, lon=-47.058, dlon=-123.908, s=45.076, z=2.749

annular 25.03.-3278 09:19:43.5 0.9802/0.9894/0.9608
1 min 49.86 sec 07:56:42.6 09:18:48.6 09:20:38.5 10:51:47.4
alt=33.130, lon=131.772, dlon=54.922, s=45.019, z=1.220

annular 28.07.-3276 17:34:20.8 0.9395/0.9694/0.8826
4 min 7.88 sec 16:24:45.4 17:32:17.1 17:36:25.0 18:36:21.8
alt=15.763, lon=156.867, dlon=80.017, s=44.962, z=1.780

annular 15.03.-3269 12:46:28.7 0.9964/0.9981/0.9928
0 min 26.50 sec 11:05:45.8 12:46:15.7 12:46:42.2 14:21:34.3
alt=47.082, lon=-157.664, dlon=125.486, s=44.762, z=2.803

total 21.10.-3262 12:05:16.6 1.0441/1.0219/1.0902
3 min 22.81 sec 10:45:56.2 12:03:35.1 12:06:58.0 13:24:29.5
alt=58.754, lon=172.192, dlon=95.342, s=44.563, z=2.139

annular 4.04.-3260 09:54:09.9 0.9873/0.9931/0.9748
1 min 12.45 sec 08:29:21.6 09:53:33.6 09:54:46.1 11:26:00.3
alt=42.660, lon=33.655, dlon=-43.195, s=44.506, z=0.971

annular 8.08.-3258 17:22:50.5 0.9392/0.9692/0.8821
4 min 12.46 sec 16:12:19.7 17:20:44.4 17:24:56.9 18:25:41.6
alt=18.389, lon=44.081, dlon=-32.769, s=44.449, z=0.737

-total 2.02.-3257 17:21:19.7 1.0088/1.0039/1.0176
0 min 28.57 sec 16:17:09.7 17:21:05.6 17:21:34.2 -
alt=0.0637 lat=28.8828, lon=-42.8169, dlon=-119.6669, s=44.421, z=2.694
at lat=29:
total 2.02.-3257 17:21:18.2 1.0088/1.0015/1.0176
0 min 19.91 sec 16:17:08.5 17:21:08.3 17:21:28.2 -

total 28.05.-3254 12:09:26.6 1.0131/1.0062/1.0263
1 min 12.47 sec 10:31:44.2 12:08:50.5 12:10:03.0 13:47:06.5
alt=73.893, lon=68.654, dlon=-8.196, s=44.336, z=0.185

total 28.05.-3254 17:08:15.1 1.0020/1.0007/1.0040
0 min 3.79 sec 15:57:48.9 17:08:13.4 17:08:17.2 18:10:28.3
alt=15.452, lon=121.616, dlon=44.766, s=44.336, z=1.010

total 26.03.-3251 10:36:44.0 1.0021/1.0007/1.0043
0 min 5.88 sec 09:05:54.9 10:36:41.0 10:36:46.9 12:14:56.0
alt=45.369, lon=75.249, dlon=-1.601, s=44.251, z=0.036

annular 9.09.-3250 09:15:31.8 0.9222/0.9606/0.8504
8 min 25.29 sec 07:41:37.0 09:11:19.6 09:19:44.9 11:06:54.4
alt=48.7766 lat=29.9939, lon=132.1931, dlon=55.3431, s=44.222, z=1.251
at lat=30:
annular 9.09.-3250 09:15:32.0 0.9222/0.9608/0.8504
8 min 25.29 sec 07:41:37.2 09:11:19.7 09:19:45.0 11:06:54.2

total 28.06.-3246 09:51:34.4 1.0649/1.0322/1.1341
4 min 50.19 sec 08:37:44.6 09:49:09.7 09:53:59.9 11:13:29.2
alt=63.335, lon=133.227, dlon=56.377, s=44.109, z=1.278

total 31.10.-3244 11:29:59.3 1.0431/1.0214/1.0880
3 min 17.55 sec 10:11:54.9 11:28:20.5 11:31:38.1 12:50:13.1
alt=53.773, lon=31.137, dlon=-45.713, s=44.052, z=1.038

total 12.02.-3239 17:17:18.9 1.0094/1.0039/1.0189
0 min 30.56 sec 16:12:55.3 17:17:03.8 17:17:34.3 -
alt=1.882, lon=-162.786, dlon=120.364, s=43.911, z=2.741

annular 7.06.-3236 17:46:14.5 0.9948/0.9972/0.9895
0 min 22.41 sec 16:41:03.6 17:46:03.5 17:46:25.9 -
alt=8.582, lon=24.184, dlon=-52.666, s=43.826, z=1.202

-annular 19.09.-3232 08:22:58.4 0.9167/0.9579/0.8403
8 min 11.85 sec 06:57:35.3 08:18:53.0 08:27:04.8 10:05:34.4
alt=36.0537 lat=28.3182, lon=5.4827, dlon=-71.3673, s=43.714, z=1.633
at lat=29:
annular 19.09.-3232 08:23:13.6 0.9167/0.9391/0.8403
7 min 16.45 sec 06:58:00.0 08:19:35.8 08:26:52.2 10:05:22.7

total 8.07.-3228 10:00:20.0 1.0602/1.0298/1.1241
4 min 39.29 sec 08:44:02.5 09:58:00.7 10:02:40.0 11:25:08.6
alt=65.156, lon=18.120, dlon=-58.730, s=43.601, z=1.347

total 8.07.-3228 16:55:14.3 1.0510/1.0254/1.1046
3 min 1.54 sec 15:49:31.3 16:53:43.5 16:56:45.0 17:54:00.7
alt=22.464, lon=89.191, dlon=12.341, s=43.601, z=0.283

annular 25.04.-3224 10:27:52.3 0.9986/0.9990/0.9972
0 min 11.28 sec 09:03:20.5 10:27:46.6 10:27:57.9 11:58:18.7
alt=56.045, lon=-166.761, dlon=116.389, s=43.489, z=2.676

annular 30.08.-3222 16:45:44.0 0.9394/0.9692/0.8825
4 min 26.74 sec 15:30:52.5 16:43:30.8 16:47:57.5 17:52:14.3
alt=25.236, lon=166.741, dlon=89.891, s=43.432, z=2.070

total 24.02.-3221 17:09:29.0 1.0101/1.0045/1.0203
0 min 33.96 sec 16:04:11.9 17:09:12.2 17:09:46.1 -
alt=4.991, lon=78.924, dlon=2.074, s=43.404, z=0.048

annular 19.06.-3218 07:59:47.6 0.9956/0.9977/0.9913
0 min 23.82 sec 06:48:29.7 07:59:35.6 07:59:59.4 09:22:07.5
alt=38.826, lon=175.176, dlon=98.326, s=43.320, z=2.270

-annular 3.02.-3211 17:22:35.4 0.9374/0.9677/0.8787
4 min 39.82 sec 16:05:31.0 17:20:15.5 17:24:55.3 -
alt=0.0629 lat=28.8036, lon=11.1990, dlon=-65.6510, s=43.124, z=1.522
at lat=29:
annular 3.02.-3211 17:22:28.3 0.9374/0.9646/0.8787
4 min 37.76 sec 16:05:24.3 17:20:09.4 17:24:47.2 -

total 19.07.-3210 15:18:10.2 1.0515/1.0255/1.1056
3 min 38.64 sec 13:59:21.2 15:16:20.8 15:19:59.4 16:27:29.6
alt=44.012, lon=-48.851, dlon=-125.701, s=43.096, z=2.917

total 22.11.-3208 10:17:25.8 1.0411/1.0205/1.0839
3 min 1.24 sec 09:04:00.5 10:15:55.2 10:18:56.4 11:36:47.0
alt=40.254, lon=107.707, dlon=30.857, s=43.040, z=0.717

total 7.05.-3206 10:39:02.7 1.0032/1.0014/1.0064
0 min 12.25 sec 09:14:30.1 10:38:56.5 10:39:08.8 12:09:40.5
alt=61.702, lon=92.020, dlon=15.170, s=42.984, z=0.353

annular 9.09.-3204 16:20:48.7 0.9401/0.9695/0.8838
4 min 35.55 sec 15:02:35.4 16:18:31.1 16:23:06.7 17:30:11.0
alt=29.262, lon=42.866, dlon=-33.984, s=42.928, z=0.792

total 6.03.-3203 17:10:14.9 1.0099/1.0044/1.0199
0 min 33.38 sec 16:04:47.4 17:09:58.3 17:10:31.7 -
alt=6.411, lon=-34.852, dlon=-111.702, s=42.900, z=2.604

annular 29.06.-3200 06:22:36.8 0.9844/0.9919/0.9691
1 min 3.82 sec 05:21:37.9 06:22:04.8 06:23:08.6 07:31:11.7
alt=18.595, lon=46.893, dlon=-29.957, s=42.816, z=0.700

annular 29.06.-3200 18:08:54.2 0.9824/0.9911/0.9650
1 min 5.68 sec 17:06:51.0 18:08:21.6 18:09:27.3 -
alt=6.464, lon=175.463, dlon=98.613, s=42.816, z=2.303

total 30.07.-3192 11:01:10.9 1.0506/1.0247/1.1038
4 min 21.70 sec 09:35:09.5 10:59:00.3 11:03:22.0 12:32:35.1
alt=76.343, lon=149.367, dlon=72.517, s=42.593, z=1.703

total 3.12.-3190 09:41:47.0 1.0404/1.0201/1.0824
2 min 51.87 sec 08:31:18.4 09:40:21.1 09:43:13.0 10:59:16.0
alt=32.739, lon=-33.549, dlon=-110.399, s=42.538, z=2.595

total 17.05.-3188 10:49:23.3 1.0070/1.0035/1.0141
0 min 32.89 sec 09:24:17.3 10:49:06.7 10:49:39.6 12:20:54.8
alt=66.928, lon=-10.162, dlon=-87.012, s=42.482, z=2.048

annular 10.07.-3182 18:09:16.9 0.9764/0.9880/0.9533
1 min 27.17 sec 17:07:24.7 18:08:33.6 18:10:00.8 -
alt=7.504, lon=66.748, dlon=-10.102, s=42.315, z=0.239

annular 25.02.-3175 14:35:33.1 0.9469/0.9734/0.8967
5 min 25.38 sec 12:49:30.1 14:32:50.5 14:38:15.9 16:05:34.3
alt=31.947, lon=121.829, dlon=44.979, s=42.121, z=1.068

total 13.12.-3172 09:08:05.2 1.0398/1.0199/1.0812
2 min 43.08 sec 08:00:33.5 09:06:43.8 09:09:26.9 10:23:07.8
alt=25.339, lon=-173.322, dlon=109.828, s=42.038, z=2.613

annular 1.10.-3168 15:21:02.9 0.9427/0.9708/0.8887
4 min 53.08 sec 13:54:30.1 15:18:36.5 15:23:29.6 16:38:09.4
alt=37.566, lon=147.053, dlon=70.203, s=41.928, z=1.674

total 28.03.-3167 17:54:03.1 1.0054/1.0023/1.0109
0 min 16.04 sec 16:51:48.3 17:53:55.2 17:54:11.3 -
alt=0.0212 lat=29.1648, lon=114.3228, dlon=37.4728, s=41.900, z=0.894
at lat=30:
partial 28.03.-3167 17:54:06.9 0.9768/0.9768/0.9721
0 min 0.00 sec 16:51:58.0 - - -

annular 20.07.-3164 18:04:59.2 0.9705/0.9849/0.9418
1 min 49.20 sec 17:02:41.3 18:04:04.9 18:05:54.1 -
alt=9.210, lon=-44.611, dlon=-121.461, s=41.817, z=2.905

total 8.05.-3160 13:25:00.8 1.0726/1.0359/1.1505
5 min 46.62 sec 11:59:47.7 13:22:07.3 13:27:53.9 14:45:14.7
alt=59.413, lon=69.993, dlon=-6.857, s=41.707, z=0.164

annular 8.03.-3157 12:39:12.6 0.9502/0.9749/0.9028
5 min 50.09 sec 10:45:53.2 12:36:17.6 12:42:07.7 14:25:34.2
alt=45.239, lon=-0.180, dlon=-77.030, s=41.624, z=1.851

total 25.12.-3154 08:35:41.7 1.0396/1.0197/1.0807
2 min 35.25 sec 07:31:02.7 08:34:24.2 08:36:59.4 09:47:55.0
alt=18.148, lon=47.831, dlon=-29.019, s=41.542, z=0.699

total 8.06.-3152 11:16:06.3 1.0126/1.0060/1.0255
1 min 5.17 sec 09:47:30.1 11:15:33.7 11:16:38.9 12:51:09.7
alt=76.576, lon=143.223, dlon=66.373, s=41.487, z=1.600

annular 12.10.-3150 14:47:35.9 0.9447/0.9718/0.8925
4 min 59.13 sec 13:16:48.2 14:45:06.6 14:50:05.7 16:09:22.3
alt=41.215, lon=16.166, dlon=-60.684, s=41.432, z=1.465

annular 28.03.-3148 10:01:31.0 0.9610/0.9799/0.9235
3 min 52.85 sec 08:30:39.5 09:59:34.5 10:03:27.4 11:40:00.9
alt=41.452, lon=173.660, dlon=96.810, s=41.377, z=2.340

annular 31.07.-3146 17:52:25.5 0.9649/0.9821/0.9310
2 min 12.75 sec 16:48:36.9 17:51:19.4 17:53:32.2 18:50:14.3
alt=12.4119 lat=30.5705, lon=-159.5196, dlon=123.6304, s=41.322, z=2.992
at lat=30:
annular 31.07.-3146 17:53:14.1 0.9648/0.9728/0.9308
1 min 52.53 sec 16:49:32.0 17:52:18.0 17:54:10.5 18:50:56.2

annular 18.03.-3139 06:40:21.5 0.9397/0.9583/0.8831
4 min 9.02 sec - 06:38:17.1 06:42:26.1 07:57:08.4
alt=0.032, lon=-164.344, dlon=118.806, s=41.130, z=2.889

total 19.06.-3134 11:38:47.5 1.0144/1.0067/1.0290
1 min 17.21 sec 10:06:52.6 11:38:08.9 11:39:26.2 13:15:39.0
alt=80.725, lon=38.743, dlon=-38.107, s=40.993, z=0.930

total 19.06.-3134 17:29:26.4 1.0009/1.0003/1.0018
0 min -0.33 sec 16:21:24.6 17:29:27.7 17:29:27.4 18:29:59.3
alt=13.456, lon=100.821, dlon=23.971, s=40.993, z=0.585

annular 8.04.-3130 10:22:39.6 0.9615/0.9803/0.9245
3 min 50.60 sec 08:50:49.7 10:20:44.2 10:24:34.8 12:00:52.7
alt=48.596, lon=77.117, dlon=0.267, s=40.884, z=0.007

annular 11.08.-3128 17:45:17.9 0.9589/0.9790/0.9195
2 min 37.61 sec 16:40:26.7 17:43:59.3 17:46:36.9 18:44:00.4
alt=13.684, lon=84.695, dlon=7.845, s=40.830, z=0.192

total 25.01.-3126 09:28:08.1 1.0519/1.0255/1.1065
3 min 55.42 sec 08:13:49.9 09:26:10.7 09:30:06.1 10:51:13.4
alt=23.492, lon=148.757, dlon=71.907, s=40.775, z=1.764

total 25.01.-3126 11:37:01.9 1.0555/1.0271/1.1140
4 min 41.32 sec 10:10:28.1 11:34:41.3 11:39:22.6 13:04:28.6
alt=35.781, lon=169.576, dlon=92.726, s=40.775, z=2.274

total 30.05.-3124 09:12:03.2 1.0731/1.0364/1.1516
5 min 12.35 sec 08:01:25.1 09:09:27.5 09:14:39.8 10:30:51.2
alt=52.026, lon=164.406, dlon=87.556, s=40.720, z=2.150

total 16.01.-3117 07:40:34.9 1.0399/1.0199/1.0815
2 min 25.27 sec - 07:39:22.4 07:41:47.6 08:47:36.5
alt=6.002, lon=136.843, dlon=59.993, s=40.530, z=1.480

total 29.06.-3116 15:26:45.0 1.0093/1.0042/1.0186
0 min 40.03 sec 14:00:42.5 15:26:25.1 15:27:05.1 16:41:17.5
alt=40.594, lon=-35.039, dlon=-111.889, s=40.503, z=2.762

annular 3.11.-3114 13:36:59.4 0.9500/0.9744/0.9025
4 min 58.19 sec 11:59:57.2 13:34:30.5 13:39:28.7 15:08:34.1
alt=45.560, lon=110.951, dlon=34.101, s=40.448, z=0.843

annular 18.04.-3112 10:37:41.6 0.9612/0.9803/0.9240
3 min 53.23 sec 09:05:20.6 10:35:44.9 10:39:38.1 12:16:07.2
alt=54.885, lon=-18.947, dlon=-95.797, s=40.394, z=2.372

annular 22.08.-3110 17:29:49.6 0.9535/0.9762/0.9091
3 min 4.53 sec 16:22:42.5 17:28:17.5 17:31:22.0 18:30:22.8
alt=16.389, lon=-35.024, dlon=-111.874, s=40.340, z=2.773

total 5.02.-3108 07:43:57.4 1.0495/1.0244/1.1015
3 min 8.53 sec - 07:42:23.4 07:45:32.0 08:54:17.3
alt=6.437, lon=3.623, dlon=-73.227, s=40.286, z=1.818

total 5.02.-3108 12:03:32.5 1.0590/1.0289/1.1216
4 min 53.90 sec 10:36:59.1 12:01:05.7 12:05:59.6 13:28:11.5
alt=37.741, lon=48.360, dlon=-28.490, s=40.286, z=0.707

total 10.06.-3106 07:27:11.3 1.0676/1.0335/1.1398
4 min 4.22 sec 06:27:16.4 07:25:09.5 07:29:13.7 08:33:55.1
alt=31.032, lon=30.832, dlon=-46.018, s=40.231, z=1.144

total 26.01.-3099 07:19:33.4 1.0406/1.0200/1.0828
2 min 23.60 sec - 07:18:21.7 07:20:45.3 08:24:40.8
alt=1.653, lon=5.573, dlon=-71.277, s=40.042, z=1.780

total 26.01.-3099 17:05:09.4 1.0412/1.0205/1.0842
2 min 26.17 sec 15:59:52.6 17:03:56.4 17:06:22.6 -
alt=1.981, lon=109.101, dlon=32.251, s=40.042, z=0.805

annular 13.11.-3096 13:00:49.5 0.9532/0.9761/0.9086
4 min 48.32 sec 11:22:35.3 12:58:25.6 13:03:13.9 14:36:51.5
alt=45.650, lon=-22.581, dlon=-99.431, s=39.961, z=2.488

-annular 22.08.-3091 08:55:31.7 0.9255/0.9623/0.8566
7 min 55.10 sec 07:23:00.5 08:51:34.5 08:59:29.7 10:44:48.6
alt=46.9380 lat=28.7238, lon=93.4286, dlon=16.5786, s=39.826, z=0.416
at lat=29:
annular 22.08.-3091 08:55:32.4 0.9255/0.9551/0.8566
7 min 44.37 sec 07:23:08.7 08:51:40.6 08:59:25.0 10:44:33.4

annular 8.04.-3084 17:13:40.7 0.9448/0.9719/0.8927
4 min 9.99 sec 15:55:46.5 17:11:35.9 17:15:45.9 -
alt=9.874, lon=1.235, dlon=-75.615, s=39.637, z=1.908

annular 22.09.-3083 18:24:34.0 0.9505/0.9669/0.9035
2 min 53.81 sec 17:21:52.5 18:23:07.3 18:26:01.1 -
alt=-0.029, lon=42.972, dlon=-33.878, s=39.610, z=0.855

total 6.02.-3081 15:51:18.1 1.0480/1.0239/1.0982
3 min 12.72 sec 14:36:54.0 15:49:41.8 15:52:54.5 16:57:10.9
alt=16.822, lon=-30.910, dlon=-107.760, s=39.557, z=2.724

annular 10.05.-3076 11:03:33.9 0.9590/0.9795/0.9197
4 min 13.81 sec 09:28:50.5 11:01:26.9 11:05:40.7 12:45:02.7
alt=66.391, lon=151.160, dlon=74.310, s=39.422, z=1.885

annular 13.09.-3074 16:49:22.9 0.9438/0.9713/0.8908
4 min 4.47 sec 15:35:36.6 16:47:20.8 16:51:25.3 17:55:19.6
alt=22.340, lon=78.168, dlon=1.318, s=39.369, z=0.033

annular 2.09.-3073 07:07:50.2 0.9170/0.9581/0.8408
7 min 6.01 sec 05:52:34.0 07:04:17.4 07:11:23.4 08:36:21.3
alt=22.136, lon=-40.546, dlon=-117.396, s=39.342, z=2.984

annular 2.09.-3073 09:30:37.3 0.9230/0.9609/0.8520
8 min 28.86 sec 07:53:21.5 09:26:23.2 09:34:52.0 11:20:31.6
alt=52.889, lon=-14.487, dlon=-91.337, s=39.342, z=2.322

total 27.02.-3072 12:16:03.1 1.0655/1.0323/1.1353
5 min 11.26 sec 10:52:32.3 12:13:27.5 12:18:38.8 13:36:47.9
alt=42.810, lon=166.730, dlon=89.880, s=39.315, z=2.286

+total 2.07.-3070 04:47:24.9 1.0551/1.0036/1.1132
1 min 12.75 sec - 04:46:48.7 04:48:01.4 05:38:25.6
alt=-0.0680 lat=31.5651, lon=120.9733, dlon=44.1233, s=39.261, z=1.124
at lat=31:
partial 2.07.-3070 04:46:51.5 0.9913/0.9913/0.9946
0 min 0.00 sec - - - 05:37:46.9

annular 15.12.-3069 13:09:22.1 0.9462/0.9726/0.8953
6 min 10.03 sec 11:17:31.8 13:06:17.2 13:12:27.2 14:52:22.5
alt=35.9402 lat=30.3968, lon=22.6024, dlon=-54.2476, s=39.235, z=1.383
at lat=30:
annular 15.12.-3069 13:09:40.7 0.9463/0.9663/0.8954
5 min 58.53 sec 11:17:34.9 13:06:41.6 13:12:40.1 14:52:49.3

total 17.02.-3063 07:04:39.8 1.0437/1.0215/1.0893
2 min 33.27 sec - 07:03:23.3 07:05:56.6 08:09:14.2
alt=0.0562 lat=29.4478, lon=115.3710, dlon=38.5210, s=39.074, z=0.986
at lat=30:
total 17.02.-3063 07:05:12.6 1.0437/1.0081/1.0893
1 min 57.25 sec - 07:04:14.2 07:06:11.5 08:09:47.9

total 16.02.-3063 14:23:56.9 1.0540/1.0269/1.1110
4 min 8.20 sec 12:59:48.7 14:21:52.7 14:26:00.9 15:39:19.5
alt=31.883, lon=-169.024, dlon=114.126, s=39.074, z=2.921

annular 5.12.-3060 11:53:48.3 0.9608/0.9799/0.9231
4 min 7.03 sec 10:17:03.3 11:51:44.9 11:55:51.9 13:35:43.6
alt=41.548, lon=72.344, dlon=-4.506, s=38.994, z=0.116

annular 21.05.-3058 11:19:08.7 0.9571/0.9784/0.9160
4 min 33.76 sec 09:41:47.2 11:16:51.8 11:21:25.5 13:03:31.7
alt=71.749, lon=57.399, dlon=-19.451, s=38.941, z=0.500

annular 12.09.-3055 05:47:21.9 0.9094/0.9543/0.8271
6 min 37.27 sec - 05:44:03.4 05:50:40.7 07:01:30.2
alt=3.330, lon=-174.721, dlon=108.429, s=38.861, z=2.790

total 9.03.-3054 12:17:46.4 1.0682/1.0338/1.1411
5 min 17.77 sec 10:55:51.5 12:15:07.6 12:20:25.4 13:37:11.2
alt=46.177, lon=48.482, dlon=-28.368, s=38.834, z=0.730

annular 30.04.-3048 11:55:12.6 0.9616/0.9807/0.9246
4 min 23.21 sec 10:08:50.0 11:53:01.0 11:57:24.2 13:43:25.9
alt=65.687, lon=111.004, dlon=34.154, s=38.674, z=0.883

annular 14.10.-3047 16:50:13.4 0.9457/0.9723/0.8943
4 min 5.67 sec 15:32:40.7 16:48:10.7 16:52:16.3 17:58:08.7
alt=15.094, lon=128.572, dlon=51.722, s=38.648, z=1.338

total 28.02.-3045 06:59:12.0 1.0451/1.0070/1.0922
1 min 52.04 sec - 06:58:16.3 07:00:08.3 08:03:28.8
alt=0.049, lon=-6.173, dlon=-83.023, s=38.594, z=2.151

total 28.02.-3045 12:36:37.0 1.0581/1.0287/1.1196
4 min 53.96 sec 11:07:55.3 12:34:10.1 12:39:04.1 14:01:53.7
alt=43.112, lon=53.673, dlon=-23.177, s=38.594, z=0.601

annular 31.05.-3040 11:38:43.3 0.9546/0.9770/0.9112
5 min 1.37 sec 09:57:27.2 11:36:12.7 11:41:14.1 13:26:28.4
alt=76.335, lon=-36.564, dlon=-113.414, s=38.462, z=2.949

annular 4.10.-3038 15:55:22.8 0.9363/0.9675/0.8767
5 min 14.57 sec 14:31:42.3 15:52:45.6 15:58:00.2 17:09:35.9
alt=29.205, lon=-177.808, dlon=105.342, s=38.409, z=2.743

annular 24.09.-3037 09:28:18.6 0.9169/0.9579/0.8407
8 min 46.98 sec 07:54:14.6 09:23:55.3 09:32:42.3 11:12:59.7
alt=48.639, lon=111.921, dlon=35.071, s=38.382, z=0.914

annular 6.01.-3032 09:29:30.8 0.9547/0.9771/0.9115
4 min 30.18 sec 08:01:54.3 09:27:15.8 09:31:46.0 11:12:51.4
alt=24.557, lon=104.597, dlon=27.747, s=38.250, z=0.725

annular 6.01.-3032 13:52:17.7 0.9555/0.9773/0.9129
4 min 42.62 sec 12:04:24.8 13:49:56.5 13:54:39.1 15:25:57.1
alt=30.332, lon=143.642, dlon=66.792, s=38.250, z=1.746

annular 11.05.-3030 09:46:50.5 0.9624/0.9810/0.9263
3 min 49.52 sec 08:16:10.3 09:44:55.7 09:48:45.2 11:30:57.1
alt=54.583, lon=-5.827, dlon=-82.677, s=38.197, z=2.164

annular 25.10.-3029 15:57:12.5 0.9443/0.9716/0.8916
4 min 42.96 sec 14:29:38.9 15:54:51.1 15:59:34.1 17:12:43.9
alt=23.300, lon=-9.606, dlon=-86.456, s=38.170, z=2.265

annular 27.12.-3024 10:59:11.6 0.9701/0.9846/0.9411
3 min 5.07 sec 09:26:33.1 10:57:39.1 11:00:44.2 12:42:22.1
alt=35.021, lon=172.349, dlon=95.499, s=38.038, z=2.511

annular 15.10.-3020 15:25:57.0 0.9333/0.9660/0.8711
5 min 52.78 sec 13:56:37.2 15:23:00.7 15:28:53.4 16:45:14.3
alt=32.300, lon=52.621, dlon=-24.229, s=37.933, z=0.639

annular 4.10.-3019 09:07:17.6 0.9139/0.9564/0.8352
8 min 41.11 sec 07:37:41.1 09:02:57.3 09:11:38.4 10:47:59.9
alt=42.252, lon=-10.844, dlon=-87.694, s=37.906, z=2.313

total 31.03.-3018 12:21:03.7 1.0719/1.0358/1.1489
5 min 26.32 sec 11:01:25.6 12:18:20.7 12:23:47.1 13:39:04.6
alt=53.889, lon=177.789, dlon=100.939, s=37.880, z=2.665

annular 16.01.-3014 08:09:52.9 0.9574/0.9785/0.9166
3 min 37.03 sec - 08:08:04.3 08:11:41.4 09:38:51.0
alt=11.186, lon=-29.782, dlon=-106.632, s=37.775, z=2.823

annular 16.01.-3014 13:49:28.8 0.9616/0.9804/0.9247
3 min 58.43 sec 12:03:51.9 13:47:29.7 13:51:28.1 15:21:27.0
alt=30.940, lon=23.207, dlon=-53.643, s=37.775, z=1.420

total 23.08.-3007 17:20:24.4 1.0441/1.0217/1.0902
2 min 25.75 sec 16:20:03.9 17:19:11.5 17:21:37.3 18:15:20.9
alt=18.245, lon=137.316, dlon=60.466, s=37.591, z=1.609

annular 7.01.-3005 10:41:44.3 0.9756/0.9873/0.9517
2 min 30.02 sec 09:10:39.5 10:40:29.3 10:42:59.3 12:24:32.9
alt=32.483, lon=46.211, dlon=-30.639, s=37.538, z=0.816

annular 7.01.-3005 16:05:44.7 0.9692/0.9844/0.9394
2 min 32.86 sec 14:39:38.2 16:04:28.6 16:07:01.4 -
alt=11.131, lon=97.355, dlon=20.505, s=37.538, z=0.546

annular 22.06.-3004 13:27:41.4 0.9474/0.9731/0.8975
6 min 7.85 sec 11:33:37.3 13:24:37.5 13:30:45.3 15:11:53.8
alt=65.623, lon=142.927, dlon=66.077, s=37.512, z=1.761

+annular 11.06.-3003 04:56:57.8 0.9421/0.9478/0.8876
2 min 8.48 sec - 04:55:53.5 04:58:02.0 05:57:31.1
alt=-0.0569 lat=31.0366, lon=37.4206, dlon=-39.4294, s=37.486, z=1.052
at lat=31:
annular 11.06.-3003 04:56:54.7 0.9421/0.9473/0.8875
2 min 3.44 sec - 04:55:52.9 04:57:56.3 05:57:27.5

total 10.04.-3000 12:23:51.5 1.0725/1.0362/1.1503
5 min 28.41 sec 11:04:39.4 12:21:07.5 12:26:35.9 13:41:53.2
alt=57.872, lon=64.876, dlon=-11.974, s=37.407, z=0.320

partial 14.08.-2998 18:53:45.8 0.9956/0.9956/0.9978
0 min 0.00 sec 18:03:33.0 - - -
alt=-0.0627 lat=30.8631, lon=168.4213, dlon=91.5713, s=37.355, z=2.451
at lat=30:
partial 14.08.-2998 18:54:46.5 0.9807/0.9807/0.9833
0 min 0.00 sec 18:04:42.6 - - -

total 4.08.-2997 08:50:03.7 1.0359/1.0175/1.0731
2 min 44.37 sec 07:35:26.5 08:48:41.8 08:51:26.1 10:14:35.4
alt=47.878, lon=173.471, dlon=96.621, s=37.329, z=2.588

annular 2.06.-2994 05:44:55.7 0.9554/0.9772/0.9128
2 min 54.59 sec - 05:43:28.4 05:46:23.0 06:51:20.6
alt=8.145, lon=108.034, dlon=31.184, s=37.250, z=0.837

annular 16.11.-2993 13:58:17.4 0.9425/0.9708/0.8883
6 min 8.41 sec 12:11:07.8 13:55:13.2 14:01:21.6 15:33:24.7
alt=38.076, lon=74.938, dlon=-1.912, s=37.224, z=0.051

annular 16.11.-2993 16:42:53.1 0.9357/0.9674/0.8754
5 min 7.36 sec 15:20:20.8 16:40:19.5 16:45:26.8 -
alt=8.539, lon=104.916, dlon=28.066, s=37.224, z=0.754

annular 16.11.-2993 17:21:22.4 0.9335/0.9458/0.8715
3 min 49.88 sec 16:05:36.0 17:19:27.6 17:23:17.4 -
alt=0.0365 lat=30.7105, lon=113.7037, dlon=36.8537, s=37.224, z=0.990
at lat=30:
partial 16.11.-2993 17:22:21.7 0.9306/0.9306/0.8705
0 min 0.00 sec 16:06:43.2 - - -

total 3.09.-2989 16:14:24.6 1.0457/1.0225/1.0934
2 min 48.65 sec 15:06:31.4 16:13:00.2 16:15:48.9 17:15:24.0
alt=31.295, lon=-5.237, dlon=-82.087, s=37.120, z=2.211

+annular 17.01.-2987 15:13:13.4 0.9777/0.9886/0.9559
2 min 0.45 sec 13:40:36.5 15:12:13.4 15:14:13.9 16:32:52.7
alt=19.1669 lat=31.8345, lon=-34.2122, dlon=-111.0622, s=37.068, z=2.996
at lat=31:
partial 17.01.-2987 15:13:56.3 0.9720/0.9720/0.9520
0 min 0.00 sec 13:41:04.2 - - 16:33:38.1

annular 6.11.-2984 14:23:03.3 0.9292/0.9639/0.8633
7 min 10.55 sec 12:42:33.3 14:19:28.0 14:26:38.6 15:54:07.8
alt=37.218, lon=151.306, dlon=74.456, s=36.990, z=2.013

annular 26.10.-2983 08:07:18.7 0.9088/0.9539/0.8258
8 min 7.46 sec 06:48:17.0 08:03:15.3 08:11:22.7 09:37:18.6
alt=25.752, lon=95.713, dlon=18.863, s=36.963, z=0.510

partial 24.08.-2980 18:47:46.1 0.9963/0.9963/0.9982
0 min 0.00 sec 17:56:56.0 - - -
alt=-0.0550 lat=30.2517, lon=41.0450, dlon=-35.8050, s=36.885, z=0.971
at lat=30:
partial 24.08.-2980 18:48:04.9 0.9921/0.9921/0.9948
0 min 0.00 sec 17:57:17.3 - - -

total 14.08.-2979 07:02:41.4 1.0235/1.0115/1.0475
1 min 28.83 sec 06:00:06.4 07:01:57.1 07:03:25.9 08:13:14.8
alt=23.549, lon=30.790, dlon=-46.060, s=36.859, z=1.250

total 14.08.-2979 11:37:32.6 1.0345/1.0167/1.0701
3 min 0.27 sec 10:07:02.4 11:36:02.6 11:39:02.9 13:06:26.0
alt=79.943, lon=78.797, dlon=1.947, s=36.859, z=0.053

annular 7.02.-2978 13:41:34.7 0.9751/0.9873/0.9508
2 min 27.90 sec 12:01:40.6 13:40:21.0 13:42:48.9 15:10:06.7
alt=34.501, lon=148.291, dlon=71.441, s=36.833, z=1.940

annular 26.11.-2975 16:03:55.6 0.9356/0.9674/0.8753
5 min 35.46 sec 14:33:17.4 16:01:07.9 16:06:43.3 -
alt=14.134, lon=-30.009, dlon=-106.859, s=36.755, z=2.907

annular 1.04.-2972 17:37:46.5 0.9940/0.9964/0.9881
0 min 25.47 sec 16:30:45.3 17:37:33.9 17:37:59.4 -
alt=4.093, lon=174.798, dlon=97.948, s=36.678, z=2.670

annular 29.01.-2969 11:01:12.0 0.9887/0.9938/0.9775
1 min 13.38 sec 09:26:40.0 11:00:35.3 11:01:48.7 12:44:38.7
alt=34.150, lon=166.928, dlon=90.078, s=36.600, z=2.461

annular 28.01.-2969 12:58:11.1 0.9888/0.9939/0.9777
1 min 14.31 sec 11:14:33.9 12:57:34.1 12:58:48.4 14:35:32.7
alt=35.932, lon=-175.897, dlon=107.253, s=36.600, z=2.930

annular 17.11.-2966 13:52:42.9 0.9279/0.9633/0.8609
7 min 45.48 sec 12:07:45.5 13:48:50.1 13:56:35.6 15:29:51.3
alt=38.363, lon=21.211, dlon=-55.639, s=36.522, z=1.523

annular 6.11.-2965 07:39:07.4 0.9072/0.9531/0.8230
7 min 46.87 sec 06:24:35.9 07:35:14.2 07:43:01.1 09:03:57.9
alt=18.0676 lat=29.3893, lon=-32.4584, dlon=-109.3084, s=36.496, z=2.995
at lat=30:
annular 6.11.-2965 07:38:53.1 0.9071/0.9378/0.8229
7 min 18.92 sec 06:24:28.9 07:35:13.9 07:42:32.8 09:03:29.9

annular 18.02.-2960 13:38:09.0 0.9821/0.9909/0.9646
1 min 44.52 sec 12:01:17.8 13:37:17.0 13:39:01.5 15:05:00.3
alt=37.124, lon=33.971, dlon=-42.879, s=36.367, z=1.179

annular 8.12.-2957 11:42:51.4 0.9404/0.9698/0.8844
7 min 2.28 sec 09:55:14.1 11:39:20.4 11:46:22.7 13:35:30.2
alt=40.759, lon=162.903, dlon=86.053, s=36.289, z=2.371

partial 12.04.-2954 14:55:13.1 1.0000/1.0000/1.0000
0 min 0.00 sec 13:25:12.6 - - 16:14:33.4
alt=38.793, lon=35.397, dlon=-41.453, s=36.212, z=1.145

total 25.09.-2953 14:07:07.3 1.0469/1.0232/1.0960
3 min 31.24 sec 12:45:26.9 14:05:21.6 14:08:52.9 15:21:32.6
alt=53.615, lon=69.228, dlon=-7.622, s=36.186, z=0.211

annular 14.07.-2949 05:30:08.6 0.9430/0.9712/0.8892
3 min 37.71 sec - 05:28:19.6 05:31:57.4 06:34:33.8
alt=7.625, lon=102.799, dlon=25.949, s=36.083, z=0.719

total 13.05.-2946 12:51:00.8 1.0689/1.0340/1.1426
5 min 22.48 sec 11:29:23.1 12:48:19.6 12:53:42.1 14:11:24.2
alt=66.032, lon=94.943, dlon=18.093, s=36.006, z=0.502

total 15.09.-2944 18:30:39.1 1.0338/1.0095/1.0688
1 min 28.92 sec 17:37:36.4 18:29:54.6 18:31:23.6 -
alt=-0.035, lon=138.796, dlon=61.946, s=35.955, z=1.723

annular 18.12.-2939 10:33:31.7 0.9387/0.9690/0.8811
6 min 55.02 sec 08:54:01.0 10:30:04.4 10:36:59.4 12:26:54.9
alt=34.558, lon=28.849, dlon=-48.001, s=35.826, z=1.340

annular 18.12.-2939 15:09:34.8 0.9361/0.9677/0.8762
6 min 13.07 sec 13:27:41.1 15:06:28.1 15:12:41.2 16:34:38.1
alt=20.804, lon=70.105, dlon=-6.745, s=35.826, z=0.188

annular 24.07.-2931 05:28:16.5 0.9419/0.9707/0.8873
3 min 42.14 sec - 05:26:25.4 05:30:07.5 06:32:53.9
alt=6.509, lon=-3.856, dlon=-80.706, s=35.621, z=2.266

annular 9.12.-2930 13:04:13.6 0.9266/0.9627/0.8586
8 min 37.55 sec 11:13:16.4 12:59:54.9 13:08:32.5 14:51:43.6
alt=37.722, lon=126.010, dlon=49.160, s=35.596, z=1.381

annular 9.12.-2930 17:04:23.0 0.9181/0.9587/0.8429
6 min 40.70 sec 15:40:00.8 17:01:02.5 17:07:43.2 -
alt=0.690, lon=167.682, dlon=90.832, s=35.596, z=2.552

-annular 28.11.-2929 06:30:43.1 0.9054/0.9524/0.8197
6 min 54.18 sec - - 06:34:10.4 07:44:04.8
alt=0.0465 lat=28.8410, lon=67.7769, dlon=-9.0731, s=35.570, z=0.255
at lat=29:
annular 28.11.-2929 06:30:42.4 0.9054/0.9487/0.8197
6 min 52.73 sec - - 06:34:09.1 07:44:03.0

total 23.05.-2928 13:15:34.5 1.0656/1.0322/1.1355
5 min 11.97 sec 11:52:00.1 13:12:58.4 13:18:10.4 14:36:23.5
alt=64.327, lon=-12.200, dlon=-89.050, s=35.544, z=2.505

total 23.05.-2928 18:21:10.8 1.0492/1.0172/1.1009
2 min 27.32 sec 17:23:59.0 18:19:57.0 18:22:24.3 -
alt=-0.0424 lat=30.9338, lon=49.1317, dlon=-27.7183, s=35.544, z=0.780
at lat=30:
partial 23.05.-2928 18:21:31.9 0.9880/0.9880/0.9914
0 min 0.00 sec 17:24:21.8 - - -

total 26.09.-2926 18:19:21.6 1.0310/1.0134/1.0629
1 min 32.73 sec 17:24:44.1 18:18:35.2 18:20:07.9 -
alt=-0.023, lon=4.168, dlon=-72.682, s=35.493, z=2.048

total 16.09.-2925 11:05:47.6 1.0157/1.0074/1.0316
1 min 17.15 sec 09:39:34.5 11:05:09.2 11:06:26.3 12:32:56.9
alt=67.614, lon=58.276, dlon=-18.574, s=35.468, z=0.524

annular 11.03.-2924 13:35:37.5 0.9962/0.9980/0.9923
0 min 24.78 sec 12:04:16.2 13:35:25.4 13:35:50.2 14:59:31.8
alt=43.149, lon=171.839, dlon=94.989, s=35.442, z=2.680

total 4.07.-2921 10:49:19.7 1.0279/1.0134/1.0565
2 min 32.59 sec 09:18:35.3 10:48:03.5 10:50:36.1 12:26:47.2
alt=75.322, lon=-19.747, dlon=-96.597, s=35.366, z=2.731

annular 4.05.-2918 10:33:08.5 0.9980/0.9989/0.9960
0 min 16.28 sec 09:02:45.9 10:33:00.2 10:33:16.5 12:12:06.0
alt=60.397, lon=146.209, dlon=69.359, s=35.289, z=1.965

total 17.10.-2917 12:08:32.8 1.0451/1.0225/1.0921
3 min 41.87 sec 10:43:33.6 12:06:41.8 12:10:23.7 13:32:49.2
alt=59.475, lon=142.126, dlon=65.276, s=35.264, z=1.851

annular 4.08.-2913 17:59:25.4 0.9414/0.9704/0.8862
3 min 54.82 sec 16:51:22.7 17:57:28.2 18:01:23.0 -
alt=10.860, lon=24.672, dlon=-52.178, s=35.162, z=1.484

annular 19.12.-2912 12:53:24.4 0.9267/0.9627/0.8588
8 min 52.46 sec 10:59:56.8 12:48:58.3 12:57:50.7 14:44:06.9
alt=36.432, lon=2.567, dlon=-74.283, s=35.136, z=2.114

annular 19.12.-2912 16:00:57.6 0.9213/0.9603/0.8488
7 min 20.71 sec 14:23:23.2 15:57:16.9 16:04:37.6 -
alt=11.967, lon=32.665, dlon=-44.185, s=35.136, z=1.258

total 22.03.-2906 13:37:55.2 1.0028/1.0013/1.0056
0 min 10.06 sec 12:08:42.6 13:37:50.4 13:38:00.4 15:00:39.3
alt=46.049, lon=64.025, dlon=-12.825, s=34.984, z=0.367

annular 9.01.-2902 08:14:57.9 0.9339/0.9669/0.8723
5 min 55.92 sec - 08:12:00.0 08:17:55.9 09:49:18.9
alt=12.573, lon=124.164, dlon=47.314, s=34.883, z=1.356

annular 8.01.-2902 14:29:06.1 0.9381/0.9687/0.8800
6 min 24.81 sec 12:41:12.4 14:25:53.5 14:32:18.3 15:59:35.6
alt=26.5096 lat=29.5056, lon=-178.5246, dlon=104.6254, s=34.883, z=2.999
at lat=30:
annular 8.01.-2902 14:28:56.5 0.9380/0.9586/0.8798
6 min 3.00 sec 12:41:19.3 14:25:54.8 14:31:57.8 15:59:19.7

annular 14.05.-2900 08:30:19.8 0.9903/0.9948/0.9806
0 min 51.35 sec 07:14:58.7 08:29:54.0 08:30:45.4 09:56:52.8
alt=40.088, lon=22.551, dlon=-54.299, s=34.832, z=1.559

total 27.10.-2899 11:12:55.0 1.0432/1.0216/1.0883
3 min 30.96 sec 09:50:40.3 11:11:09.5 11:14:40.5 12:38:36.1
alt=53.653, lon=-2.014, dlon=-78.864, s=34.807, z=2.266

annular 15.08.-2895 05:08:59.5 0.9388/0.9651/0.8813
3 min 47.32 sec - 05:07:05.9 05:10:53.3 06:12:06.0
alt=-0.061, lon=129.891, dlon=53.041, s=34.705, z=1.528

total 18.10.-2890 17:53:54.5 1.0263/1.0124/1.0533
1 min 24.46 sec 16:55:22.4 17:53:12.3 17:54:36.7 -
alt=0.003, lon=89.674, dlon=12.824, s=34.579, z=0.371

total 8.10.-2889 10:11:09.6 1.0034/1.0013/1.0067
0 min 12.03 sec 08:50:21.5 10:11:03.6 10:11:15.6 11:36:41.2
alt=53.099, lon=151.062, dlon=74.212, s=34.554, z=2.148

total 26.07.-2885 06:51:16.4 1.0189/1.0094/1.0382
1 min 9.94 sec 05:49:40.1 06:50:41.4 06:51:51.3 08:00:54.4
alt=23.293, lon=66.625, dlon=-10.225, s=34.453, z=0.297

total 26.07.-2885 14:02:37.6 1.0263/1.0129/1.0533
2 min 6.16 sec 12:33:46.7 14:01:34.6 14:03:40.7 15:21:04.1
alt=60.914, lon=139.237, dlon=62.387, s=34.453, z=1.811

annular 20.01.-2884 07:09:31.3 0.9315/0.9644/0.8678
5 min 24.26 sec - 07:06:49.3 07:12:13.6 08:31:42.5
alt=0.0676 lat=29.5926, lon=-6.1564, dlon=-83.0064, s=34.428, z=2.411
at lat=30:
annular 20.01.-2884 07:09:57.8 0.9315/0.9580/0.8677
5 min 16.61 sec - 07:07:19.7 07:12:36.3 08:32:09.9

annular 20.01.-2884 14:21:11.6 0.9392/0.9693/0.8821
6 min 16.33 sec 12:34:07.2 14:18:03.3 14:24:19.6 15:51:42.6
alt=27.838, lon=63.135, dlon=-13.715, s=34.428, z=0.398

total 13.03.-2878 17:47:12.3 1.0511/1.0249/1.1049
2 min 45.48 sec 16:48:12.0 17:45:49.4 17:48:34.9 -
alt=0.0354 lat=29.9186, lon=167.7483, dlon=90.8983, s=34.277, z=2.652
at lat=30:
total 13.03.-2878 17:47:10.8 1.0511/1.0236/1.1049
2 min 45.00 sec 16:48:10.6 17:45:48.1 17:48:33.1 -

annular 26.08.-2877 15:26:49.5 0.9475/0.9735/0.8977
4 min 39.02 sec 13:54:26.1 15:24:30.1 15:29:09.2 16:45:23.8
alt=42.377, lon=124.855, dlon=48.005, s=34.252, z=1.402

annular 15.06.-2873 06:04:48.2 0.9883/0.9937/0.9767
0 min 45.15 sec 05:07:30.1 06:04:25.6 06:05:10.7 07:07:41.1
alt=14.022, lon=110.186, dlon=33.336, s=34.151, z=0.976

annular 18.10.-2871 09:37:51.7 0.9974/0.9983/0.9948
0 min 16.24 sec 08:20:36.3 09:37:43.6 09:37:59.8 11:01:22.1
alt=44.534, lon=14.332, dlon=-62.518, s=34.101, z=1.833

total 5.08.-2867 14:00:55.7 1.0263/1.0130/1.0533
2 min 3.80 sec 12:34:01.0 13:59:53.9 14:01:57.7 15:18:09.6
alt=61.620, lon=20.311, dlon=-56.539, s=34.001, z=1.663

total 18.11.-2863 09:27:56.5 1.0386/1.0191/1.0787
2 min 50.15 sec 08:15:22.9 09:26:31.5 09:29:21.7 10:48:32.8
alt=34.388, lon=68.765, dlon=-8.085, s=33.901, z=0.238

total 23.03.-2860 15:55:41.1 1.0628/1.0309/1.1296
4 min 3.00 sec 14:44:28.2 15:53:39.3 15:57:42.3 16:59:43.3
alt=24.217, lon=27.280, dlon=-49.570, s=33.826, z=1.465

annular 5.09.-2859 14:12:18.5 0.9497/0.9747/0.9019
5 min 3.09 sec 12:29:06.7 14:09:47.2 14:14:50.3 15:41:23.9
alt=56.849, lon=-5.684, dlon=-82.534, s=33.801, z=2.442

annular 25.06.-2855 06:13:51.8 0.9832/0.9912/0.9668
1 min 5.19 sec 05:15:19.0 06:13:19.1 06:14:24.3 07:18:35.0
alt=16.594, lon=7.126, dlon=-69.724, s=33.701, z=2.069

total 9.11.-2854 16:38:22.7 1.0269/1.0128/1.0546
1 min 39.94 sec 15:30:06.1 16:37:32.7 16:39:12.6 -
alt=10.5623 lat=30.4544, lon=160.7237, dlon=83.8737, s=33.676, z=2.491
at lat=30:
total 9.11.-2854 16:39:08.6 1.0269/1.0066/1.0546
1 min 24.94 sec 15:30:53.8 16:38:26.0 16:39:51.0 -

partial 9.11.-2854 17:28:16.8 0.9936/0.9936/0.9953
0 min 0.00 sec 16:25:23.6 - - -
alt=0.0297 lat=30.4061, lon=171.8879, dlon=95.0379, s=33.676, z=2.822
at lat=30:
partial 9.11.-2854 17:28:54.7 0.9863/0.9863/0.9875
0 min 0.00 sec 16:26:04.9 - - -

total 23.04.-2852 14:07:31.2 1.0190/1.0090/1.0384
1 min 30.00 sec 12:41:35.2 14:06:46.2 14:08:16.2 15:27:40.0
alt=49.738, lon=108.895, dlon=32.045, s=33.626, z=0.953

total 19.11.-2836 16:03:58.2 1.0276/1.0131/1.0559
1 min 49.68 sec 14:50:45.1 16:03:03.3 16:04:53.0 17:09:52.0
alt=14.8091 lat=30.8826, lon=17.4844, dlon=-59.3656, s=33.229, z=1.787
at lat=30:
partial 19.11.-2836 16:05:26.2 0.9997/0.9997/0.9999
0 min 0.00 sec 14:52:13.1 - - 17:11:14.6

annular 9.11.-2835 08:23:52.7 0.9862/0.9927/0.9726
1 min 4.18 sec 07:14:41.3 08:23:20.6 08:24:24.7 09:40:31.5
alt=25.751, lon=97.147, dlon=20.297, s=33.204, z=0.611

total 4.05.-2834 14:38:48.6 1.0222/1.0105/1.0449
1 min 43.22 sec 13:14:05.9 14:37:57.0 14:39:40.2 15:56:32.3
alt=45.490, lon=8.290, dlon=-68.560, s=33.179, z=2.066

total 24.04.-2833 06:54:37.6 1.0603/1.0295/1.1243
3 min 24.16 sec 05:57:59.0 06:52:55.9 06:56:20.0 07:56:16.4
alt=13.994, lon=65.000, dlon=-11.850, s=33.155, z=0.357

total 27.08.-2831 13:33:37.2 1.0264/1.0131/1.0535
2 min 3.92 sec 12:08:11.4 13:32:35.4 13:34:39.3 14:51:28.0
alt=66.029, lon=131.137, dlon=54.287, s=33.105, z=1.640

annular 21.02.-2830 13:59:42.5 0.9442/0.9720/0.8915
5 min 38.75 sec 12:16:35.6 13:56:53.2 14:02:31.9 15:30:01.4
alt=36.044, lon=85.726, dlon=8.876, s=33.080, z=0.268

-annular 15.06.-2827 13:08:11.8 0.9471/0.9731/0.8971
6 min 26.57 sec 11:08:02.9 13:04:58.4 13:11:25.0 14:55:51.8
alt=69.6867 lat=28.2681, lon=-22.0917, dlon=-98.9417, s=33.006, z=2.998
at lat=29:
annular 15.06.-2827 13:08:02.5 0.9471/0.9522/0.8970
3 min 52.06 sec 11:08:46.7 13:06:06.6 13:09:58.7 14:55:10.0

total   10.12.-2827   07:47:45.3   1.0338/1.0167/1.0687
2 min 7.10 sec   06:45:41.7   07:46:41.8   07:48:48.9   08:57:13.5
alt=12.309, lon=139.145, dlon=62.295, s=33.006, z=1.887

total   14.04.-2824   12:05:50.6   1.0777/1.0388/1.1614
6 min 14.08 sec   10:42:20.2   12:02:43.4   12:08:57.4   13:29:12.0
alt=60.203, lon=119.526, dlon=42.676, s=32.932, z=1.296

annular 27.09.-2823   11:49:27.9   0.9517/0.9757/0.9057
5 min 23.44 sec   10:04:18.7   11:46:46.2   11:52:09.6   13:34:05.3
alt=67.107, lon=90.212, dlon=13.362, s=32.907, z=0.406

annular 17.07.-2819   06:13:30.2   0.9708/0.9852/0.9425
1 min 54.99 sec   05:13:35.5   06:12:32.5   06:14:27.5   07:20:26.3
alt=16.111, lon=152.117, dlon=75.267, s=32.809, z=2.294

total   7.09.-2813   13:11:22.9   1.0264/1.0132/1.0536
2 min 4.95 sec   11:46:14.7   13:10:20.6   13:12:25.5   14:30:24.8
alt=67.977, lon=1.413, dlon=-75.437, s=32.661, z=2.310

annular  3.03.-2812   13:57:59.4   0.9459/0.9729/0.8946
5 min 24.94 sec   12:16:41.2   13:55:17.1   14:00:42.0   15:27:51.5
alt=38.980, lon=-20.151, dlon=-97.001, s=32.637, z=2.972

total   21.12.-2809   06:54:51.2   1.0313/1.0074/1.0636
1 min 30.40 sec   -   06:54:06.2   06:55:36.6   07:58:06.5
alt=0.0640 lat=30.0301, lon=-6.1493, dlon=-82.9993, s=32.563, z=2.549
at lat=30:
total   21.12.-2809   06:54:50.2   1.0313/1.0066/1.0636
1 min 26.31 sec   -   06:54:07.2   06:55:33.5   07:58:05.4

total   25.04.-2806   10:08:30.9   1.0784/1.0390/1.1629
5 min 52.77 sec   08:53:10.9   10:05:34.9   10:11:27.7   11:30:08.1
alt=53.669, lon=-12.326, dlon=-89.176, s=32.490, z=2.745

annular 28.07.-2801   06:07:07.5   0.9640/0.9819/0.9293
2 min 22.44 sec   05:06:59.7   06:05:56.1   06:08:18.6   07:14:29.2
alt=13.889, lon=40.619, dlon=-36.231, s=32.367, z=1.119

annular 28.07.-2801   18:03:38.5   0.9641/0.9818/0.9295
2 min 17.69 sec   16:58:29.0   18:02:29.9   18:04:47.6   -
alt=9.926, lon=170.674, dlon=93.824, s=32.367, z=2.899

annular  7.07.-2791   07:46:34.7   0.9364/0.9681/0.8768
5 min 39.13 sec   06:28:30.8   07:43:45.2   07:49:24.3   09:20:17.5
alt=36.130, lon=89.608, dlon=12.758, s=32.123, z=0.397

annular  7.07.-2791   15:19:13.3   0.9378/0.9687/0.8794
5 min 50.63 sec   13:39:55.7   15:16:18.0   15:22:08.6   16:41:26.7
alt=43.147, lon=159.899, dlon=83.049, s=32.123, z=2.585

annular 22.02.-2784 17:35:50.4 0.9360/0.9671/0.8761
4 min 38.20 sec 16:21:29.8 17:33:31.4 17:38:09.6 -
alt=0.0513 lat=29.7201, lon=-18.1215, dlon=-94.9715, s=31.952, z=2.972
at lat=30:
annular 22.02.-2784 17:35:43.4 0.9360/0.9613/0.8761
4 min 32.35 sec 16:21:23.9 17:33:27.3 17:37:59.7 -

annular 7.08.-2783 16:46:22.8 0.9620/0.9808/0.9255
2 min 48.85 sec 15:29:39.6 16:44:58.6 16:47:47.5 17:53:07.3
alt=26.028, lon=40.431, dlon=-36.419, s=31.928, z=1.141

total 26.05.-2779 08:11:19.9 1.0717/1.0355/1.1486
4 min 24.88 sec 07:09:37.8 08:09:07.8 08:13:32.7 09:19:04.3
alt=38.583, lon=107.272, dlon=30.422, s=31.831, z=0.956

total 29.09.-2777 12:16:14.3 1.0265/1.0132/1.0536
2 min 6.30 sec 10:52:31.9 12:15:11.4 12:17:17.7 13:37:50.6
alt=66.236, lon=94.346, dlon=17.496, s=31.782, z=0.551

annular 25.03.-2776 14:05:25.7 0.9483/0.9739/0.8992
5 min 4.86 sec 12:26:53.8 14:02:53.4 14:07:58.3 15:34:30.7
alt=43.745, lon=137.567, dlon=60.717, s=31.758, z=1.912

annular 18.07.-2773 15:32:22.9 0.9344/0.9672/0.8732
5 min 54.42 sec 13:57:37.3 15:29:25.7 15:35:20.1 16:51:38.8
alt=41.134, lon=60.220, dlon=-16.630, s=31.685, z=0.525

total 17.05.-2770 06:00:02.5 1.0670/1.0330/1.1386
3 min 26.97 sec - 05:58:19.3 06:01:46.3 06:56:20.9
alt=8.400, lon=72.239, dlon=-4.611, s=31.613, z=0.146

annular 30.10.-2769 08:48:17.2 0.9507/0.9750/0.9038
4 min 25.94 sec 07:27:57.8 08:46:04.3 08:50:30.2 10:20:50.9
alt=32.667, lon=43.614, dlon=-33.236, s=31.588, z=1.052

annular 19.08.-2765 05:42:58.8 0.9496/0.9748/0.9018
3 min 16.76 sec - 05:41:20.2 05:44:37.0 06:49:22.8
alt=6.181, lon=168.618, dlon=91.768, s=31.492, z=2.914

total 6.06.-2761 08:18:06.8 1.0724/1.0359/1.1501
4 min 30.93 sec 07:15:44.5 08:15:51.7 08:20:22.7 09:26:56.1
alt=41.688, lon=-3.781, dlon=-80.631, s=31.395, z=2.568

annular 5.04.-2758 14:16:37.2 0.9488/0.9740/0.9002
5 min 0.15 sec 12:38:49.2 14:14:07.2 14:19:07.4 15:45:15.5
alt=44.633, lon=40.759, dlon=-36.091, s=31.323, z=1.152

total 22.01.-2754 16:42:06.3 1.0392/1.0194/1.0799
2 min 19.72 sec 15:36:36.8 16:40:56.5 16:43:16.2 -
alt=6.068, lon=67.896, dlon=-8.954, s=31.226, z=0.287

annular 15.03.-2748 14:19:20.9 0.9553/0.9775/0.9127
4 min 33.18 sec 12:35:01.2 14:17:04.5 14:21:37.7 15:50:06.8
alt=39.376, lon=93.863, dlon=17.013, s=31.082, z=0.547

annular 29.08.-2747 05:24:18.9 0.9424/0.9704/0.8881
3 min 40.76 sec - 05:22:28.5 05:26:09.2 06:29:09.6
alt=0.646, lon=47.547, dlon=-29.303, s=31.058, z=0.943

annular 29.08.-2747 14:11:18.1 0.9561/0.9780/0.9141
4 min 23.18 sec 12:28:18.1 14:09:06.7 14:13:29.9 15:39:55.5
alt=58.032, lon=140.812, dlon=63.962, s=31.058, z=2.059

annular 21.11.-2733 07:10:44.6 0.9509/0.9750/0.9042
3 min 36.90 sec - 07:08:56.1 07:12:33.0 08:26:30.1
alt=9.040, lon=127.498, dlon=50.648, s=30.723, z=1.649

annular 9.09.-2729 12:53:25.4 0.9517/0.9758/0.9058
5 min 20.46 sec 11:04:10.8 12:50:45.2 12:56:05.7 14:33:15.1
alt=69.990, lon=10.796, dlon=-66.054, s=30.628, z=2.157

total 28.06.-2725 08:25:31.1 1.0706/1.0353/1.1462
4 min 32.74 sec 07:21:31.8 08:23:15.0 08:27:47.8 09:36:57.0
alt=44.607, lon=129.580, dlon=52.730, s=30.532, z=1.727

total 31.10.-2723 10:33:40.7 1.0266/1.0132/1.0540
2 min 1.59 sec 09:16:47.1 10:32:39.9 10:34:41.5 11:55:17.0
alt=48.366, lon=38.820, dlon=-38.030, s=30.485, z=1.247

annular 16.04.-2721 07:29:46.9 0.9511/0.9749/0.9046
3 min 51.91 sec 06:18:15.8 07:27:51.0 07:31:42.9 08:50:41.8
alt=19.340, lon=126.789, dlon=49.939, s=30.437, z=1.641

annular 19.08.-2719 15:18:11.7 0.9264/0.9629/0.8581
6 min 36.84 sec 13:45:25.5 15:14:53.3 15:21:30.1 16:37:45.6
alt=44.595, lon=98.103, dlon=21.253, s=30.389, z=0.699

-total 13.02.-2718 15:49:05.9 1.0470/1.0233/1.0962
3 min 0.91 sec 14:38:24.4 15:47:35.4 15:50:36.3 16:52:38.7
alt=19.8259 lat=28.2769, lon=167.8791, dlon=91.0291, s=30.366, z=2.998
at lat=29:
total 13.02.-2718 15:49:11.6 1.0469/1.0039/1.0959
1 min 35.16 sec 14:38:39.7 15:48:23.9 15:49:59.1 16:52:39.0

annular 1.12.-2715 06:35:15.3 0.9525/0.9752/0.9072
3 min 14.93 sec - 06:33:37.9 06:36:52.8 07:45:19.2
alt=0.0510 lat=29.1663, lon=-8.7418, dlon=-85.5918, s=30.295, z=2.825
at lat=30:
annular 1.12.-2715 06:35:35.6 0.9524/0.9542/0.9071
1 min 20.29 sec - 06:34:55.3 06:36:15.6 07:45:36.0

total 8.07.-2707 08:27:43.0 1.0684/1.0341/1.1415
4 min 29.12 sec 07:22:45.5 08:25:28.7 08:29:57.9 09:40:37.8
alt=44.858, lon=13.553, dlon=-63.297, s=30.105, z=2.103

total 8.07.-2707 18:03:03.3 1.0578/1.0288/1.1190
2 min 59.46 sec 17:06:24.1 18:01:33.6 18:04:33.1 -
alt=8.999, lon=117.479, dlon=40.629, s=30.105, z=1.350

annular 26.04.-2703 08:19:34.4 0.9573/0.9781/0.9165
3 min 35.50 sec 07:03:24.6 08:17:46.7 08:21:22.2 09:45:31.6
alt=33.130, lon=39.667, dlon=-37.183, s=30.010, z=1.239

total 24.02.-2700 15:50:46.5 1.0486/1.0240/1.0995
3 min 5.16 sec 14:41:03.3 15:49:13.9 15:52:19.1 16:53:55.6
alt=20.484, lon=47.459, dlon=-29.391, s=29.940, z=0.982

total 19.06.-2697 09:37:23.1 1.0448/1.0222/1.0916
3 min 35.17 sec 08:19:04.2 09:35:35.7 09:39:10.9 11:05:39.7
alt=59.882, lon=140.531, dlon=63.681, s=29.869, z=2.132

annular 17.04.-2694 07:37:11.5 0.9650/0.9820/0.9311
2 min 47.43 sec 06:25:41.1 07:35:47.8 07:38:35.2 08:59:36.6
alt=21.380, lon=84.578, dlon=7.728, s=29.798, z=0.259

annular 1.10.-2693 10:25:47.6 0.9402/0.9698/0.8840
6 min 34.20 sec 08:46:49.8 10:22:30.5 10:29:04.7 12:14:04.4
alt=57.052, lon=107.743, dlon=30.893, s=29.775, z=1.038

total 22.11.-2687 09:18:23.3 1.0271/1.0134/1.0550
1 min 53.71 sec 08:08:46.8 09:17:26.4 09:19:20.1 10:35:01.0
alt=31.644, lon=116.443, dlon=39.593, s=29.634, z=1.336

total 29.06.-2679 07:46:46.9 1.0340/1.0169/1.0692
2 min 17.07 sec 06:40:52.5 07:45:38.5 07:47:55.5 09:01:46.6
alt=36.257, lon=8.507, dlon=-68.343, s=29.446, z=2.321

total 29.06.-2679 16:15:43.2 1.0336/1.0167/1.0683
2 min 9.76 sec 15:03:55.7 16:14:38.4 16:16:48.2 17:19:02.1
alt=30.475, lon=94.499, dlon=17.649, s=29.446, z=0.599

total 30.07.-2671 08:35:50.9 1.0626/1.0310/1.1291
4 min 17.48 sec 07:28:17.8 08:33:42.5 08:38:00.0 09:52:12.3
alt=44.974, lon=136.565, dlon=59.715, s=29.259, z=2.041

annular 21.09.-2665 14:18:19.2 0.9213/0.9603/0.8488
7 min 44.96 sec 12:39:18.9 14:14:26.6 14:22:11.6 15:46:18.2
alt=51.945, lon=106.199, dlon=29.349, s=29.119, z=1.008

annular 25.02.-2654 16:27:39.3 0.9769/0.9881/0.9543
1 min 47.05 sec 15:08:24.5 16:26:46.0 16:28:33.0 17:36:44.2
alt=14.079, lon=15.044, dlon=-61.806, s=28.863, z=2.141

total 10.08.-2653 08:47:10.9 1.0595/1.0293/1.1225
4 min 12.67 sec 07:37:33.1 08:45:04.9 08:49:17.6 10:05:51.1
alt=46.234, lon=16.182, dlon=-60.668, s=28.840, z=2.104

total 10.08.-2653 13:28:43.1 1.0634/1.0314/1.1308
5 min 3.92 sec 12:01:59.7 13:26:10.9 13:31:14.8 14:47:59.7
alt=68.369, lon=61.453, dlon=-15.397, s=28.840, z=0.534

annular 29.05.-2649 09:15:24.1 0.9678/0.9837/0.9366
2 min 54.37 sec 07:54:23.9 09:13:56.8 09:16:51.2 10:47:44.9
alt=52.843, lon=116.904, dlon=40.054, s=28.747, z=1.393

total 28.03.-2646 15:52:09.9 1.0514/1.0251/1.1055
3 min 18.08 sec 14:42:01.3 15:50:30.7 15:53:48.8 16:56:14.4
alt=25.912, lon=58.961, dlon=-17.889, s=28.678, z=0.624

total 21.07.-2643 04:54:18.8 1.0113/1.0055/1.0227
0 min 33.06 sec - 04:54:02.1 04:54:35.2 05:49:51.2
alt=-0.0680 lat=29.9958, lon=100.3071, dlon=23.4571, s=28.608, z=0.820
at lat=30:
total 21.07.-2643 04:54:19.0 1.0113/1.0056/1.0227
0 min 33.07 sec - 04:54:02.4 04:54:35.4 05:49:51.5

annular 2.11.-2639 07:29:14.0 0.9221/0.9606/0.8502
6 min 24.72 sec 06:16:07.2 07:26:01.7 07:32:26.4 08:53:52.1
alt=16.336, lon=65.260, dlon=-11.590, s=28.516, z=0.406

total 25.12.-2633 07:26:29.5 1.0296/1.0146/1.0601
1 min 44.51 sec - 07:25:37.2 07:27:21.7 08:31:23.1
alt=5.632, lon=53.296, dlon=-23.554, s=28.378, z=0.830

annular 8.06.-2631 09:28:16.3 0.9698/0.9849/0.9406
2 min 47.91 sec 08:05:19.2 09:26:52.2 09:29:40.1 11:03:35.3
alt=57.110, lon=19.773, dlon=-57.077, s=28.332, z=2.015

annular 28.03.-2627 06:23:43.7 0.9879/0.9923/0.9759
0 min 48.03 sec - 06:23:19.7 06:24:07.8 07:31:00.0
alt=0.017, lon=12.275, dlon=-64.575, s=28.240, z=2.287

total 1.08.-2625 16:13:38.7 1.0154/1.0075/1.0311
0 min 57.83 sec 15:02:49.2 16:13:10.0 16:14:07.8 17:16:40.0
alt=32.962, lon=110.150, dlon=33.300, s=28.194, z=1.181

annular 19.03.-2618 13:02:29.2 0.9834/0.9917/0.9671
1 min 46.15 sec 11:19:35.9 13:01:36.4 13:03:22.5 14:38:09.4
alt=49.036, lon=120.547, dlon=43.697, s=28.034, z=1.559

-total 1.09.-2617 09:31:14.8 1.0537/1.0263/1.1102
4 min 8.61 sec 08:15:10.9 09:29:10.9 09:33:19.5 10:55:47.7
alt=53.2256 lat=28.0782, lon=132.6131, dlon=55.7631, s=28.011, z=1.991
at lat=29:
partial 1.09.-2617 09:31:27.3 0.9967/0.9967/0.9987
0 min 0.00 sec 08:15:42.0 - - 10:55:28.5

+annular 19.06.-2613 18:42:11.4 0.9570/0.9693/0.9159
2 min 26.28 sec 17:38:48.6 18:40:58.4 18:43:24.6 -
alt=-0.0643 lat=31.7123, lon=17.7338, dlon=-59.1162, s=27.919, z=2.117
at lat=31:
partial 19.06.-2613 18:42:44.2 0.9518/0.9518/0.9130
0 min 0.00 sec 17:39:27.1 - - -

annular 23.10.-2611 12:49:06.5 0.9200/0.9596/0.8464
8 min 43.70 sec 11:05:18.3 12:44:44.8 12:53:28.5 14:29:50.1
alt=53.586, lon=91.555, dlon=14.705, s=27.874, z=0.528

annular 29.03.-2600 10:58:25.5 0.9823/0.9909/0.9648
1 min 53.66 sec 09:21:56.2 10:57:28.6 10:59:22.2 12:41:05.1
alt=50.922, lon=-3.662, dlon=-80.512, s=27.623, z=2.915

total 10.06.-2585 08:33:55.9 1.0435/1.0217/1.0889
3 min 6.58 sec 07:23:56.8 08:32:22.7 08:35:29.3 09:53:29.6
alt=45.588, lon=42.005, dlon=-34.845, s=27.283, z=1.277

total 10.06.-2585 18:06:19.7 1.0313/1.0156/1.0636
1 min 40.22 sec 17:07:49.8 18:05:29.7 18:07:10.0 -
alt=5.507, lon=144.691, dlon=67.841, s=27.283, z=2.487

annular 11.07.-2577 10:25:52.3 0.9735/0.9863/0.9476
2 min 49.62 sec 08:51:29.1 10:24:27.6 10:27:17.2 12:13:32.2
alt=70.116, lon=79.055, dlon=2.205, s=27.102, z=0.081

annular 11.07.-2577 15:42:02.7 0.9678/0.9837/0.9366
2 min 48.20 sec 14:10:52.0 15:40:38.9 15:43:27.1 16:59:04.4
alt=38.712, lon=127.892, dlon=51.042, s=27.102, z=1.883

annular 30.04.-2573 09:16:18.8 0.9930/0.9960/0.9860
0 min 38.50 sec 07:58:42.0 09:15:59.5 09:16:38.0 10:42:08.4
alt=45.991, lon=94.174, dlon=17.324, s=27.012, z=0.641

annular 2.09.-2571 15:26:35.0 0.9979/0.9985/0.9957
0 min 12.48 sec 14:09:43.6 15:26:28.9 15:26:41.4 16:35:22.7
alt=41.251, lon=101.381, dlon=24.531, s=26.967, z=0.910

total 20.06.-2567 18:13:50.1 1.0324/1.0161/1.0659
1 min 41.25 sec 17:16:54.4 18:12:59.6 18:14:40.9 -
alt=5.237, lon=35.240, dlon=-41.610, s=26.877, z=1.548

total 6.02.-2560 16:57:26.1 1.0462/1.0228/1.0945
2 min 43.68 sec 15:52:14.6 16:56:04.2 16:58:47.9 -
alt=5.427, lon=0.469, dlon=-76.381, s=26.721, z=2.858

annular 21.07.-2559 13:24:40.5 0.9731/0.9861/0.9468
2 min 57.68 sec 11:35:09.3 13:23:11.8 13:26:09.5 15:02:18.0
alt=69.0881 lat=29.6002, lon=-3.2372, dlon=-80.0872, s=26.698, z=3.000
at lat=30:
annular 21.07.-2559 13:24:23.3 0.9731/0.9749/0.9468
1 min 37.02 sec 11:35:16.6 13:23:35.0 13:25:12.0 15:01:48.6

annular 25.11.-2557 11:07:39.1 0.9227/0.9611/0.8514
8 min 30.56 sec 09:28:58.9 11:03:24.2 11:11:54.8 12:56:14.5
alt=42.537, lon=66.641, dlon=-10.209, s=26.653, z=0.383

total 8.03.-2552 17:47:00.1 1.0048/1.0018/1.0095
0 min 13.34 sec 16:44:59.5 17:46:53.5 17:47:06.9 -
alt=0.0370 lat=29.5305, lon=102.2432, dlon=25.3932, s=26.542, z=0.957
at lat=30:
partial 8.03.-2552 17:47:01.6 0.9884/0.9884/0.9867
0 min 0.00 sec 16:45:03.6 - - -

total 2.07.-2549 05:24:10.0 1.0346/1.0170/1.0704
1 min 46.89 sec - 05:23:16.6 05:25:03.4 06:20:22.1
alt=6.515, lon=135.610, dlon=58.760, s=26.475, z=2.219

total 9.03.-2533 10:44:54.3 1.0631/1.0309/1.1301
4 min 53.34 sec 09:25:54.1 10:42:27.8 10:47:21.2 12:06:45.1
alt=42.052, lon=48.898, dlon=-27.952, s=26.119, z=1.070

total 28.02.-2524 14:12:27.4 1.0638/1.0318/1.1316
4 min 48.86 sec 12:49:49.8 14:10:02.8 14:14:51.7 15:27:23.6
alt=36.755, lon=84.418, dlon=7.568, s=25.920, z=0.292

-annular 1.06.-2519 09:39:30.0 0.9836/0.9917/0.9674
1 min 31.53 sec 08:17:17.1 09:38:44.0 09:40:15.5 11:12:46.7
alt=58.8900 lat=28.6804, lon=154.2671, dlon=77.4171, s=25.810, z=2.999
at lat=29:
annular 1.06.-2519 09:40:12.2 0.9836/0.9859/0.9675
1 min 6.41 sec 08:17:57.5 09:39:38.9 09:40:45.3 11:13:26.6

annular 5.10.-2517 14:08:43.1 0.9823/0.9907/0.9649
1 min 33.74 sec 12:41:48.7 14:07:56.4 14:09:30.1 15:28:39.3
alt=49.214, lon=71.557, dlon=-5.293, s=25.766, z=0.205

total 23.07.-2513 18:05:21.4 1.0342/1.0167/1.0695
1 min 44.98 sec 17:09:34.4 18:04:29.0 18:06:14.0 -
alt=9.524, lon=49.345, dlon=-27.505, s=25.678, z=1.071

annular 27.12.-2503 09:33:54.6 0.9299/0.9648/0.8647
6 min 59.76 sec 08:06:26.2 09:30:25.0 09:37:24.7 11:17:39.2
alt=25.977, lon=44.674, dlon=-32.176, s=25.459, z=1.264

annular 12.06.-2501 10:02:33.0 0.9797/0.9897/0.9598
1 min 58.51 sec 08:36:04.4 10:01:33.6 10:03:32.1 11:40:56.4
alt=64.706, lon=56.366, dlon=-20.484, s=25.415, z=0.806

annular 22.05.-2491 09:50:54.1 0.9484/0.9741/0.8995
5 min 31.09 sec 08:16:32.8 09:48:08.5 09:53:39.6 11:40:58.8
alt=59.070, lon=79.576, dlon=2.726, s=25.197, z=0.108

annular 22.06.-2483 17:53:14.1 0.9639/0.9819/0.9292
2 min 26.10 sec 16:43:55.1 17:52:01.3 17:54:27.4 -
alt=9.713, lon=34.825, dlon=-42.025, s=25.023, z=1.679

total 10.04.-2479 11:07:15.2 1.0766/1.0380/1.1591
5 min 40.12 sec 09:51:10.3 11:04:25.3 11:10:05.4 12:25:39.6
alt=56.751, lon=66.517, dlon=-10.333, s=24.936, z=0.414

total 1.04.-2470 06:18:29.1 1.0611/1.0099/1.1259
2 min 22.19 sec - 06:17:18.3 06:19:40.5 07:17:00.2
alt=0.012, lon=6.365, dlon=-70.485, s=24.741, z=2.849

total 2.09.-2468 17:33:31.7 1.0180/1.0085/1.0363 saros 5/15
0 min 59.22 sec 16:32:15.9 17:33:02.2 17:34:01.4 18:29:18.4
alt=13.667, lon=22.450, dlon=-54.400, s=24.698, z=2.203

annular 6.11.-2463 12:31:38.6 0.9699/0.9845/0.9407
2 min 58.22 sec 10:58:03.2 12:30:09.6 12:33:07.8 14:05:03.5
alt=48.865, lon=29.678, dlon=-47.172, s=24.590, z=1.918

total 24.08.-2459 17:24:15.4 1.0337/1.0163/1.0685
1 min 49.09 sec 16:25:20.8 17:23:20.9 17:25:10.0 18:18:30.5
alt=16.851, lon=35.732, dlon=-41.118, s=24.504, z=1.678

annular 29.01.-2448 08:40:45.4 0.9428/0.9711/0.8889
5 min 14.23 sec 07:20:12.0 08:38:08.3 08:43:22.6 10:17:08.9
alt=16.499, lon=41.779, dlon=-35.071, s=24.268, z=1.445

annular 29.01.-2448 14:49:55.5 0.9444/0.9721/0.8919
5 min 36.29 sec 13:04:46.1 14:47:07.5 14:52:43.8 16:18:20.7
alt=25.695, lon=98.116, dlon=21.266, s=24.268, z=0.876

annular 14.07.-2447 12:14:53.5 0.9654/0.9822/0.9321
4 min 4.52 sec 10:24:18.1 12:12:51.3 12:16:55.8 14:04:03.5
alt=82.184, lon=125.161, dlon=48.311, s=24.246, z=1.993

total 24.09.-2432 15:20:01.2 1.0243/1.0117/1.0492 saros 5/17
1 min 41.67 sec 14:02:37.6 15:19:10.3 15:20:52.0 16:29:09.9
alt=37.967, lon=97.452, dlon=20.602, s=23.926, z=0.861

annular 28.11.-2427 11:24:44.3 0.9635/0.9814/0.9284
3 min 41.80 sec 09:51:54.5 11:22:53.4 11:26:35.2 13:04:27.1
alt=42.030, lon=121.104, dlon=44.254, s=23.820, z=1.858

total 13.05.-2425 11:26:31.5 1.0827/1.0411/1.1721
6 min 12.02 sec 10:09:38.9 11:23:25.6 11:29:37.6 12:46:32.8
alt=71.010, lon=92.717, dlon=15.867, s=23.777, z=0.667

total 15.09.-2423 16:40:03.2 1.0332/1.0160/1.0676
1 min 56.10 sec 15:36:24.8 16:39:05.1 16:41:01.2 17:38:22.9
alt=22.909, lon=131.727, dlon=54.877, s=23.735, z=2.312

total 5.09.-2422 06:05:38.4 1.0373/1.0183/1.0760
2 min 4.16 sec - 06:04:36.4 06:06:40.5 07:06:24.9
alt=7.919, lon=131.536, dlon=54.686, s=23.714, z=2.306

annular 1.03.-2421 11:40:59.9 0.9511/0.9751/0.9045 saros 1/26
5 min 22.93 sec 09:56:46.0 11:38:18.3 11:43:41.3 13:23:59.8
alt=44.126, lon=143.895, dlon=67.045, s=23.693, z=2.830

total 15.09.-2404 09:38:20.4 1.0452/1.0220/1.0925
3 min 23.47 sec 08:23:12.1 09:36:38.9 09:40:02.4 10:58:39.6
alt=51.560, lon=45.939, dlon=-30.911, s=23.334, z=1.325

annular 11.03.-2403 11:49:31.3 0.9569/0.9781/0.9156 saros 1/27
4 min 35.48 sec 10:08:06.4 11:47:13.5 11:51:49.0 13:29:25.3
alt=48.167, lon=39.464, dlon=-37.386, s=23.313, z=1.604

total 4.05.-2397 12:22:37.6 1.0440/1.0217/1.0900
3 min 51.78 sec 10:51:58.3 12:20:41.8 12:24:33.6 13:52:19.6
alt=67.742, lon=102.510, dlon=25.660, s=23.187, z=1.107

annular 9.01.-2381 09:42:45.2 0.9749/0.9871/0.9504 saros 3/25
2 min 27.56 sec 08:16:01.5 09:41:31.4 09:43:58.9 11:22:43.3
alt=25.829, lon=33.424, dlon=-43.426, s=22.852, z=1.900

annular 9.01.-2381 12:38:49.8 0.9778/0.9883/0.9561 saros 3/25
2 min 24.82 sec 10:54:04.2 12:37:37.5 12:40:02.3 14:17:13.5
alt=35.520, lon=59.859, dlon=-16.991, s=22.852, z=0.744

total 27.10.-2378 12:17:12.2 1.0296/1.0146/1.0600 saros 5/20
2 min 30.45 sec 10:49:17.8 12:15:56.8 12:18:27.3 13:44:20.3
alt=53.334, lon=29.047, dlon=-47.803, s=22.790, z=2.098

annular 15.08.-2374 18:34:28.4 0.9195/0.9593/0.8455 saros 7/13
5 min 14.68 sec 17:28:57.8 18:31:51.2 18:37:05.9 -
alt=3.1878 lat=30.1548, lon=119.5533, dlon=42.7033, s=22.707, z=1.881
at lat=30:
annular 15.08.-2374 18:34:40.5 0.9195/0.9573/0.8455 saros 7/13
5 min 14.07 sec 17:29:11.7 18:32:03.4 18:37:17.5 -

annular 31.12.-2373 09:57:51.7 0.9573/0.9784/0.9164
4 min 11.16 sec 08:30:47.5 09:55:46.0 09:59:57.2 11:38:59.4
alt=28.472, lon=87.405, dlon=10.555, s=22.686, z=0.465

total 14.06.-2371 12:37:57.5 1.0798/1.0392/1.1659
6 min 27.05 sec 11:13:32.3 12:34:43.9 12:41:10.9 14:01:30.2
alt=75.315, lon=126.282, dlon=49.432, s=22.645, z=2.183

total 18.10.-2369 15:10:55.4 1.0344/1.0165/1.0700
2 min 20.99 sec 13:56:36.4 15:09:44.9 15:12:05.9 16:19:11.8
alt=33.090, lon=77.900, dlon=1.050, s=22.603, z=0.046

total 7.10.-2368 08:53:34.1 1.0347/1.0168/1.0707
2 min 24.76 sec 07:44:07.1 08:52:21.9 08:54:46.7 10:08:57.4
alt=38.298, lon=135.657, dlon=58.807, s=22.582, z=2.604

annular 25.07.-2364 08:16:19.3 0.9806/0.9900/0.9615
1 min 42.81 sec 06:58:51.0 08:15:27.8 08:17:10.6 09:47:22.9
alt=40.931, lon=26.158, dlon=-50.692, s=22.500, z=2.253

annular 25.07.-2364 12:10:11.8 0.9854/0.9922/0.9710
1 min 37.14 sec 10:25:07.3 12:09:23.3 12:11:00.5 13:49:43.3
alt=82.728, lon=62.807, dlon=-14.043, s=22.500, z=0.624

annular 10.01.-2354 16:10:02.6 0.9535/0.9766/0.9091
3 min 54.47 sec 14:42:00.5 16:08:05.6 16:12:00.0 -
alt=10.832, lon=22.770, dlon=-54.080, s=22.293, z=2.426

annular 13.04.-2349 12:13:31.7 0.9731/0.9865/0.9470 saros 1/30
2 min 43.00 sec 10:37:43.5 12:12:10.0 12:14:53.0 13:48:58.2
alt=60.884, lon=96.653, dlon=19.803, s=22.190, z=0.892

annular 31.01.-2345 07:09:28.2 0.9675/0.9825/0.9361 saros 3/27
2 min 24.05 sec - 07:08:16.1 07:10:40.2 08:26:09.4
alt=0.0630 lat=29.6257, lon=120.9625, dlon=44.1125, s=22.108, z=1.995
at lat=30:
annular 31.01.-2345 07:09:56.9 0.9675/0.9770/0.9361 saros 3/27
2 min 12.42 sec - 07:08:50.6 07:11:03.1 08:26:39.5

total 5.06.-2343 06:30:13.7 1.0204/1.0098/1.0412
1 min 10.83 sec 05:32:00.8 06:29:38.3 06:30:49.1 07:34:52.5
alt=18.549, lon=75.145, dlon=-1.705, s=22.067, z=0.077

total 18.11.-2342 10:26:26.1 1.0305/1.0152/1.0619 saros 5/22
2 min 27.79 sec 09:06:10.3 10:25:12.1 10:27:39.9 11:54:01.1
alt=41.081, lon=101.769, dlon=24.919, s=22.047, z=1.130

total 23.03.-2339 17:55:59.6 1.0232/1.0109/1.0469
1 min 16.87 sec 16:54:51.2 17:55:21.1 17:56:38.0 -
alt=0.0198 lat=29.8749, lon=50.1024, dlon=-26.7476, s=21.985, z=1.217
at lat=30:
total 23.03.-2339 17:55:57.3 1.0232/1.0083/1.0469
1 min 13.48 sec 16:54:49.2 17:55:20.5 17:56:34.0 -

annular 16.08.-2328 05:18:33.7 0.9707/0.9850/0.9423
1 min 49.09 sec - 05:17:39.0 05:19:28.1 06:21:29.5
alt=1.102, lon=118.488, dlon=41.638, s=21.761, z=1.913

annular 10.02.-2327 12:34:21.7 0.9786/0.9888/0.9576 saros 3/28
2 min 14.35 sec 10:52:57.3 12:33:14.6 12:35:28.9 14:09:11.9
alt=39.992, lon=58.258, dlon=-18.592, s=21.740, z=0.855

annular 16.09.-2320 14:48:33.3 0.9229/0.9611/0.8517 saros 7/16
7 min 43.88 sec 13:05:11.5 14:44:41.2 14:52:25.1 16:16:27.7
alt=46.220, lon=92.476, dlon=15.626, s=21.598, z=0.724

annular 1.02.-2318 09:39:53.4 0.9569/0.9780/0.9156
4 min 19.72 sec 08:11:23.4 09:37:43.5 09:42:03.2 11:23:59.0
alt=26.034, lon=82.982, dlon=6.132, s=21.557, z=0.284

annular 1.02.-2318 13:15:36.7 0.9598/0.9795/0.9212
4 min 30.27 sec 11:24:44.1 13:13:21.6 13:17:51.8 14:56:03.5
alt=36.309, lon=114.894, dlon=38.044, s=21.557, z=1.765

total 19.11.-2315 13:28:35.4 1.0381/1.0184/1.0777
3 min 1.46 sec 12:04:55.1 13:27:04.6 13:30:06.0 14:48:58.9
alt=39.243, lon=13.867, dlon=-62.983, s=21.496, z=2.930

total 9.11.-2314 07:05:28.5 1.0185/1.0087/1.0374
1 min 3.75 sec - 07:04:56.7 07:06:00.4 08:09:04.2
alt=9.906, lon=71.290, dlon=-5.560, s=21.476, z=0.259

annular 27.08.-2310 12:27:54.9 0.9854/0.9924/0.9710
1 min 28.47 sec 10:50:47.9 12:27:10.8 12:28:39.3 13:58:47.2
alt=75.691, lon=79.967, dlon=3.117, s=21.395, z=0.146

total 14.04.-2303 13:23:38.0 1.0486/1.0240/1.0995
4 min 1.66 sec 11:55:16.4 13:21:37.0 13:25:38.7 14:46:41.6
alt=55.733, lon=133.505, dlon=56.655, s=21.254, z=2.666

total 17.07.-2298 04:54:11.9 1.0113/1.0042/1.0228 saros 9/16
0 min 31.17 sec - 04:53:56.3 04:54:27.5 05:48:07.1
alt=-0.068, lon=64.164, dlon=-12.686, s=21.153, z=0.600

total 20.12.-2288 07:49:05.0 1.0305/1.0151/1.0619 saros 5/25
1 min 56.55 sec - 07:48:06.7 07:50:03.3 08:59:59.2
alt=10.199, lon=29.561, dlon=-47.289, s=20.953, z=2.257

total 20.12.-2288 16:58:13.6 1.0271/1.0131/1.0548 saros 5/25
1 min 35.88 sec 15:52:38.1 16:57:25.6 16:59:01.5 -
alt=0.983, lon=125.256, dlon=48.406, s=20.953, z=2.310

total 27.07.-2280 18:54:07.5 1.0062/1.0017/1.0125 saros 9/17
0 min 14.35 sec 17:59:06.8 18:54:00.3 18:54:14.7 -
alt=0.020, lon=114.691, dlon=37.841, s=20.793, z=1.820

total 11.12.-2279 12:28:22.9 1.0417/1.0202/1.0851
3 min 28.82 sec 11:02:42.3 12:26:38.5 12:30:07.3 13:54:37.9
alt=38.363, lon=93.398, dlon=16.548, s=20.773, z=0.797

total 11.12.-2279 16:45:34.6 1.0313/1.0153/1.0637
1 min 57.07 sec 15:36:32.2 16:44:36.0 16:46:33.1 -
alt=3.8920 lat=29.5183, lon=138.6138, dlon=61.7638, s=20.773, z=2.973
at lat=30:
total 11.12.-2279 16:44:57.7 1.0313/1.0050/1.0636
1 min 23.74 sec 15:35:54.5 16:44:15.7 16:45:39.4 -

annular 26.05.-2277 14:02:42.0 0.9863/0.9925/0.9728 saros 1/34
1 min 23.70 sec 12:23:56.8 14:02:00.3 14:03:24.0 15:33:05.1
alt=56.303, lon=71.396, dlon=-5.454, s=20.733, z=0.263

annular 26.05.-2277 17:07:59.6 0.9772/0.9882/0.9550 saros 1/34
1 min 40.84 sec 15:52:22.3 17:07:09.4 17:08:50.2 18:14:18.2
alt=16.535, lon=106.228, dlon=29.378, s=20.733, z=1.417

annular 15.03.-2273 12:29:03.7 0.9797/0.9897/0.9598 saros 3/31
2 min 2.13 sec 10:52:40.4 12:28:02.8 12:30:04.9 14:01:25.9
alt=50.057, lon=81.898, dlon=5.048, s=20.653, z=0.244

annular 19.10.-2266 11:28:01.4 0.9223/0.9611/0.8506 saros 7/19
9 min 14.75 sec 09:39:35.9 11:23:24.1 11:32:38.8 13:21:03.3
alt=56.217, lon=63.490, dlon=-13.360, s=20.514, z=0.651

total 26.05.-2258 06:21:55.0 1.0361/1.0175/1.0735 saros 11/14
1 min 58.56 sec 05:26:59.0 06:20:55.8 06:22:54.4 07:21:41.8
alt=15.358, lon=81.755, dlon=4.905, s=20.356, z=0.241

annular 28.09.-2256 11:23:06.6 0.9858/0.9927/0.9718
1 min 22.50 sec 09:53:34.9 11:22:25.3 11:23:47.8 12:53:33.0
alt=63.811, lon=61.120, dlon=-15.730, s=20.317, z=0.774

total 17.05.-2249 07:31:57.7 1.0536/1.0264/1.1102
3 min 19.04 sec 06:30:39.5 07:30:18.4 07:33:37.5 08:40:19.4
alt=28.741, lon=102.778, dlon=25.928, s=20.179, z=1.285

annular 29.07.-2234 06:33:47.3 0.9402/0.9700/0.8840 saros 0/41
4 min 32.48 sec 05:25:47.9 06:31:31.0 06:36:03.5 07:52:38.6
alt=18.728, lon=51.565, dlon=-25.285, s=19.884, z=1.272

annular 29.07.-2234 13:21:07.0 0.9500/0.9747/0.9026 saros 0/41
5 min 25.98 sec 11:30:16.6 13:18:23.9 13:23:49.9 14:57:18.3
alt=70.070, lon=118.464, dlon=41.614, s=19.884, z=2.093

total 22.01.-2233 15:29:42.0 1.0446/1.0222/1.0912 saros 5/28
2 min 58.54 sec 14:15:53.8 15:28:12.7 15:31:11.2 16:35:32.1
alt=18.974, lon=75.021, dlon=-1.829, s=19.865, z=0.092

annular 29.08.-2226 15:09:30.2 0.9986/0.9991/0.9972 saros 9/20
0 min 10.50 sec 13:44:54.2 15:09:25.1 15:09:35.6 16:23:24.9
alt=45.104, lon=69.173, dlon=-7.677, s=19.728, z=0.389

total 13.01.-2224 12:40:50.4 1.0492/1.0240/1.1008
4 min 12.55 sec 11:11:49.7 12:38:44.1 12:42:56.6 14:07:38.0
alt=35.3870 lat=30.2617, lon=57.2676, dlon=-19.5824, s=19.689, z=0.995
at lat=30:
total 13.01.-2224 12:40:55.0 1.0493/1.0201/1.1010
4 min 8.89 sec 11:11:47.1 12:38:50.5 12:42:59.4 14:07:48.6

annular 16.04.-2219 12:43:26.7 0.9779/0.9887/0.9562 saros 3/34
2 min 13.33 sec 11:07:46.4 12:42:20.2 12:44:33.5 14:16:57.3
alt=60.933, lon=131.644, dlon=54.794, s=19.592, z=2.797

annular 20.11.-2212 08:40:05.2 0.9201/0.9598/0.8466 saros 7/22
7 min 34.89 sec 07:16:56.4 08:36:18.1 08:43:53.0 10:18:35.3
alt=25.228, lon=26.578, dlon=-50.272, s=19.456, z=2.584

total 27.06.-2204 06:56:44.3 1.0436/1.0215/1.0891 saros 11/17
2 min 31.29 sec 05:59:12.3 06:55:28.7 06:58:00.0 08:00:23.8
alt=25.393, lon=119.091, dlon=42.241, s=19.302, z=2.188

annular 31.10.-2202 09:48:59.2 0.9870/0.9933/0.9743
1 min 8.70 sec 08:30:17.5 09:48:24.8 09:49:33.5 11:14:59.4
alt=42.2010 lat=29.3278, lon=19.1817, dlon=-57.6683, s=19.263, z=2.994
at lat=30:
partial 31.10.-2202 09:48:20.3 0.9778/0.9778/0.9654
0 min 0.00 sec 08:29:53.0 - - 11:14:02.4

annular 27.04.-2201 12:57:23.7 0.9761/0.9877/0.9528 saros 3/35
2 min 25.76 sec 11:20:15.3 12:56:11.0 12:58:36.7 14:31:59.5
alt=62.790, lon=33.321, dlon=-43.529, s=19.244, z=2.262

annular 6.04.-2191 12:25:36.4 0.9463/0.9731/0.8955
6 min 17.83 sec 10:34:12.1 12:22:27.7 12:28:45.5 14:14:02.5
alt=58.627, lon=63.671, dlon=-13.179, s=19.052, z=0.692

total 23.02.-2179 14:38:56.6 1.0607/1.0302/1.1251 saros 5/31
4 min 11.25 sec 13:23:31.2 14:36:50.9 14:41:02.1 15:47:46.1
alt=32.870, lon=52.108, dlon=-24.742, s=18.822, z=1.315

annular 12.12.-2176 06:59:34.9 0.9203/0.9598/0.8470 saros 7/24
6 min 9.39 sec - 06:56:30.3 07:02:39.7 08:19:07.0
alt=2.253, lon=118.805, dlon=41.955, s=18.765, z=2.236

annular 30.09.-2172 11:38:42.9 0.9834/0.9916/0.9670 saros 9/23
1 min 44.26 sec 10:02:03.9 11:37:50.8 11:39:35.1 13:16:13.4
alt=63.703, lon=24.095, dlon=-52.755, s=18.689, z=2.823

annular 22.11.-2166 08:26:28.4 0.9882/0.9938/0.9766
0 min 55.06 sec 07:17:43.7 08:26:00.7 08:26:55.8 09:43:18.3
alt=22.507, lon=101.355, dlon=24.505, s=18.575, z=1.319

annular 7.05.-2164 05:27:30.0 0.9359/0.9658/0.8759 saros 13/22
4 min 8.45 sec - 05:25:25.8 05:29:34.3 06:32:34.7
alt=-0.031, lon=85.342, dlon=8.492, s=18.537, z=0.458

annular 10.09.-2162 12:57:17.5 0.9308/0.9653/0.8663 saros 0/45
7 min 22.82 sec 11:12:04.9 12:53:36.1 13:00:59.0 14:33:40.9
alt=67.797, lon=33.266, dlon=-43.584, s=18.499, z=2.356

total 29.06.-2158 09:17:59.5 1.0702/1.0348/1.1453 saros 2/40
5 min 13.58 sec 08:04:33.5 09:15:23.1 09:20:36.7 10:40:31.4
alt=55.690, lon=24.409, dlon=-52.441, s=18.424, z=2.846

total 29.06.-2158 14:16:37.1 1.0707/1.0349/1.1463 saros 2/40
5 min 17.29 sec 12:53:42.6 14:13:58.1 14:19:15.3 15:30:26.2
alt=56.622, lon=71.961, dlon=-4.889, s=18.424, z=0.265

total 30.07.-2150 06:52:35.0 1.0421/1.0209/1.0859 saros 11/20
2 min 28.21 sec 05:54:24.7 06:51:21.0 06:53:49.2 07:57:30.8
alt=22.4086 lat=29.7070, lon=131.4420, dlon=54.5920, s=18.273, z=2.988
at lat=30:
total 30.07.-2150 06:52:55.4 1.0421/1.0136/1.0860 saros 11/20
2 min 18.30 sec 05:54:43.6 06:51:46.5 06:54:04.8 07:57:52.1

annular 9.05.-2137 05:25:49.6 0.9393/0.9663/0.8823
3 min 54.48 sec - 05:23:52.4 05:27:46.9 06:31:22.3
alt=-0.033, lon=56.503, dlon=-20.347, s=18.029, z=1.129

annular 22.10.-2136 09:38:48.4 0.9700/0.9847/0.9409 saros 9/25
2 min 49.38 sec 08:14:08.7 09:37:23.5 09:40:12.9 11:13:57.4
alt=42.566, lon=110.742, dlon=33.892, s=18.011, z=1.882

total 9.08.-2132 14:54:57.5 1.0473/1.0236/1.0969 saros 11/21
3 min 25.56 sec 13:34:41.5 14:53:14.6 14:56:40.2 16:05:55.2
alt=49.859, lon=93.937, dlon=17.087, s=17.936, z=0.953

total 28.03.-2125 14:26:16.1 1.0722/1.0357/1.1497 saros 5/34
4 min 59.52 sec 13:11:21.9 14:23:46.1 14:28:45.7 15:36:02.6
alt=42.500, lon=55.933, dlon=-20.917, s=17.806, z=1.175

total 21.07.-2122 05:58:05.1 1.0499/1.0249/1.1023 saros 2/42
2 min 41.29 sec 05:04:17.1 05:56:44.6 05:59:25.9 06:57:12.7
alt=12.094, lon=110.916, dlon=34.066, s=17.750, z=1.919

annular 12.10.-2108 11:44:13.9 0.9196/0.9598/0.8457 saros 0/48
8 min 49.34 sec 10:01:58.1 11:39:49.2 11:48:38.5 13:27:45.2
alt=58.894, lon=30.190, dlon=-46.660, s=17.491, z=2.668

total 31.07.-2104 14:49:24.0 1.0562/1.0281/1.1156 saros 2/43
3 min 53.07 sec 13:32:58.4 14:47:27.4 14:51:20.5 15:57:35.9
alt=51.198, lon=86.857, dlon=10.007, s=17.417, z=0.575

annular 24.01.-2103 16:38:59.4 0.9391/0.9693/0.8820 saros 7/28
4 min 41.20 sec 15:19:37.9 16:36:39.0 16:41:20.2 -
alt=7.484, lon=95.103, dlon=18.253, s=17.399, z=1.049

total 19.03.-2097 14:41:55.0 1.0248/1.0121/1.0502
1 min 55.59 sec 13:15:48.4 14:40:57.2 14:42:52.8 15:58:47.0
alt=37.993, lon=70.846, dlon=-6.004, s=17.288, z=0.347

total 31.08.-2096 06:44:21.6 1.0366/1.0180/1.0746 saros 11/23
2 min 9.01 sec 05:46:08.7 06:43:17.2 06:45:26.2 07:49:12.5
alt=16.529, lon=121.789, dlon=44.939, s=17.270, z=2.602

annular 19.06.-2092 07:39:21.4 0.9431/0.9713/0.8894 saros 13/26
4 min 36.48 sec 06:26:56.7 07:37:03.1 07:41:39.6 09:03:20.5
alt=34.322, lon=96.790, dlon=19.940, s=17.197, z=1.160

annular 24.11.-2082 07:13:10.0 0.9520/0.9756/0.9063 saros 9/28
3 min 32.52 sec - 07:11:23.6 07:14:56.2 08:29:06.8
alt=8.290, lon=56.498, dlon=-20.352, s=17.014, z=1.196

total 11.09.-2078 10:03:17.5 1.0452/1.0221/1.0925 saros 11/24
3 min 37.56 sec 08:43:36.8 10:01:29.0 10:05:06.5 11:29:38.9
alt=56.938, lon=32.708, dlon=-44.142, s=16.941, z=2.606

+annular 30.06.-2074 18:50:05.5 0.9334/0.9488/0.8712 saros 13/27
3 min 36.23 sec 17:45:38.2 18:48:17.5 18:51:53.7 -
alt=-0.0691 lat=31.3065, lon=118.8269, dlon=41.9769, s=16.869, z=2.488
at lat=31:
annular 30.06.-2074 18:50:22.5 0.9333/0.9421/0.8711 saros 13/27
2 min 54.62 sec 17:45:58.6 18:48:55.4 18:51:50.0 -

total 29.04.-2071 15:43:33.0 1.0730/1.0358/1.1512 saros 5/37
4 min 45.05 sec 14:32:03.3 15:41:10.1 15:45:55.2 16:48:45.9
alt=32.515, lon=89.310, dlon=12.460, s=16.814, z=0.741

total 29.04.-2071 18:09:15.5 1.0631/1.0309/1.1302 saros 5/37
3 min 17.99 sec 17:12:09.0 18:07:36.4 18:10:54.4 -
alt=1.100, lon=121.709, dlon=44.859, s=16.814, z=2.668

total 19.04.-2070 07:32:14.7 1.0337/1.0162/1.0686 saros 15/28
2 min 6.02 sec 06:30:08.5 07:31:11.9 07:33:17.9 08:40:28.2
alt=22.021, lon=120.579, dlon=43.729, s=16.796, z=2.604

annular 9.06.-2064 16:20:17.4 0.9945/0.9970/0.9891 saros 4/38
0 min 27.53 sec 15:01:36.2 16:20:03.8 16:20:31.4 17:28:26.0
alt=28.395, lon=70.040, dlon=-6.810, s=16.688, z=0.408

total 2.09.-2050 14:09:56.3 1.0413/1.0205/1.0843 saros 2/46
2 min 58.94 sec 12:51:20.5 14:08:26.9 14:11:25.8 15:21:43.3
alt=56.733, lon=73.317, dlon=-3.533, s=16.436, z=0.215

annular 26.02.-2049 15:58:41.8 0.9598/0.9795/0.9212 saros 7/31
3 min 12.00 sec 14:37:13.1 15:57:06.0 16:00:18.0 17:10:46.2
alt=20.421, lon=107.999, dlon=31.149, s=16.418, z=1.897

total 20.04.-2043 08:48:41.2 1.0192/1.0092/1.0387
1 min 25.08 sec 07:35:04.0 08:47:58.7 08:49:23.8 10:11:49.2
alt=38.576, lon=43.018, dlon=-33.832, s=16.310, z=2.074

total 3.10.-2042 06:32:46.5 1.0305/1.0148/1.0620 saros 11/26
1 min 44.39 sec - 06:31:54.4 06:33:38.8 07:35:31.0
alt=9.2257 lat=29.1087, lon=90.9210, dlon=14.0710, s=16.292, z=0.864
at lat=30:
partial 3.10.-2042 06:33:06.1 0.9871/0.9871/0.9891 saros 11/26
0 min 0.00 sec - - - 07:35:44.8

annular 1.07.-2028 06:13:52.8 0.9961/0.9978/0.9922 saros 4/40
0 min 17.68 sec 05:14:33.0 06:13:43.9 06:14:01.5 07:20:22.7
alt=16.340, lon=111.826, dlon=34.976, s=16.043, z=2.180

annular 1.08.-2020 08:38:34.7 0.9399/0.9697/0.8835 saros 13/30
5 min 49.61 sec 07:13:52.0 08:35:40.0 08:41:29.6 10:21:01.4
alt=44.722, lon=63.201, dlon=-13.649, s=15.902, z=0.858

annular 1.08.-2020 14:10:50.7 0.9418/0.9708/0.8871 saros 13/30
6 min 16.99 sec 12:18:39.3 14:07:42.2 14:13:59.2 15:45:07.7
alt=59.544, lon=112.707, dlon=35.857, s=15.902, z=2.255

annular 6.12.-2018 08:56:56.2 0.9097/0.9548/0.8276 saros 0/53
8 min 36.18 sec 07:33:25.0 08:52:38.6 09:01:14.7 10:35:02.2
alt=24.183, lon=114.479, dlon=37.629, s=15.866, z=2.372

annular 12.07.-2010 16:58:52.5 0.9976/0.9986/0.9952 saros 4/41
0 min 12.53 sec 15:50:26.6 16:58:46.5 16:58:59.0 17:59:50.5
alt=22.936, lon=116.847, dlon=39.997, s=15.725, z=2.544

total 27.02.-2003 15:11:18.6 1.0372/1.0184/1.0758
2 min 41.73 sec 13:51:12.4 15:09:57.7 15:12:39.5 16:22:34.3
alt=29.063, lon=106.384, dlon=29.534, s=15.602, z=1.893

total 1.06.-1998 08:33:59.4 1.0261/1.0128/1.0529 saros 15/32
1 min 48.54 sec 07:25:18.7 08:33:05.2 08:34:53.7 09:50:56.1
alt=44.830, lon=63.230, dlon=-13.620, s=15.515, z=0.878

total 4.10.-1996 12:55:34.7 1.0265/1.0130/1.0538 saros 2/49
2 min 4.24 sec 11:32:48.6 12:54:32.7 12:56:36.9 14:15:10.3
alt=58.647, lon=37.219, dlon=-39.631, s=15.480, z=2.560

-annular 10.04.-1977 17:48:39.2 0.9777/0.9883/0.9559 saros 7/35
1 min 29.65 sec 16:41:05.2 17:47:54.6 17:49:24.2 -
alt=3.8105 lat=28.9684, lon=66.0619, dlon=-10.7881, s=15.150, z=0.712
at lat=29:
annular 10.04.-1977 17:48:39.3 0.9777/0.9884/0.9559 saros 7/35
1 min 29.68 sec 16:41:05.5 17:47:54.7 17:49:24.3 -

annular 7.01.-1963 07:11:31.4 0.9100/0.9421/0.8281 saros 0/56
6 min 50.37 sec - 07:08:06.5 07:14:56.9 08:33:01.3
alt=0.0693 lat=30.4518, lon=94.0818, dlon=17.2318, s=14.909, z=1.156
at lat=30:
annular 7.01.-1963 07:11:16.0 0.9100/0.9311/0.8282 saros 0/56
6 min 3.47 sec - 07:08:14.4 07:14:17.9 08:32:46.4

annular 7.01.-1963 07:20:16.6 0.9105/0.9551/0.8289 saros 0/56
7 min 13.52 sec - 07:16:40.1 07:23:53.6 08:43:29.6
alt=2.571, lon=96.158, dlon=19.308, s=14.909, z=1.295

total 10.04.-1958 09:39:10.4 1.0473/1.0231/1.0969 saros 17/27
3 min 27.44 sec 08:26:03.4 09:37:26.9 09:40:54.4 10:58:03.3
alt=45.176, lon=58.256, dlon=-18.594, s=14.823, z=1.254

total 1.04.-1949 09:54:48.9 1.0577/1.0284/1.1187
4 min 26.02 sec 08:38:25.9 09:52:36.1 09:57:02.1 11:18:21.5
alt=44.629, lon=66.306, dlon=-10.544, s=14.669, z=0.719

-annular 18.01.-1945 17:18:24.0 0.9128/0.9556/0.8331 saros 0/57
6 min 53.69 sec 15:56:42.2 17:14:56.9 - -
alt=0.0642 lat=28.2312, lon=79.3434, dlon=2.4934, s=14.601, z=0.171
at lat=29:
annular 18.01.-1945 17:17:51.2 0.9127/0.9385/0.8330 saros 0/57
6 min 18.69 sec 15:56:10.8 17:14:41.7 - -

total 3.07.-1944 09:00:16.0 1.0113/1.0055/1.0228 saros 15/35
0 min 50.69 sec 07:44:37.9 08:59:50.5 09:00:41.2 10:27:21.0
alt=51.580, lon=105.692, dlon=28.842, s=14.584, z=1.978

annular 13.06.-1934 07:58:18.0 0.9516/0.9757/0.9056 saros 6/42
4 min 11.78 sec 06:41:24.8 07:56:11.9 08:00:23.7 09:29:28.7
alt=38.132, lon=46.379, dlon=-30.471, s=14.415, z=2.114

total 14.07.-1926 15:49:45.1 1.0033/1.0015/1.0066 saros 15/36
0 min 11.09 sec 14:27:16.8 15:49:39.7 15:49:50.8 17:00:49.1
alt=37.756, lon=61.634, dlon=-15.216, s=14.280, z=1.066

annular 23.06.-1916 17:48:47.2 0.9425/0.9712/0.8884 saros 6/43
3 min 55.80 sec 16:38:43.6 17:46:49.5 17:50:45.3 -
alt=11.367, lon=48.607, dlon=-28.243, s=14.112, z=2.001

annular 24.09.-1911 17:19:54.0 0.9774/0.9882/0.9553 saros 23/14
1 min 30.91 sec 16:12:00.8 17:19:08.7 17:20:39.6 -
alt=11.280, lon=102.681, dlon=25.831, s=14.028, z=1.841

total 28.11.-1906 10:06:43.0 1.0053/1.0025/1.0105 saros 2/54
0 min 21.65 sec 08:48:50.2 10:06:32.1 10:06:53.7 11:32:53.7
alt=35.368, lon=67.550, dlon=-9.300, s=13.945, z=0.667

total 12.05.-1904 10:05:43.8 1.0619/1.0308/1.1276 saros 17/30
4 min 32.32 sec 08:52:21.0 10:03:27.8 10:08:00.1 11:25:22.2
alt=60.402, lon=92.047, dlon=15.197, s=13.911, z=1.092

total 15.09.-1902 15:40:56.9 1.0024/1.0006/1.0048 saros 4/47
0 min 4.57 sec 14:26:41.8 15:40:54.7 15:40:59.2 16:48:07.6
alt=34.768, lon=116.275, dlon=39.425, s=13.878, z=2.841

annular 12.03.-1901 16:36:36.1 0.9526/0.9758/0.9075 saros 9/38
3 min 37.68 sec 15:18:25.4 16:34:47.4 16:38:25.1 17:46:05.7
alt=15.702, lon=39.422, dlon=-37.428, s=13.861, z=2.700

annular 19.02.-1891 13:34:29.9 0.9329/0.9663/0.8702 saros 0/60
7 min 46.82 sec 11:38:14.1 13:30:36.4 13:38:23.2 15:16:36.5
alt=39.953, lon=65.121, dlon=-11.729, s=13.696, z=0.856

total 15.09.-1883 07:08:15.8 1.0405/1.0197/1.0827 saros 14/38
2 min 28.27 sec 06:07:38.2 07:07:01.8 07:09:30.1 08:15:11.9
alt=19.3970 lat=29.0264, lon=42.9450, dlon=-33.9050, s=13.564, z=2.500
at lat=30:
partial 15.09.-1883 07:08:16.5 0.9886/0.9886/0.9914 saros 14/38
0 min 0.00 sec 06:07:46.8 - - 08:14:57.9

total 3.05.-1876 14:03:28.5 1.0742/1.0366/1.1539 saros 8/40
5 min 44.68 sec 12:39:10.8 14:00:35.8 14:06:20.5 15:20:43.1
alt=54.6234 lat=28.2718, lon=117.1470, dlon=40.2970, s=13.449, z=2.996
at lat=29:
total 3.05.-1876 14:03:39.6 1.0741/1.0135/1.1538 saros 8/40
4 min 22.78 sec 12:39:46.8 14:01:27.9 14:05:50.7 15:20:36.1

annular 22.03.-1864 09:47:35.7 0.9394/0.9691/0.8825 saros 19/27
6 min 10.61 sec 08:15:36.2 09:44:30.4 09:50:41.0 11:29:02.5
alt=40.324, lon=109.496, dlon=32.646, s=13.253, z=2.463

annular 26.07.-1862 18:11:50.0 0.9303/0.9647/0.8655 saros 6/46
4 min 32.78 sec 17:06:00.9 18:09:33.7 18:14:06.5 -
alt=8.418, lon=113.338, dlon=36.488, s=13.220, z=2.760

total 14.05.-1858 17:56:17.6 1.0595/1.0294/1.1226 saros 8/41
3 min 9.20 sec 16:58:08.1 17:54:42.9 17:57:52.1 -
alt=5.667, lon=52.509, dlon=-24.341, s=13.155, z=1.850

annular 27.10.-1857 13:55:19.8 0.9893/0.9942/0.9788 saros 23/17
1 min 2.84 sec 12:20:50.6 13:54:48.5 13:55:51.3 15:21:07.1
alt=42.3933 lat=29.6360, lon=37.4442, dlon=-39.4058, s=13.139, z=2.999
at lat=30:
partial 27.10.-1857 13:54:44.7 0.9870/0.9870/0.9772 saros 23/17
0 min 0.00 sec 12:20:23.5 - - 15:20:29.9

total 17.10.-1848 14:14:25.7 1.0063/1.0025/1.0126 saros 4/50
0 min 25.57 sec 12:50:58.3 14:14:12.9 14:14:38.5 15:31:59.0
alt=42.220, lon=75.686, dlon=-1.164, s=12.993, z=0.090

total 24.06.-1832 16:10:06.1 1.0605/1.0300/1.1246 saros 17/34
3 min 54.08 sec 14:58:17.5 16:08:08.8 16:12:02.9 17:13:44.0
alt=32.154, lon=67.977, dlon=-8.873, s=12.736, z=0.697

total 31.01.-1824 08:00:44.6 1.0123/1.0058/1.0248 saros 21/26
0 min 49.61 sec - 08:00:19.8 08:01:09.4 09:18:25.0
alt=9.942, lon=87.597, dlon=10.747, s=12.608, z=0.852

total 5.06.-1822 07:52:19.4 1.0632/1.0314/1.1304 saros 8/43
4 min 1.17 sec 06:49:20.1 07:50:19.1 07:54:20.3 09:03:00.6
alt=36.267, lon=80.611, dlon=3.761, s=12.576, z=0.299

annular 18.11.-1821 11:45:42.4 0.9951/0.9972/0.9903 saros 23/19
0 min 33.22 sec 10:11:31.0 11:45:25.8 11:45:59.0 13:22:51.4
alt=44.506, lon=114.215, dlon=37.365, s=12.560, z=2.975

annular 6.09.-1817 18:26:18.5 0.9189/0.9593/0.8444 saros 25/13
5 min 21.54 sec 17:19:52.1 18:23:37.9 18:28:59.4 -
alt=0.966, lon=79.812, dlon=2.962, s=12.497, z=0.237

annular 21.01.-1815 07:27:31.8 0.9923/0.9961/0.9846 saros 2/59
0 min 34.80 sec - 07:27:14.2 07:27:49.0 08:39:56.7
alt=3.404, lon=108.608, dlon=31.758, s=12.465, z=2.548

annular 16.08.-1807 10:36:49.4 0.9480/0.9734/0.8987 saros 16/37
5 min 52.76 sec 08:53:27.2 10:33:53.0 10:39:45.7 12:25:28.4
alt=67.777, lon=67.536, dlon=-9.314, s=12.339, z=0.755

total 15.06.-1804 18:41:40.1 1.0495/1.0050/1.1014 saros 8/44
1 min 24.13 sec 17:48:42.1 18:40:57.9 18:42:22.1 -
alt=-0.0634 lat=30.1565, lon=89.8886, dlon=13.0386, s=12.291, z=1.061
at lat=30:
total 15.06.-1804 18:41:48.5 1.0494/1.0012/1.1013 saros 8/44
0 min 35.29 sec 17:48:51.8 18:41:30.7 18:42:06.0 -

annular 1.02.-1797 15:16:27.6 0.9990/0.9995/0.9980 saros 2/60
0 min 8.82 sec 13:49:27.9 15:16:23.4 15:16:32.2 16:31:54.6
alt=23.168, lon=62.772, dlon=-14.078, s=12.181, z=1.156

annular 4.05.-1792 10:49:19.4 0.9529/0.9764/0.9081 saros 19/31
4 min 52.22 sec 09:15:04.8 10:46:53.2 10:51:45.4 12:32:07.5
alt=65.616, lon=90.102, dlon=13.252, s=12.103, z=1.095

annular 7.09.-1790 18:29:06.4 0.9134/0.9453/0.8343 saros 6/50
5 min 29.74 sec 17:23:33.8 18:26:21.6 18:31:51.3 -
alt=-0.035, lon=48.419, dlon=-28.431, s=12.072, z=2.355

partial 14.04.-1782 14:59:54.4 0.9994/0.9994/0.9991 saros 10/39
0 min 0.00 sec 13:29:47.5 - - 16:19:17.9
alt=40.090, lon=106.718, dlon=29.868, s=11.947, z=2.500

total 20.12.-1767 08:53:39.5 1.0013/1.0005/1.0027 saros 23/22
0 min 1.93 sec 07:39:11.2 08:53:38.4 08:53:40.3 10:19:22.8
alt=20.740, lon=50.055, dlon=-26.795, s=11.715, z=2.287

partial 20.12.-1767 15:19:57.1 0.9996/0.9996/0.9994 saros 23/22
0 min 0.00 sec 13:55:39.2 - - 16:33:07.8
alt=18.6850 lat=29.5651, lon=111.9044, dlon=35.0544, s=11.715, z=2.992
at lat=30:
partial 20.12.-1767 15:19:38.8 0.9896/0.9896/0.9867 saros 23/22
0 min 0.00 sec 13:55:27.0 - - 16:32:48.0

annular 8.10.-1763 14:39:05.7 0.9176/0.9584/0.8419 saros 25/16
8 min 36.36 sec 12:52:27.0 14:34:47.1 14:43:23.5 16:10:26.2
alt=40.7214 lat=29.7205, lon=41.9023, dlon=-34.9477, s=11.653, z=2.999
at lat=30:
annular 8.10.-1763 14:38:31.1 0.9176/0.9533/0.8419 saros 25/16
8 min 31.89 sec 12:51:56.4 14:34:14.8 14:42:46.7 16:09:53.3

annular 23.02.-1761 07:01:23.9 0.9915/0.9957/0.9831 saros 2/62
0 min 37.16 sec - 07:01:05.1 07:01:42.2 08:12:16.6
alt=1.393, lon=99.099, dlon=22.249, s=11.622, z=1.914

total 11.12.-1758 11:20:38.7 1.0182/1.0086/1.0368 saros 4/55
1 min 31.92 sec 09:55:25.7 11:19:52.7 11:21:24.7 12:51:56.6
alt=37.707, lon=102.541, dlon=25.691, s=11.576, z=2.219

annular 18.09.-1753 10:35:30.5 0.9449/0.9721/0.8929 saros 16/40
5 min 44.18 sec 08:59:12.1 10:32:38.4 10:38:22.6 12:16:13.9
alt=60.572, lon=84.891, dlon=8.041, s=11.499, z=0.699

total 16.05.-1728 08:31:01.2 1.0149/1.0072/1.0299 saros 10/42
1 min 4.23 sec 07:18:49.6 08:30:29.1 08:31:33.3 09:53:30.8
alt=41.973, lon=87.764, dlon=10.914, s=11.120, z=0.981

annular 16.06.-1720 14:08:40.0 0.9562/0.9775/0.9143 saros 19/35
4 min 47.77 sec 12:17:40.6 14:06:16.1 14:11:03.9 15:45:19.5
alt=57.8177 lat=29.6931, lon=93.7522, dlon=16.9022, s=11.000, z=1.537
at lat=30:
annular 16.06.-1720 14:08:38.1 0.9562/0.9693/0.9143 saros 19/35
4 min 24.06 sec 12:17:58.4 14:06:26.2 14:10:50.2 15:45:07.1

total 22.01.-1712 14:09:50.5 1.0191/1.0093/1.0386 saros 23/25
1 min 29.85 sec 12:42:26.6 14:09:05.6 14:10:35.5 15:27:45.0
alt=30.442, lon=72.968, dlon=-3.882, s=10.880, z=0.357

total 29.08.-1705 15:50:12.6 1.0379/1.0186/1.0772 saros 27/17
2 min 28.73 sec 14:37:45.9 15:48:58.2 15:51:27.0 16:54:48.3
alt=35.731, lon=62.926, dlon=-13.924, s=10.775, z=1.292

total 12.01.-1703 10:02:30.4 1.0293/1.0142/1.0594 saros 4/58
2 min 20.54 sec 08:43:54.6 10:01:20.2 10:03:40.8 11:30:52.2
alt=28.253, lon=55.268, dlon=-21.582, s=10.746, z=2.008

total 12.01.-1703 14:52:33.6 1.0274/1.0134/1.0556 saros 4/58
2 min 6.36 sec 13:27:10.2 14:51:30.4 14:53:36.7 16:07:48.8
alt=23.760, lon=101.008, dlon=24.158, s=10.746, z=2.248

annular 20.10.-1699 09:17:44.1 0.9424/0.9708/0.8881 saros 16/43
5 min 16.67 sec 07:54:50.8 09:15:05.8 09:20:22.5 10:49:56.5
alt=38.979, lon=67.665, dlon=-9.185, s=10.686, z=0.860

annular 26.03.-1688 18:01:08.0 0.9412/0.9700/0.8859 saros 12/55
4 min 4.50 sec 16:50:17.2 17:59:05.9 18:03:10.4 -
alt=0.0105 lat=29.6973, lon=47.3908, dlon=-29.4592, s=10.524, z=2.799
at lat=30:
annular 26.03.-1688 18:01:01.5 0.9412/0.9623/0.8859 saros 12/55
3 min 54.86 sec 16:50:11.8 17:59:04.1 18:02:59.0 -

annular 27.06.-1683 05:11:58.5 0.9956/0.9974/0.9912 saros 29/12
0 min 16.88 sec - 05:11:50.0 05:12:06.9 06:08:48.6
alt=3.738, lon=61.723, dlon=-15.127, s=10.451, z=1.447

annular 20.08.-1677 05:23:40.3 0.9604/0.9800/0.9225 saros 18/42
2 min 31.35 sec - 05:22:24.4 05:24:55.8 06:28:29.5
alt=0.884, lon=46.796, dlon=-30.054, s=10.363, z=2.900

annular 2.12.-1673 09:29:09.3 0.9101/0.9550/0.8284 saros 25/21
9 min 45.97 sec 07:55:28.9 09:24:17.0 09:34:02.9 11:21:40.4
alt=29.472, lon=106.658, dlon=29.808, s=10.304, z=2.893

total 23.02.-1658 13:26:09.1 1.0399/1.0198/1.0813 saros 23/28
3 min 6.66 sec 12:02:12.4 13:24:35.8 13:27:42.5 14:44:10.8
alt=42.219, lon=56.135, dlon=-20.715, s=10.087, z=2.054

annular 12.12.-1655 16:38:55.0 0.9054/0.9526/0.8198 saros 25/22
8 min 2.89 sec 15:10:33.2 16:34:53.2 16:42:56.1 -
alt=4.518, lon=52.230, dlon=-24.620, s=10.043, z=2.451

annular 12.12.-1655 16:56:51.7 0.9045/0.9315/0.8181 saros 25/22
7 min 3.40 sec 15:32:26.2 16:53:19.8 17:00:23.2 -
alt=0.0646 lat=30.8454, lon=56.3758, dlon=-20.4742, s=10.043, z=2.039
at lat=30:
annular 12.12.-1655 16:57:39.4 0.9045/0.9121/0.8182 saros 25/22
4 min 17.73 sec 15:33:17.6 16:55:30.7 16:59:48.4 -

total 18.05.-1644 12:05:15.4 1.0139/1.0065/1.0279 saros 21/36
1 min 12.57 sec 10:33:59.4 12:04:39.1 12:05:51.6 13:39:06.7
alt=75.224, lon=82.622, dlon=5.772, s=9.885, z=0.584

annular 30.07.-1629 05:19:50.7 0.9983/0.9990/0.9966 saros 29/15
0 min 8.46 sec - 05:19:46.3 05:19:54.7 06:18:07.7
alt=2.990, lon=93.473, dlon=16.623, s=9.672, z=1.719

-annular 3.01.-1618 07:01:08.7 0.9084/0.9538/0.8251 saros 25/24
7 min 27.05 sec - - 07:04:52.7 08:25:26.4
alt=0.0659 lat=28.1380, lon=76.7586, dlon=-0.0914, s=9.516, z=0.010
at lat=29:
annular 3.01.-1618 07:01:56.1 0.9083/0.9347/0.8250 saros 25/24
6 min 46.19 sec - - 07:05:19.5 08:26:14.1

total 22.10.-1615 10:14:28.8 1.0153/1.0075/1.0307 saros 27/22
1 min 13.69 sec 08:52:42.1 10:13:51.9 10:15:05.6 11:43:29.4
alt=46.958, lon=86.119, dlon=9.269, s=9.474, z=0.978

total 9.08.-1611 16:03:57.3 1.0060/1.0028/1.0121 saros 29/16
0 min 22.13 sec 14:47:31.1 16:03:46.3 16:04:08.5 17:11:00.7
alt=34.777, lon=95.353, dlon=18.503, s=9.418, z=1.965

total 27.03.-1604 13:10:55.2 1.0587/1.0292/1.1208 saros 23/31
4 min 26.92 sec 11:50:33.5 13:08:41.7 13:13:08.6 14:28:05.4
alt=53.805, lon=62.732, dlon=-14.118, s=9.320, z=1.515

total 31.07.-1583 13:29:14.5 1.0684/1.0339/1.1415 saros 20/40
5 min 11.15 sec 12:06:24.9 13:26:38.7 13:31:49.9 14:44:44.0
alt=68.3551 lat=30.0000, lon=96.7566, dlon=19.9066, s=9.029, z=2.205
at lat=30:
total 31.07.-1583 13:29:14.5 1.0684/1.0339/1.1415 saros 20/40
5 min 11.15 sec 12:06:24.9 13:26:38.7 13:31:49.9 14:44:44.0

total 18.03.-1576 16:14:41.8 1.0542/1.0266/1.1114 saros 14/55
3 min 26.38 sec 15:04:42.4 16:12:58.4 16:16:24.7 17:17:35.1
alt=21.544, lon=86.307, dlon=9.457, s=8.933, z=1.059

annular 24.10.-1569 09:42:51.9 0.9395/0.9695/0.8827 saros 18/48
5 min 43.85 sec 08:17:01.1 09:39:59.8 09:45:43.7 11:17:46.5
alt=41.957, lon=102.595, dlon=25.745, s=8.837, z=2.913

total 11.09.-1557 11:45:17.3 1.0132/1.0064/1.0266 saros 29/19
1 min 9.55 sec 10:11:59.6 11:44:42.4 11:45:52.0 13:18:11.4
alt=69.833, lon=51.334, dlon=-25.516, s=8.674, z=2.942

total 29.04.-1550 13:37:18.9 1.0713/1.0351/1.1477 saros 23/34
5 min 23.77 sec 12:16:49.8 13:34:36.8 13:40:00.6 14:54:25.8
alt=58.574, lon=88.353, dlon=11.503, s=8.579, z=1.341

partial 19.04.-1549 05:46:35.6 0.9948/0.9948/0.9974 saros 33/25
0 min 0.00 sec - - - 06:41:23.5
alt=-0.0168 lat=31.3294, lon=97.5019, dlon=20.6519, s=8.566, z=2.411
at lat=31:
partial 19.04.-1549 05:46:05.9 0.9895/0.9895/0.9932 saros 33/25
0 min 0.00 sec - - - 06:40:50.3

annular 15.02.-1546 14:28:39.1 0.9296/0.9647/0.8642 saros 25/28
6 min 57.45 sec 12:47:42.5 14:25:10.4 14:32:07.8 15:56:30.1
alt=32.8310 lat=30.8229, lon=51.3848, dlon=-25.4652, s=8.526, z=2.987
at lat=30:
annular 15.02.-1546 14:28:04.6 0.9298/0.9475/0.8645 saros 25/28
6 min 4.80 sec 12:46:40.3 14:25:02.1 14:31:06.9 15:56:12.0

annular 11.07.-1535 05:51:33.6 0.9357/0.9676/0.8755 saros 31/16
4 min 20.51 sec - 05:49:23.3 05:53:43.8 07:00:18.7
alt=10.978, lon=53.670, dlon=-23.180, s=8.379, z=2.766

total 2.09.-1529 13:03:58.0 1.0596/1.0298/1.1228 saros 20/43
4 min 27.70 sec 11:43:40.7 13:01:44.2 13:06:11.9 14:19:22.2
alt=67.894, lon=86.194, dlon=9.344, s=8.299, z=1.126

annular 22.07.-1517 17:46:22.3 0.9331/0.9663/0.8707 saros 31/17
4 min 42.97 sec 16:34:07.7 17:44:00.9 17:48:43.9 18:49:57.9
alt=13.652, lon=80.698, dlon=3.848, s=8.140, z=0.473

annular 25.11.-1515 07:55:10.9 0.9254/0.9624/0.8563 saros 18/51
6 min 4.28 sec 06:42:23.9 07:52:08.8 07:58:13.1 09:18:24.9
alt=15.489, lon=68.400, dlon=-8.450, s=8.114, z=1.041

annular 1.07.-1507 15:16:47.2 0.9617/0.9807/0.9248 saros 22/38
3 min 26.41 sec 13:42:27.1 15:15:04.2 15:18:30.7 16:36:09.8
alt=44.395, lon=99.570, dlon=22.720, s=8.009, z=2.837

annular 19.03.-1492 14:12:25.5 0.9442/0.9718/0.8916 saros 25/31
5 min 28.52 sec 12:34:07.5 14:09:41.3 14:15:09.8 15:41:24.2
alt=44.011, lon=92.121, dlon=15.271, s=7.814, z=1.954

annular 27.02.-1482 15:59:11.4 0.9907/0.9950/0.9815 saros 16/55
0 min 45.96 sec 14:38:22.3 15:58:48.6 15:59:34.5 17:10:01.7
alt=21.417, lon=87.743, dlon=10.893, s=7.685, z=1.417

partial 4.11.-1467 06:16:35.4 0.9994/0.9994/0.9994 saros 29/24
0 min 0.00 sec - - - 07:18:54.6
alt=0.0338 lat=29.7216, lon=64.0434, dlon=-12.8066, s=7.493, z=1.709
at lat=30:
partial 4.11.-1467 06:16:40.7 0.9932/0.9932/0.9917 saros 29/24
0 min 0.00 sec - - - 07:18:59.1

annular 23.08.-1463 12:58:05.5 0.9324/0.9661/0.8694 saros 31/20
8 min 2.69 sec 11:00:22.5 12:54:03.9 13:02:06.6 14:43:33.0
alt=71.122, lon=71.558, dlon=-5.292, s=7.443, z=0.711

total 31.03.-1428 10:55:38.6 1.0179/1.0087/1.0362 saros 16/58
1 min 33.67 sec 09:27:16.3 10:54:51.7 10:56:25.4 12:29:42.3
alt=54.692, lon=60.889, dlon=-15.961, s=7.005, z=2.278

total 3.07.-1423 07:45:21.7 1.0507/1.0253/1.1039 saros 33/32
3 min 11.81 sec 06:43:03.8 07:43:45.9 07:46:57.7 08:55:20.1
alt=35.056, lon=67.744, dlon=-9.106, s=6.943, z=1.311

total 28.11.-1385 09:03:42.0 1.0328/1.0163/1.0666 saros 20/51
2 min 14.53 sec 07:55:49.3 09:02:34.7 09:04:49.2 10:19:00.3
alt=26.349, lon=70.846, dlon=-6.004, s=6.483, z=0.926

total 5.08.-1369 08:21:26.3 1.0354/1.0173/1.0720 saros 33/35
2 min 31.12 sec 07:11:47.5 08:20:10.9 08:22:42.0 09:40:58.1
alt=40.039, lon=90.753, dlon=13.903, s=6.293, z=2.209

annular 2.04.-1344 15:19:02.9 0.9956/0.9972/0.9912 saros 27/37
0 min 24.27 sec 13:55:53.8 15:18:50.9 15:19:15.2 16:34:05.9
alt=35.262, lon=66.477, dlon=-10.373, s=6.001, z=1.729

total 24.06.-1311 17:29:00.6 1.0199/1.0099/1.0401 saros 35/32
1 min 9.67 sec 16:23:27.0 17:28:25.9 17:29:35.6 18:27:38.6
alt=16.114, lon=79.621, dlon=2.771, s=5.624, z=0.493

annular 13.04.-1307 08:13:31.9 0.9465/0.9727/0.8959 saros 37/28
4 min 31.78 sec 06:57:07.8 08:11:16.0 08:15:47.7 09:40:01.9
alt=30.565, lon=75.231, dlon=-1.619, s=5.579, z=0.290

annular 17.08.-1305 16:02:23.6 0.9536/0.9764/0.9094 saros 24/47
3 min 37.00 sec 14:42:16.0 16:00:35.2 16:04:12.2 17:12:52.6
alt=34.278, lon=77.674, dlon=0.824, s=5.557, z=0.148

total 10.02.-1304 17:35:27.1 1.0341/1.0165/1.0694 saros 29/33
1 min 51.06 sec 16:36:16.0 17:34:31.6 17:36:22.6 -
alt=0.0519 lat=29.5015, lon=88.8053, dlon=11.9553, s=5.546, z=2.156
at lat=30:
total 10.02.-1304 17:35:25.5 1.0341/1.0022/1.0693 saros 29/33
0 min 50.45 sec 16:36:16.5 17:35:00.2 17:35:50.6 -

total 15.06.-1283 17:14:37.3 1.0684/1.0341/1.1416 saros 26/41
3 min 45.20 sec 16:14:03.1 17:12:44.5 17:16:29.7 18:09:30.6
alt=18.352, lon=90.403, dlon=13.553, s=5.313, z=2.551

total 1.02.-1276 16:21:27.8 1.0326/1.0161/1.0663 saros 20/57
2 min 5.45 sec 15:10:18.3 16:20:25.1 16:22:30.6 17:24:42.9
alt=12.728, lon=71.676, dlon=-5.174, s=5.236, z=0.988

annular 18.09.-1251 15:23:16.8 0.9378/0.9683/0.8794 saros 24/50
5 min 22.26 sec 13:55:33.5 15:20:35.7 15:25:58.0 16:41:03.8
alt=36.1784 lat=30.8600, lon=91.6980, dlon=14.8480, s=4.966, z=2.990
at lat=30:
annular 18.09.-1251 15:25:12.6 0.9378/0.9588/0.8794 saros 24/50
5 min 4.93 sec 13:57:32.6 15:22:40.2 15:27:45.1 16:42:50.0

total 14.03.-1250 17:49:38.9 1.0489/1.0233/1.1002 saros 29/36
2 min 36.49 sec 16:51:37.8 17:48:20.5 17:50:57.0 -
alt=1.544, lon=88.772, dlon=11.922, s=4.956, z=2.406

annular 11.12.-1237 10:36:07.1 0.9745/0.9869/0.9496 saros 22/53
2 min 30.36 sec 09:08:05.2 10:34:51.9 10:37:22.2 12:14:54.2
alt=34.462, lon=76.482, dlon=-0.368, s=4.818, z=0.076

annular 26.05.-1235 09:26:03.6 0.9497/0.9747/0.9019 saros 37/32
4 min 49.64 sec 08:00:36.3 09:23:38.7 09:28:28.3 11:05:06.6
alt=55.613, lon=64.643, dlon=-12.207, s=4.797, z=2.545

annular 21.10.-1197 14:29:16.0 0.9254/0.9621/0.8564 saros 24/53
7 min 30.24 sec 12:49:01.4 14:25:30.8 14:33:01.0 15:59:22.5
alt=36.983, lon=84.400, dlon=7.550, s=4.403, z=1.715

total 27.03.-1186 07:02:59.5 1.0346/1.0168/1.0704 saros 20/62
2 min 4.36 sec - 07:01:57.4 07:04:01.8 08:09:03.8
alt=10.7517 lat=29.9037, lon=89.3438, dlon=12.4938, s=4.292, z=2.911
at lat=30:
total 27.03.-1186 07:03:08.1 1.0346/1.0147/1.0704 saros 20/62
2 min 3.01 sec - 07:02:06.7 07:04:09.8 08:09:13.0

-annular 8.07.-1163 12:34:43.2 0.9452/0.9721/0.8934 saros 37/36
6 min 57.27 sec 10:34:20.1 12:31:14.5 12:38:11.8 14:29:01.9
alt=80.1543 lat=28.2489, lon=67.2293, dlon=-9.6207, s=4.063, z=2.368
at lat=29:
annular 8.07.-1163 12:34:41.3 0.9452/0.9506/0.8934 saros 37/36
4 min 13.06 sec 10:35:12.3 12:32:34.9 12:36:47.9 14:28:16.2

-annular 22.11.-1143 13:26:26.1 0.9186/0.9587/0.8438 saros 24/56
9 min 36.03 sec 11:33:22.6 13:21:38.0 13:31:14.1 15:12:15.7
alt=37.5068 lat=28.8442, lon=65.2809, dlon=-11.5691, s=3.869, z=2.991
at lat=29:
annular 22.11.-1143 13:26:09.5 0.9186/0.9564/0.8438 saros 24/56
9 min 34.54 sec 11:33:11.1 13:21:22.1 13:30:56.7 15:11:57.4

annular 17.04.-1131 17:33:56.7 0.9759/0.9875/0.9525 saros 30/52
1 min 40.36 sec 16:22:57.0 17:33:06.6 17:34:47.0 -
alt=8.7087 lat=29.7885, lon=65.8611, dlon=-10.9889, s=3.754, z=2.928
at lat=30:
annular 17.04.-1131 17:33:50.2 0.9759/0.9821/0.9525 saros 30/52
1 min 28.30 sec 16:22:51.5 17:33:06.1 17:34:34.4 -

annular 25.12.-1089 14:34:05.5 0.9151/0.9571/0.8375 saros 24/59
9 min 29.81 sec 12:39:12.8 14:29:19.9 14:38:49.7 16:10:31.6
alt=24.4355 lat=30.8964, lon=66.8388, dlon=-10.0112, s=3.362, z=2.977
at lat=30:
annular 25.12.-1089 14:35:05.4 0.9153/0.9421/0.8377 saros 24/59
8 min 51.22 sec 12:39:45.0 14:30:39.2 14:39:30.4 16:11:35.2

total 20.06.-1069 12:13:34.2 1.0472/1.0230/1.0966 saros 39/37
4 min 15.49 sec 10:41:24.8 12:11:26.5 12:15:42.0 13:46:19.0
alt=82.7258 lat=28.5170, lon=86.3948, dlon=9.5448, s=3.182, z=2.999
at lat=29:
total 20.06.-1069 12:13:56.8 1.0472/1.0087/1.0966 saros 39/37
3 min 14.81 sec 10:42:05.3 12:12:19.4 12:15:34.2 13:46:19.6

total 23.10.-1067 17:30:01.1 1.0218/1.0064/1.0440 saros 26/53
1 min 6.51 sec 16:27:35.9 17:29:27.8 17:30:34.3 -
alt=0.024, lon=69.683, dlon=-7.167, s=3.164, z=2.265

total 29.04.-1029 12:13:16.3 1.0361/1.0177/1.0735 saros 41/32
3 min 0.91 sec 10:47:39.8 12:11:45.7 12:14:46.6 13:40:16.2
alt=70.363, lon=74.691, dlon=-2.159, s=2.834, z=0.762

total 20.04.-1001 11:44:54.2 1.0789/1.0393/1.1641 saros 32/54
6 min 19.92 sec 10:22:27.7 11:41:44.2 11:48:04.1 13:09:18.5
alt=67.445, lon=80.663, dlon=3.813, s=2.600, z=1.467

total 4.10.-954 11:02:56.8 1.0391/1.0194/1.0797 saros 38/44
3 min 1.31 sec 09:44:07.4 11:01:26.1 11:04:27.4 12:24:11.9
alt=57.032, lon=74.659, dlon=-2.191, s=2.225, z=0.985

annular 23.07.-950 13:50:51.5 0.9425/0.9710/0.8882 saros 40/40
6 min 5.37 sec 12:01:32.8 13:47:48.7 13:53:54.1 15:23:58.5
alt=64.011, lon=81.775, dlon=4.925, s=2.194, z=2.245

total 3.07.-902 06:31:39.0 1.0665/1.0331/1.1375 saros 51/29
3 min 34.35 sec 05:37:48.0 06:29:52.0 06:33:26.4 07:30:43.1
alt=19.103, lon=73.493, dlon=-3.357, s=1.838, z=1.826

total 13.07.-884 17:35:15.1 1.0632/1.0314/1.1304 saros 51/30
3 min 23.14 sec 16:36:20.4 17:33:33.4 17:36:56.5 18:28:53.8
alt=16.078, lon=80.882, dlon=4.032, s=1.710, z=2.358

partial 9.02.-783 16:27:15.5 0.9997/0.9997/0.9997 saros 47/30
0 min 0.00 sec 15:16:32.9 - - 17:30:54.6
alt=13.821, lon=76.599, dlon=-0.251, s=1.063, z=0.236

-total 5.05.-769 16:29:48.0 1.0325/1.0157/1.0661 saros 45/38
2 min 9.40 sec 15:16:11.1 16:28:43.2 16:30:52.6 17:35:15.1
alt=24.6363 lat=28.4340, lon=74.0057, dlon=-2.8443, s=0.983, z=2.895
at lat=29:
partial 5.05.-769 16:29:44.7 0.9982/0.9982/0.9993 saros 45/38
0 min 0.00 sec 15:16:18.4 - - 17:35:06.7

annular 16.07.-754 08:33:12.6 0.9857/0.9926/0.9716 saros 53/30
1 min 16.08 sec 07:16:17.2 08:32:34.4 08:33:50.5 10:03:41.6
alt=43.827, lon=75.767, dlon=-1.083, s=0.899, z=1.205

-annular 5.05.-750 06:59:24.1 0.9723/0.9857/0.9454 saros 55/29
1 min 56.43 sec 05:55:34.5 06:58:25.7 07:00:22.2 08:10:34.2
alt=20.7682 lat=28.3689, lon=79.3292, dlon=2.4792, s=0.877, z=2.826
at lat=29:
annular 5.05.-750 07:00:34.0 0.9724/0.9764/0.9456 saros 55/29
1 min 24.51 sec 05:56:36.9 06:59:51.7 07:01:16.2 08:11:51.2

total 14.03.-729 15:58:59.8 1.0222/1.0105/1.0449 saros 47/33
1 min 27.64 sec 14:46:15.0 15:58:15.9 15:59:43.6 17:05:06.0
alt=25.117, lon=74.709, dlon=-2.141, s=0.766, z=2.795

+annular 1.01.-679 08:19:24.1 0.9349/0.9673/0.8741 saros 40/55
5 min 37.67 sec - 08:16:35.3 08:22:13.0 09:49:40.7
alt=12.6238 lat=31.4158, lon=78.3107, dlon=1.4607, s=0.525, z=2.784
at lat=31:
annular 1.01.-679 08:19:08.6 0.9350/0.9582/0.8742 saros 40/55
5 min 23.82 sec - 08:16:26.9 08:21:50.7 09:49:30.8

-annular 14.01.-558 11:15:38.6 0.9614/0.9801/0.9242 saros 61/24
4 min 18.81 sec 09:32:37.7 11:13:29.1 11:17:47.9 13:01:57.0
alt=36.8796 lat=28.8736, lon=77.1282, dlon=0.2782, s=0.095, z=2.942
at lat=29:
annular 14.01.-558 11:15:46.7 0.9613/0.9779/0.9242 saros 61/24
4 min 16.44 sec 09:32:48.5 11:13:38.4 11:17:54.8 13:02:00.8

+annular 16.02.-504 11:24:36.8 0.9623/0.9806/0.9260 saros 61/27
3 min 56.30 sec 09:46:11.2 11:22:38.6 11:26:34.8 13:03:40.6
alt=42.3860 lat=31.3441, lon=76.8484, dlon=-0.0016, s=0.002, z=0.973
at lat=31:
annular 16.02.-504 11:24:02.5 0.9624/0.9767/0.9262 saros 61/27
3 min 50.00 sec 09:45:30.0 11:22:07.4 11:25:57.4 13:03:16.9
at lon76.85, lat=30:
annular 16.02.-504 11:20:41.6 0.9625/0.9660/0.9264 saros 61/27
2 min 24.04 sec 09:41:55.7 11:19:29.5 11:21:53.5 13:00:30.6

-annular 3.08.-411 05:24:41.8 0.9326/0.9396/0.8698 saros 58/40
2 min 49.77 sec - 05:23:16.8 05:26:06.6 06:33:36.5

annular 3.09.-403 14:04:49.6 0.9906/0.9951/0.9812 saros 67/18
0 min 55.29 sec 12:30:25.0 14:04:22.2 14:05:17.4 15:28:35.6
alt=54.4706 lat=29.9366, lon=76.2524, dlon=-0.5976, s=0.206, z=2.900
at lat=30:
annular 3.09.-403 14:04:42.7 0.9906/0.9937/0.9812 saros 67/18
0 min 52.60 sec 12:30:19.1 14:04:16.4 14:05:09.0 15:28:28.4

total 15.08.-309 13:48:42.3 1.0606/1.0302/1.1248 saros 69/24
4 min 41.23 sec 12:24:13.2 13:46:21.5 13:51:02.8 15:05:23.0
alt=61.927, lon=78.464, dlon=1.614, s=0.580, z=2.783
at lon=76.85, lat=30:
total 15.08.-309 13:37:42.3 1.0609/1.0054/1.1255 saros 69/24
2 min 37.81 sec 12:12:22.2 13:36:23.2 13:39:01.0 14:55:31.5

+total 24.03.-274 14:08:13.0 1.0106/1.0049/1.0214 saros 54/57
0 min 51.00 sec 12:36:54.6 14:07:47.6 14:08:38.6 15:31:09.1
alt=47.0827 lat=31.7286, lon=74.6664, dlon=-2.1836, s=0.751, z=2.909
at lat=31:
partial 24.03.-274 14:07:53.3 0.9845/0.9845/0.9832 saros 54/57
0 min 0.00 sec 12:36:09.8 - - 15:31:06.9

annular 19.11.-231 09:29:39.1 0.9106/0.9552/0.8291 saros 58/50
9 min 4.33 sec 08:00:48.5 09:25:07.4 09:34:11.7 11:13:25.8
alt=30.698, lon=75.326, dlon=-1.524, s=0.983, z=1.550
at lon=76.85, lat=30:
annular 19.11.-231 09:36:25.3 0.9108/0.9349/0.8295 saros 58/50
8 min 9.25 sec 08:06:38.7 09:32:21.1 09:40:30.3 11:21:13.3

annular 15.04.-154 17:17:34.5 0.9893/0.9941/0.9786 saros 65/34
0 min 46.82 sec 16:06:10.1 17:17:11.2 17:17:58.0 18:21:27.2
alt=13.2096 lat=31.0681, lon=80.9108, dlon=4.0608, s=1.453, z=2.795
at lat=31:
annular 15.04.-154 17:17:35.1 0.9892/0.9919/0.9786 saros 65/34
0 min 41.58 sec 16:06:09.9 17:17:14.4 17:17:56.0 18:21:28.0

annular 18.06.-111 07:09:59.2 0.9451/0.9725/0.8932 saros 64/41
4 min 23.79 sec 05:58:38.4 07:07:47.2 07:12:11.0 08:33:50.1
alt=27.040, lon=78.905, dlon=2.055, s=1.745, z=1.178
at lon=76.85, lat=30:
annular 18.06.-111 06:59:32.4 0.9446/0.9467/0.8922 saros 64/41
1 min 47.19 sec 05:49:35.6 06:58:38.6 07:00:25.7 08:21:18.4

annular 19.07.-103 15:00:07.4 0.9962/0.9980/0.9923 saros 73/34
0 min 23.76 sec 13:28:36.3 14:59:55.8 15:00:19.5 16:18:32.2
alt=49.291, lon=71.770, dlon=-5.080, s=1.802, z=2.819

annular 29.06.-093 16:13:57.2 0.9447/0.9723/0.8924 saros 64/42
4 min 32.08 sec 14:48:11.9 16:11:41.3 16:16:13.4 17:26:57.8
alt=33.1548 lat=29.7522, lon=71.3022, dlon=-5.5478, s=1.874, z=2.961
at lat=30:
annular 29.06.-093 16:13:31.4 0.9447/0.9673/0.8925 saros 64/42
4 min 27.55 sec 14:47:44.3 16:11:17.6 16:15:45.1 17:26:34.8

total 18.05.-081 08:37:22.7 1.0655/1.0325/1.1352 saros 75/30
4 min 14.55 sec 07:32:52.3 08:35:15.7 08:39:30.2 09:48:53.1
alt=44.577, lon=73.569, dlon=-3.281, s=1.961, z=1.673

annular 17.03.-078 15:22:28.9 0.9452/0.9721/0.8934 saros 67/36
4 min 54.26 sec 13:51:34.2 15:20:01.8 15:24:56.0 16:43:13.0
alt=33.750, lon=71.109, dlon=-5.741, s=1.983, z=2.895

total 15.02.-002 17:47:07.1 1.0383/1.0187/1.0782 saros 69/41
2 min 2.40 sec 16:49:14.4 17:46:05.9 17:48:08.3 -
alt=0.0381 lat=28.6674, lon=74.8800, dlon=-1.9700, s=2.575, z=0.765
at lat=29:
total 15.02.-002 17:47:08.2 1.0383/1.0091/1.0781 saros 69/41
1 min 43.03 sec 16:49:17.0 17:46:16.6 17:47:59.6 -

total 10.06.0001 07:04:10.6 1.0530/1.0263/1.1087 saros 66/43
3 min 9.62 sec 06:05:03.0 07:02:35.9 07:05:45.6 08:10:16.3
alt=25.817, lon=70.372, dlon=-6.478, s=2.600, z=2.492

# L: Total and Annular Solar Eclipses Observable in Dvārakā

This is a list of total, near-total (m > 99%), and annular solar eclipses that could have been observed from Dvārakā (68E58, 22N14) between 3500 BCE and 1 BCE. Due to the uncertainty of ΔT there are more candidates for the more remote past, but the likelihood of observability is higher for more recent eclipses. Explanation of data is given in Appendix K.

annular 14.08.-3500 14:37:02.0 0.9877/0.9938/0.9756
1 min 6.73 sec 13:06:04.2 14:36:29.0 14:37:35.7 15:55:11.6
alt=53.630, lon=147.203, dlon=78.237, s=51.573, z=1.517

total 6.02.-3499 14:23:55.5 1.0205/1.0101/1.0414
1 min 37.61 sec 12:54:27.5 14:23:06.8 14:24:44.5 15:42:08.7
alt=35.632, lon=-140.525, dlon=150.508, s=51.543, z=2.920

total 1.06.-3496 13:08:30.6 1.0620/1.0307/1.1279
5 min 24.33 sec 11:35:44.4 13:05:48.2 13:11:12.5 14:35:25.9
alt=69.259, lon=3.507, dlon=-65.460, s=51.452, z=1.272

total 1.06.-3496 15:42:22.2 1.0547/1.0270/1.1125
3 min 47.34 sec 14:24:49.3 15:40:28.3 15:44:15.7 16:50:01.3
alt=33.874, lon=29.461, dlon=-39.506, s=51.452, z=0.768

annular 26.11.-3496 12:26:27.5 0.9185/0.9590/0.8436
10 min 44.63 sec 10:25:04.7 12:21:05.4 12:31:50.0 14:26:19.1
alt=52.082, lon=84.181, dlon=15.214, s=51.452, z=0.296

annular 26.11.-3496 17:04:53.6 0.9087/0.9541/0.8257
7 min 29.92 sec 15:39:19.5 17:01:08.4 17:08:38.3 -
alt=5.359, lon=130.140, dlon=61.173, s=51.452, z=1.189

annular 26.11.-3496 17:25:34.2 0.9075/0.9310/0.8236
6 min 19.41 sec 16:04:29.0 17:22:24.4 17:28:43.8 -
alt=0.0353 lat=22.4959, lon=134.8810, dlon=65.9143, s=51.452, z=1.281
at lat=22.23333:
annular 26.11.-3496 17:25:51.1 0.9075/0.9247/0.8236
5 min 39.67 sec 16:04:49.1 17:23:01.3 17:28:41.0 -

total 13.09.-3492 15:36:43.9 1.0361/1.0178/1.0735
2 min 26.66 sec 14:21:22.6 15:35:30.6 15:37:57.3 16:43:16.4
alt=38.905, lon=-160.989, dlon=130.045, s=51.330, z=2.534

annular 2.07.-3488 06:32:28.4 0.9810/0.9903/0.9624
1 min 16.39 sec 05:32:06.9 06:31:50.1 06:33:06.5 07:40:16.9
alt=18.580, lon=-6.691, dlon=-75.658, s=51.208, z=1.477

annular 6.11.-3486 10:27:21.6 0.9333/0.9666/0.8711
6 min 52.69 sec 08:54:09.7 10:23:55.3 10:30:48.0 12:09:46.5
alt=53.571, lon=159.090, dlon=90.124, s=51.148, z=1.762

annular 25.08.-3482 14:17:47.4 0.9820/0.9910/0.9643
1 min 38.63 sec 12:44:59.5 14:16:58.4 14:18:37.0 15:38:22.3
alt=58.290, lon=23.891, dlon=-45.076, s=51.026, z=0.883

total 18.02.-3481 14:16:29.7 1.0276/1.0137/1.0560
2 min 10.73 sec 12:48:58.7 14:15:24.5 14:17:35.2 15:33:58.4
alt=38.614, lon=100.577, dlon=31.610, s=50.996, z=0.620

total 12.06.-3478 16:39:19.5 1.0516/1.0256/1.1059
3 min 9.70 sec 15:31:00.4 16:37:44.5 16:40:54.2 17:39:38.2
alt=21.466, lon=-72.497, dlon=-141.464, s=50.905, z=2.779

annular 7.12.-3478 11:16:41.8 0.9188/0.9592/0.8442
10 min 33.73 sec 09:23:02.9 11:11:25.5 11:21:59.2 13:23:05.2
alt=48.486, lon=-46.367, dlon=-115.333, s=50.905, z=2.266

annular 7.12.-3478 16:33:37.6 0.9110/0.9553/0.8299
7 min 50.24 sec 15:00:50.3 16:29:42.1 16:37:32.4 -
alt=10.822, lon=1.963, dlon=-67.004, s=50.905, z=1.316

annular 12.04.-3475 11:04:16.2 0.9660/0.9829/0.9332
3 min 54.72 sec 09:19:39.2 11:02:18.7 11:06:13.5 12:56:10.6
alt=61.081, lon=122.691, dlon=53.724, s=50.814, z=1.057

total 25.09.-3474 14:38:42.0 1.0347/1.0171/1.0707
2 min 36.79 sec 13:15:33.1 14:37:23.6 14:40:00.4 15:52:31.5
alt=50.676, lon=56.654, dlon=-12.313, s=50.784, z=0.242

annular 16.11.-3468 09:52:06.5 0.9349/0.9674/0.8741
6 min 23.71 sec 08:24:09.4 09:48:54.7 09:55:18.4 11:31:38.5
alt=45.014, lon=28.883, dlon=-40.083, s=50.603, z=0.792

total 13.05.-3467 13:02:52.1 1.0311/1.0153/1.0632
2 min 40.78 sec 11:32:44.0 13:01:31.8 13:04:12.6 14:30:26.2
alt=68.352, lon=122.027, dlon=53.061, s=50.572, z=1.049

total 28.02.-3463 14:11:02.7 1.0346/1.0172/1.0704
2 min 41.45 sec 12:45:31.5 14:09:42.1 14:12:23.5 15:27:43.0
alt=41.644, lon=-15.964, dlon=-84.930, s=50.452, z=1.683

total 23.06.-3460 08:43:24.6 1.0593/1.0296/1.1221
4 min 17.40 sec 07:32:43.4 08:41:16.3 08:45:33.6 10:04:31.8
alt=48.111, lon=93.989, dlon=25.022, s=50.361, z=0.497

total 23.06.-3460 16:54:35.1 1.0507/1.0252/1.1039
2 min 58.59 sec 15:49:18.3 16:53:05.8 16:56:04.4 17:52:37.5
alt=18.867, lon=175.936, dlon=106.970, s=50.361, z=2.124

annular 17.12.-3460 10:06:05.8 0.9186/0.9592/0.8438
9 min 42.05 sec 08:24:24.9 10:01:15.5 10:10:57.6 12:09:27.8
alt=39.022, lon=-175.719, dlon=115.314, s=50.361, z=2.290

annular 23.04.-3457 08:46:22.2 0.9602/0.9798/0.9220
3 min 46.25 sec 07:22:37.5 08:44:29.0 08:48:15.2 10:25:15.7
alt=38.739, lon=2.393, dlon=-66.573, s=50.271, z=1.324

annular 24.07.-3452 06:17:19.9 0.9805/0.9902/0.9614
1 min 16.80 sec 05:18:11.7 06:16:41.4 06:17:58.2 07:23:53.0
alt=14.219, lon=125.867, dlon=56.900, s=50.120, z=1.135

total 24.05.-3449 13:24:03.9 1.0261/1.0126/1.0528
2 min 17.04 sec 11:51:18.4 13:22:55.5 13:25:12.5 14:52:27.8
alt=65.199, lon=17.993, dlon=-50.973, s=50.030, z=1.019

annular 16.09.-3446 13:27:12.9 0.9713/0.9856/0.9435
2 min 45.64 sec 11:50:36.9 13:25:50.3 13:28:36.0 14:54:21.2
alt=68.114, lon=130.200, dlon=61.233, s=49.940, z=1.226

total 4.07.-3442 07:12:03.9 1.0533/1.0265/1.1094
3 min 15.56 sec 06:11:47.5 07:10:26.3 07:13:41.9 08:20:15.0
alt=27.329, lon=-40.527, dlon=-109.494, s=49.820, z=2.198

total 4.07.-3442 16:56:02.9 1.0501/1.0250/1.1028
2 min 54.04 sec 15:51:53.3 16:54:35.9 16:57:29.9 17:53:18.0
alt=19.479, lon=59.611, dlon=-9.355, s=49.820, z=0.188

annular 29.12.-3442 08:56:16.4 0.9179/0.9589/0.8426
8 min 32.29 sec 07:27:17.9 08:52:00.9 09:00:33.2 10:47:09.1
alt=26.350, lon=55.662, dlon=-13.304, s=49.820, z=0.267

annular 29.12.-3442 15:47:47.8 0.9164/0.9580/0.8398
8 min 2.65 sec 14:05:12.7 15:43:46.0 15:51:48.7 17:10:34.3
alt=18.786, lon=115.586, dlon=46.620, s=49.820, z=0.936

total 17.10.-3438 12:47:14.8 1.0306/1.0152/1.0620
2 min 38.45 sec 11:15:58.8 12:45:55.8 12:48:34.2 14:14:22.5
alt=65.636, lon=131.419, dlon=62.452, s=49.700, z=1.257

total 19.02.-3435 17:37:58.4 1.0535/1.0262/1.1099
2 min 55.29 sec 16:37:52.6 17:36:30.7 17:39:26.0 -
alt=1.325, lon=29.378, dlon=-39.589, s=49.611, z=0.798

annular 4.08.-3434 06:02:57.1 0.9795/0.9897/0.9594
1 min 18.90 sec - 06:02:17.5 06:03:36.4 07:07:57.6
alt=10.063, lon=6.388, dlon=-62.579, s=49.581, z=1.262

annular 4.08.-3434 17:46:04.8 0.9782/0.9889/0.9570
1 min 24.19 sec 16:40:37.2 17:45:23.0 17:46:47.2 -
alt=10.858, lon=130.867, dlon=61.900, s=49.581, z=1.248

annular 8.12.-3432 08:42:43.4 0.9393/0.9696/0.8822
5 min 17.40 sec 07:25:09.5 08:40:04.7 08:45:22.1 10:12:58.4
alt=27.752, lon=128.790, dlon=59.824, s=49.521, z=1.208

total 3.06.-3431 14:30:02.9 1.0186/1.0089/1.0375
1 min 33.21 sec 12:57:13.7 14:29:16.4 14:30:49.6 15:52:59.9
alt=50.7355 lat=22.7778, lon=-79.4273, dlon=-148.3940, s=49.491, z=2.998
at lat=22.23333:
partial 3.06.-3431 14:29:40.9 0.9918/0.9918/0.9930
0 min 0.00 sec 12:56:31.6 - - 15:52:51.9

total 3.06.-3431 16:51:09.0 1.0110/1.0052/1.0220
0 min 41.49 sec 15:37:12.5 16:50:48.5 16:51:29.9 17:55:49.3
alt=18.281, lon=-52.835, dlon=-121.802, s=49.491, z=2.461

annular 24.05.-3430 06:08:37.1 0.9576/0.9785/0.9170
2 min 48.95 sec - 06:07:12.5 06:10:01.5 07:16:05.7
alt=9.732, lon=79.065, dlon=10.099, s=49.461, z=0.204

annular 26.09.-3428 12:57:20.9 0.9665/0.9832/0.9340
3 min 19.35 sec 11:19:38.3 12:55:41.5 12:59:00.8 14:28:08.7
alt=71.364, lon=0.483, dlon=-68.484, s=49.401, z=1.386

total 22.03.-3427 14:06:06.2 1.0471/1.0235/1.0964
3 min 34.12 sec 12:43:52.4 14:04:19.1 14:07:53.3 15:21:29.2
alt=47.280, lon=116.505, dlon=47.538, s=49.372, z=0.963

total 14.07.-3424 05:52:39.3 1.0466/1.0231/1.0954
2 min 28.37 sec - 05:51:25.3 05:53:53.6 06:50:59.7
alt=9.515, lon=-177.354, dlon=113.679, s=49.282, z=2.307

total 14.07.-3424 16:49:32.5 1.0497/1.0248/1.1018
2 min 52.39 sec 15:45:26.5 16:48:06.3 16:50:58.7 17:46:50.4
alt=21.856, lon=-60.365, dlon=-129.332, s=49.282, z=2.624

annular 8.01.-3423 07:46:53.9 0.9170/0.9584/0.8408
7 min 24.21 sec - 07:43:12.2 07:50:36.4 09:21:21.9
alt=12.109, lon=-72.371, dlon=-141.338, s=49.252, z=2.870

annular 8.01.-3423 15:31:05.4 0.9195/0.9596/0.8455
7 min 54.72 sec 13:46:13.5 15:27:07.7 15:35:02.4 16:55:43.1
alt=22.024, lon=-2.831, dlon=-71.797, s=49.252, z=1.458

total 27.10.-3420 11:52:55.7 1.0278/1.0138/1.0564
2 min 26.94 sec 10:22:37.0 11:51:42.2 11:54:09.1 13:24:15.5
alt=64.087, lon=-11.270, dlon=-80.236, s=49.163, z=1.632

annular 14.08.-3416 16:36:52.1 0.9825/0.9910/0.9653
1 min 17.52 sec 15:21:24.2 16:36:13.7 16:37:31.2 17:42:21.9
alt=26.415, lon=-3.699, dlon=-72.666, s=49.044, z=1.482

annular 19.12.-3414 08:09:42.4 0.9421/0.9710/0.8876
4 min 43.66 sec 06:56:48.7 08:07:20.5 08:12:04.2 09:34:35.0
alt=19.466, lon=-0.331, dlon=-69.298, s=48.984, z=1.415

annular 3.06.-3412 06:36:47.7 0.9556/0.9775/0.9132
3 min 5.82 sec 05:33:17.1 06:35:14.7 06:38:20.5 07:48:08.1
alt=17.824, lon=-13.211, dlon=-82.178, s=48.925, z=1.680

total 2.04.-3409 14:07:25.2 1.0524/1.0260/1.1075
3 min 55.85 sec 12:46:15.7 14:05:27.2 14:09:23.1 15:22:24.8
alt=49.354, lon=5.014, dlon=-63.953, s=48.836, z=1.310

total 26.07.-3406 16:37:05.6 1.0491/1.0245/1.1007
2 min 52.62 sec 15:32:15.2 16:35:39.3 16:38:31.9 17:35:05.1
alt=25.452, lon=176.206, dlon=107.239, s=48.747, z=2.200

annular 14.05.-3402 15:14:02.3 0.9486/0.9740/0.8999
5 min 6.86 sec 13:29:02.5 15:11:29.0 15:16:35.8 16:40:58.5
alt=39.741, lon=117.559, dlon=48.592, s=48.628, z=0.999

total 7.11.-3402 10:59:48.8 1.0245/1.0122/1.0497
2 min 7.28 sec 09:33:09.8 10:58:45.1 11:00:52.4 12:32:28.3
alt=56.804, lon=-153.988, dlon=137.045, s=48.628, z=2.818

total 13.03.-3399 14:38:59.9 1.0694/1.0346/1.1437
5 min 8.16 sec 13:17:00.7 14:36:25.5 14:41:33.7 15:52:01.3
alt=40.039, lon=116.630, dlon=47.663, s=48.539, z=0.982

annular 26.08.-3398 05:28:00.8 0.9768/0.9843/0.9542
1 min 18.92 sec - 05:27:21.4 05:28:40.3 06:29:04.8
alt=-0.0463 lat=22.9419, lon=116.7377, dlon=47.7711, s=48.509, z=0.985
at lat=22.23333:
partial 26.08.-3398 05:27:31.8 0.9655/0.9655/0.9444
0 min 0.00 sec - - - 06:28:31.1

annular 18.10.-3392 11:51:57.9 0.9576/0.9787/0.9170
4 min 20.23 sec 10:15:10.8 11:49:48.0 11:54:08.3 13:29:06.9
alt=67.835, lon=97.701, dlon=28.734, s=48.332, z=0.595

total 5.08.-3388 16:20:07.7 1.0486/1.0242/1.0995
2 min 54.32 sec 15:13:55.4 16:18:40.6 16:21:34.9 17:19:21.3
alt=29.875, lon=49.736, dlon=-19.231, s=48.214, z=0.399

annular 30.01.-3387 15:07:14.0 0.9266/0.9632/0.8586
7 min 16.77 sec 13:22:18.7 15:03:35.4 15:10:52.2 16:33:20.3
alt=28.011, lon=129.947, dlon=60.980, s=48.184, z=1.266

annular 24.05.-3384 11:46:37.4 0.9543/0.9770/0.9107
5 min 41.79 sec 09:52:58.5 11:43:46.6 11:49:28.4 13:45:00.7
alt=81.192, lon=-9.518, dlon=-78.485, s=48.096, z=1.632

annular 24.05.-3384 18:09:19.6 0.9393/0.9683/0.8823
4 min 6.98 sec 16:59:38.1 18:07:16.2 18:11:23.1 -
alt=-0.032, lon=58.049, dlon=-10.918, s=48.096, z=0.227

total 18.11.-3384 10:07:00.8 1.0211/1.0105/1.0427
1 min 43.84 sec 08:45:46.5 10:06:08.9 10:07:52.8 11:37:41.7
alt=46.691, lon=63.436, dlon=-5.531, s=48.096, z=0.115

total 24.03.-3381 12:53:59.8 1.0743/1.0371/1.1540
6 min 9.22 sec 11:25:34.3 12:50:55.2 12:57:04.5 14:17:40.2
alt=56.656, lon=-15.817, dlon=-84.783, s=48.007, z=1.766

annular 5.09.-3380 14:20:48.8 0.9898/0.9948/0.9798
0 min 59.44 sec 12:44:38.0 14:20:19.4 14:21:18.8 15:43:49.3
alt=57.141, lon=85.476, dlon=16.510, s=47.978, z=0.344

annular 10.01.-3377 07:11:48.2 0.9495/0.9746/0.9015
3 min 40.61 sec - 07:09:57.8 07:13:38.4 08:27:11.0
alt=4.957, lon=106.866, dlon=37.899, s=47.890, z=0.791

annular 25.06.-3376 06:54:35.5 0.9480/0.9738/0.8988
3 min 48.40 sec 05:48:29.0 06:52:41.2 06:56:29.6 08:10:11.1
alt=23.411, lon=150.089, dlon=81.122, s=47.860, z=1.695

annular 29.10.-3374 11:17:29.6 0.9536/0.9768/0.9094
4 min 43.97 sec 09:42:51.3 11:15:07.5 11:19:51.5 12:56:32.8
alt=61.716, lon=-34.657, dlon=-103.624, s=47.801, z=2.168

total 24.04.-3373 14:24:46.5 1.0600/1.0297/1.1237
4 min 26.60 sec 13:04:44.9 14:22:33.0 14:26:59.6 15:38:52.9
alt=49.351, lon=146.413, dlon=77.446, s=47.772, z=1.621

total 13.04.-3372 07:14:03.2 1.0687/1.0340/1.1421
4 min 1.04 sec 06:15:31.5 07:12:03.1 07:16:04.2 08:18:24.6
alt=15.370, lon=175.181, dlon=106.214, s=47.743, z=2.225

annular 10.02.-3369 14:59:25.4 0.9304/0.9652/0.8657
6 min 51.37 sec 13:15:57.2 14:55:59.7 15:02:51.1 16:25:30.5
alt=30.897, lon=20.927, dlon=-48.039, s=47.655, z=1.008

total 3.04.-3363 10:52:43.4 1.0746/1.0371/1.1547
6 min 8.29 sec 09:29:37.9 10:49:39.6 10:55:47.8 12:20:34.5
alt=56.9883 lat=21.8757, lon=-148.6622, dlon=142.3711, s=47.479, z=2.999
at lat=22.23333:
total 3.04.-3363 10:53:15.0 1.0745/1.0282/1.1546
5 min 56.41 sec 09:30:11.8 10:50:17.3 10:56:13.7 12:21:00.1

annular 16.09.-3362 13:14:16.7 0.9924/0.9962/0.9849
0 min 49.45 sec 11:33:02.7 13:13:52.3 13:14:41.8 14:45:44.5
alt=70.632, lon=-51.088, dlon=-120.055, s=47.449, z=2.530

annular 20.01.-3359 06:51:40.0 0.9542/0.9769/0.9105
3 min 12.27 sec - 06:50:03.8 06:53:16.1 08:04:00.8
alt=0.0543 lat=21.8196, lon=-15.1518, dlon=-84.1185, s=47.362, z=1.776
at lat=22.23333:
annular 20.01.-3359 06:51:47.4 0.9541/0.9661/0.9104
2 min 50.03 sec - 06:50:22.4 06:53:12.5 08:04:07.3

annular 6.07.-3358 06:54:37.4 0.9433/0.9715/0.8898
4 min 12.96 sec 05:47:50.1 06:52:30.8 06:56:43.8 08:11:36.1
alt=23.359, lon=47.503, dlon=-21.464, s=47.332, z=0.453

annular 8.11.-3356 10:42:21.7 0.9500/0.9750/0.9025
5 min 1.24 sec 09:10:49.3 10:39:50.9 10:44:52.2 12:22:00.2
alt=54.269, lon=-167.195, dlon=123.838, s=47.274, z=2.620

total 4.05.-3355 14:48:44.1 1.0618/1.0305/1.1274
4 min 29.74 sec 13:29:33.0 14:46:29.0 14:50:58.7 16:01:16.1
alt=45.056, lon=39.827, dlon=-29.139, s=47.244, z=0.617

total 24.04.-3354 08:07:06.6 1.0735/1.0363/1.1523
4 min 36.17 sec 07:04:19.7 08:04:49.0 08:09:25.1 09:16:02.2
alt=30.362, lon=73.541, dlon=4.575, s=47.215, z=0.097

total 27.08.-3352 15:35:16.1 1.0473/1.0235/1.0968
3 min 1.15 sec 14:24:48.4 15:33:45.5 15:36:46.6 16:38:28.7
alt=40.339, lon=148.570, dlon=79.603, s=47.157, z=1.688

annular 15.06.-3348 07:48:06.0 0.9481/0.9739/0.8988
4 min 28.97 sec 06:31:54.1 07:45:51.5 07:50:20.5 09:19:27.3
alt=35.162, lon=116.126, dlon=47.159, s=47.040, z=1.003

total 10.12.-3348 08:22:14.0 1.0137/1.0067/1.0275
0 min 56.07 sec 07:13:25.7 08:21:45.9 08:22:42.0 09:41:14.5
alt=23.445, lon=139.097, dlon=70.130, s=47.040, z=1.491

total 15.04.-3345 08:38:29.9 1.0690/1.0342/1.1429
4 min 46.41 sec 07:30:10.4 08:36:07.3 08:40:53.7 09:55:19.0
alt=34.845, lon=75.503, dlon=6.536, s=46.953, z=0.139

annular 27.09.-3344 12:10:32.1 0.9941/0.9970/0.9882
0 min 40.87 sec 10:30:12.5 12:10:11.9 12:10:52.8 13:47:53.8
alt=76.248, lon=171.189, dlon=102.223, s=46.923, z=2.179

annular 31.01.-3341 17:33:21.1 0.9592/0.9773/0.9201
2 min 50.32 sec 16:20:55.0 17:31:56.1 17:34:46.5 -
alt=0.053, lon=-22.394, dlon=-91.361, s=46.836, z=1.951

annular 16.07.-3340 06:50:34.5 0.9382/0.9690/0.8802
4 min 38.25 sec 05:43:27.2 06:48:15.3 06:52:53.6 08:08:25.7
alt=21.950, lon=-58.025, dlon=-126.991, s=46.807, z=2.713

annular 20.11.-3338 10:07:28.7 0.9467/0.9733/0.8963
5 min 11.96 sec 08:39:38.7 10:04:52.6 10:10:04.6 11:46:15.4
alt=46.258, lon=60.752, dlon=-8.215, s=46.749, z=0.176

total 15.05.-3337 16:15:53.5 1.0585/1.0289/1.1204
3 min 46.62 sec 15:04:30.2 16:13:59.9 16:17:46.5 17:19:49.1
alt=25.555, lon=-54.801, dlon=-123.768, s=46.720, z=2.649

total 4.05.-3336 08:27:18.2 1.0747/1.0370/1.1550
4 min 46.72 sec 07:23:11.0 08:24:55.3 08:29:42.0 09:37:38.2
alt=37.772, lon=-34.438, dlon=-103.405, s=46.691, z=2.215

total 7.09.-3334 15:07:59.5 1.0466/1.0231/1.0954
3 min 6.17 sec 13:54:50.5 15:06:26.4 15:09:32.5 16:13:55.5
alt=46.055, lon=14.097, dlon=-54.869, s=46.632, z=1.177

annular 4.03.-3333 14:53:17.7 0.9377/0.9688/0.8793
5 min 59.09 sec 13:13:54.0 14:50:18.3 14:56:17.4 16:18:28.0
alt=35.838, lon=172.319, dlon=103.352, s=46.603, z=2.218

annular 26.06.-3330 06:11:06.3 0.9426/0.9711/0.8884
4 min 3.25 sec 05:07:29.9 06:09:04.7 06:13:07.9 07:24:00.0
alt=13.782, lon=-5.726, dlon=-74.693, s=46.516, z=1.606

total 21.12.-3330 07:29:42.1 1.0098/1.0047/1.0198
0 min 35.89 sec - 07:29:24.1 07:30:00.0 08:41:20.8
alt=11.191, lon=-2.545, dlon=-71.512, s=46.516, z=1.537

annular 8.10.-3326 11:09:28.7 0.9951/0.9974/0.9901
0 min 34.30 sec 09:34:35.4 11:09:11.5 11:09:45.8 12:48:39.3
alt=68.198, lon=32.368, dlon=-36.599, s=46.400, z=0.789

annular 10.02.-3323 16:16:12.0 0.9702/0.9849/0.9413
2 min 25.24 sec 14:51:08.1 16:14:59.7 16:17:25.0 17:28:23.4
alt=17.2233 lat=22.2235, lon=-152.1910, dlon=138.8423, s=46.313, z=2.998
at lat=22.23333:
annular 10.02.-3323 16:16:11.9 0.9702/0.9850/0.9413
2 min 25.25 sec 14:51:08.1 16:14:59.6 16:17:24.9 17:28:23.3

annular 27.07.-3322 06:43:41.1 0.9328/0.9664/0.8701
5 min 3.58 sec 05:36:30.6 06:41:09.2 06:46:12.8 08:01:55.5
alt=19.584, lon=-166.043, dlon=124.990, s=46.284, z=2.701

annular 27.07.-3322 17:58:18.0 0.9305/0.9650/0.8659
4 min 46.45 sec 16:47:50.9 17:55:54.9 18:00:41.4 -
alt=7.914, lon=-51.349, dlon=-120.315, s=46.284, z=2.600

annular 30.11.-3320 09:39:36.9 0.9442/0.9721/0.8916
5 min 18.28 sec 08:14:47.7 09:36:57.7 09:42:16.0 11:17:20.8
alt=39.7631 lat=21.3312, lon=-69.6336, dlon=-138.6003, s=46.227, z=2.998
at lat=22.23333:
annular 30.11.-3320 09:38:39.4 0.9440/0.9521/0.8912
3 min 46.19 sec 08:14:09.3 09:36:46.2 09:40:32.4 11:15:56.1

annular 14.03.-3315 14:55:18.2 0.9410/0.9703/0.8854
5 min 35.86 sec 13:17:50.6 14:52:30.5 14:58:06.3 16:19:51.4
alt=37.491, lon=72.160, dlon=3.193, s=46.082, z=0.069

annular 22.02.-3305 14:49:35.2 0.9811/0.9905/0.9625
1 min 49.19 sec 13:10:18.7 14:48:41.0 14:50:30.2 16:13:34.7
alt=34.680, lon=80.277, dlon=11.310, s=45.794, z=0.247

annular 7.08.-3304 06:32:43.8 0.9274/0.9636/0.8600
5 min 26.50 sec 05:26:01.9 06:30:00.6 06:35:27.1 07:50:26.7
alt=16.080, lon=82.427, dlon=13.461, s=45.765, z=0.294

annular 6.08.-3304 16:43:36.6 0.9300/0.9648/0.8648
5 min 37.62 sec 15:19:23.5 16:40:47.8 16:46:25.4 17:54:37.5
alt=24.730, lon=-177.820, dlon=113.213, s=45.765, z=2.474

annular 12.12.-3302 09:00:15.1 0.9415/0.9707/0.8864
5 min 15.66 sec 07:40:23.8 08:57:37.2 09:02:52.9 10:33:34.5
alt=30.064, lon=159.462, dlon=90.495, s=45.707, z=1.980

total 26.05.-3300 08:41:50.3 1.0727/1.0362/1.1507
4 min 44.96 sec 07:36:37.0 08:39:28.2 08:44:13.2 09:53:55.0
alt=45.532, lon=104.012, dlon=35.045, s=45.650, z=0.768

total 29.09.-3298 14:06:11.3 1.0456/1.0226/1.0932
3 min 18.25 sec 12:47:41.8 14:04:32.1 14:07:50.4 15:18:36.7
alt=56.795, lon=99.321, dlon=30.354, s=45.592, z=0.666

annular 25.03.-3297 15:02:17.3 0.9439/0.9717/0.8910
5 min 14.65 sec 13:26:36.1 14:59:40.2 15:04:54.8 16:26:00.6
alt=37.969, lon=-25.228, dlon=-94.195, s=45.563, z=2.067

total 11.01.-3293 17:09:04.6 1.0092/1.0045/1.0184
0 min 31.17 sec 16:02:02.9 17:08:49.2 17:09:20.4 -
alt=3.310, lon=-160.443, dlon=130.590, s=45.449, z=2.873

total 6.05.-3290 15:09:43.3 1.0175/1.0084/1.0354
1 min 22.34 sec 13:40:37.6 15:09:02.2 15:10:24.5 16:26:53.7
alt=40.483, lon=-50.479, dlon=-119.445, s=45.362, z=2.633

annular 30.10.-3290 09:18:10.6 0.9957/0.9976/0.9914
0 min 26.06 sec 07:58:55.0 09:17:57.5 09:18:23.6 10:48:22.0
alt=42.908, lon=111.515, dlon=42.548, s=45.362, z=0.938

annular 4.03.-3287 13:07:17.7 0.9908/0.9953/0.9817
1 min 2.88 sec 11:19:50.1 13:06:46.5 13:07:49.4 14:44:59.5
alt=50.056, lon=-45.481, dlon=-114.448, s=45.276, z=2.528

annular 18.08.-3286 06:18:23.4 0.9219/0.9609/0.8498
5 min 46.27 sec - 06:15:30.3 06:21:16.6 07:34:42.7
alt=11.677, lon=-32.189, dlon=-101.155, s=45.248, z=2.236

annular 18.08.-3286 15:27:56.5 0.9291/0.9644/0.8632
6 min 44.70 sec 13:46:48.1 15:24:34.0 15:31:18.7 16:50:34.2
alt=42.081, lon=56.063, dlon=-12.904, s=45.248, z=0.285

annular 22.12.-3284 08:29:42.0 0.9395/0.9697/0.8827
5 min 11.78 sec 07:13:28.4 08:27:06.0 08:32:17.8 09:59:22.9
alt=22.534, lon=31.454, dlon=-37.513, s=45.191, z=0.830

total 6.06.-3282 08:43:46.3 1.0701/1.0349/1.1450
4 min 37.93 sec 07:38:00.3 08:41:27.7 08:46:05.7 09:56:57.1
alt=47.310, lon=-8.378, dlon=-77.344, s=45.133, z=1.714

total 9.10.-3280 13:32:40.9 1.0451/1.0223/1.0923
3 min 24.08 sec 12:12:09.8 13:30:58.9 13:34:23.0 14:48:32.0
alt=60.617, lon=-40.227, dlon=-109.194, s=45.076, z=2.422

annular 28.07.-3276 18:35:46.1 0.9354/0.9589/0.8750
3 min 48.45 sec 17:34:08.0 18:33:52.0 18:37:40.4 -
alt=-0.055, lon=170.761, dlon=101.794, s=44.962, z=2.264

total 22.01.-3275 16:44:21.1 1.0113/1.0056/1.0227
0 min 40.75 sec 15:34:22.3 16:44:01.0 16:44:41.7 -
alt=9.288, lon=69.908, dlon=0.942, s=44.933, z=0.021

total 17.05.-3272 12:15:33.2 1.0183/1.0089/1.0369
1 min 45.28 sec 10:35:38.7 12:14:40.7 12:16:26.0 13:54:55.3
alt=77.287, lon=176.280, dlon=107.313, s=44.848, z=2.393

annular 9.11.-3272 08:27:27.8 0.9959/0.9977/0.9919
0 min 22.48 sec 07:15:37.8 08:27:16.5 08:27:39.0 09:49:46.9
alt=30.403, lon=-30.199, dlon=-99.166, s=44.848, z=2.211

annular 16.03.-3269 06:35:43.9 0.9852/0.9914/0.9707
1 min 0.86 sec - 06:35:13.5 06:36:14.4 07:45:44.2
alt=0.0289 lat=22.1717, lon=139.6835, dlon=70.7168, s=44.762, z=1.580
at lat=22.23333:
annular 16.03.-3269 06:35:48.0 0.9852/0.9922/0.9707
1 min 1.49 sec - 06:35:17.2 06:36:18.7 07:45:48.7

annular 15.03.-3269 10:58:35.2 0.9974/0.9985/0.9949
0 min 21.05 sec 09:20:26.3 10:58:24.6 10:58:45.7 12:43:44.2
alt=50.732, lon=-172.469, dlon=118.564, s=44.762, z=2.649

total   21.10.-3262   12:57:45.7   1.0447/1.0221/1.0914
3 min 28.34 sec   11:36:01.2   12:56:01.6   12:59:29.9   14:16:51.6
alt=62.336, lon=179.056, dlon=110.089, s=44.563, z=2.470

annular 16.04.-3261   15:45:28.2   0.9472/0.9733/0.8972
4 min 40.31 sec   14:14:35.6   15:43:08.2   15:47:48.5   17:04:47.1
alt=31.201, lon=148.955, dlon=79.988, s=44.534, z=1.796

annular  4.04.-3260   08:46:39.0   0.9855/0.9924/0.9713
1 min 17.37 sec   07:27:57.5   08:46:00.3   08:47:17.7   10:15:27.2
alt=33.843, lon=24.381, dlon=-44.586, s=44.506, z=1.002

annular  8.08.-3258   18:27:04.2   0.9350/0.9672/0.8743
4 min 1.26 sec   17:24:45.7   18:25:03.8   18:29:05.0   -
alt=2.199, lon=58.272, dlon=-10.695, s=44.449, z=0.241

total   2.02.-3257   16:23:49.7   1.0131/1.0065/1.0264
0 min 49.38 sec   15:11:31.4   16:23:25.3   16:24:14.6   17:27:34.9
alt=14.621, lon=-56.278, dlon=-125.245, s=44.421, z=2.820

total   28.05.-3254   10:09:02.8   1.0119/1.0059/1.0239
1 min 2.22 sec   08:40:54.5   10:08:31.6   10:09:33.8   11:49:03.5
alt=65.818, lon=51.830, dlon=-17.137, s=44.336, z=0.387

annular 20.11.-3254   07:38:40.8   0.9964/0.9979/0.9929
0 min 18.27 sec   06:33:25.1   07:38:31.6   07:38:49.9   08:52:57.5
alt=18.200, lon=-172.318, dlon=118.716, s=44.336, z=2.678

annular  9.09.-3250   05:39:03.2   0.9114/0.9500/0.8306
6 min 8.19 sec   -   05:35:59.4   05:42:07.6   06:50:06.7
alt=-0.035, lon=88.478, dlon=19.512, s=44.222, z=0.441

annular  9.09.-3250   12:54:57.2   0.9255/0.9627/0.8566
9 min 18.68 sec   10:51:32.3   12:50:17.6   12:59:36.3   14:44:27.1
alt=75.848, lon=163.072, dlon=94.105, s=44.222, z=2.128

annular 13.01.-3247   07:37:45.0   0.9372/0.9686/0.8783
4 min 59.01 sec   -   07:35:15.5   07:40:14.5   09:00:40.2
alt=9.778, lon=142.880, dlon=73.913, s=44.137, z=1.675

total   28.06.-3246   08:41:49.9   1.0619/1.0309/1.1276
4 min 13.11 sec   07:34:40.7   08:39:43.7   08:43:56.8   09:57:46.0
alt=47.640, lon=122.544, dlon=53.578, s=44.109, z=1.215

total   31.10.-3244   12:22:48.5   1.0444/1.0220/1.0907
3 min 30.91 sec   11:00:50.3   12:21:03.0   12:24:33.9   13:44:36.6
alt=61.244, lon=38.267, dlon=-30.700, s=44.052, z=0.697

annular 26.04.-3243 17:30:59.4 0.9433/0.9713/0.8898
4 min 11.44 sec 16:15:04.5 17:28:53.9 17:33:05.4 -
alt=7.5553 lat=21.9384, lon=74.9301, dlon=5.9635, s=44.024, z=0.135
at lat=22.23333:
annular 26.04.-3243 17:31:04.7 0.9433/0.9632/0.8898
4 min 0.23 sec 16:15:14.0 17:29:04.7 17:33:04.9 -

annular 18.08.-3240 18:10:02.6 0.9351/0.9672/0.8744
4 min 7.71 sec 17:05:53.5 18:07:59.0 18:12:06.7 -
alt=5.729, lon=-59.583, dlon=-128.549, s=43.939, z=2.926

total 12.02.-3239 16:08:10.0 1.0145/1.0071/1.0291
0 min 56.11 sec 14:54:14.5 16:07:42.2 16:08:38.3 17:13:28.1
alt=19.165, lon=-178.541, dlon=112.493, s=43.911, z=2.562

annular 1.12.-3236 06:50:58.9 0.9972/0.9983/0.9944
0 min 13.64 sec - 06:50:52.0 06:51:05.7 07:57:52.8
alt=6.200, lon=45.285, dlon=-23.681, s=43.826, z=0.540

annular 19.09.-3232 11:39:14.8 0.9224/0.9611/0.8508
10 min 2.46 sec 09:40:12.9 11:34:13.7 11:44:16.1 13:38:16.0
alt=77.651, lon=35.216, dlon=-33.751, s=43.714, z=0.772

annular 24.01.-3229 07:19:15.4 0.9369/0.9684/0.8778
4 min 52.72 sec - 07:16:49.0 07:21:41.7 08:40:00.6
alt=5.360, lon=23.927, dlon=-45.039, s=43.629, z=1.032

annular 24.01.-3229 17:31:17.9 0.9365/0.9680/0.8771
4 min 41.09 sec 16:14:34.3 17:28:57.4 17:33:38.5 -
alt=0.0539 lat=21.8376, lon=124.5729, dlon=55.6062, s=43.629, z=1.275
at lat=22.23333:
annular 24.01.-3229 17:31:06.6 0.9365/0.9582/0.8771
4 min 27.33 sec 16:14:23.1 17:28:52.9 17:33:20.2 -

total 8.07.-3228 08:39:09.8 1.0567/1.0283/1.1167
3 min 55.96 sec 07:31:11.7 08:37:12.1 08:41:08.1 09:56:37.3
alt=46.651, lon=5.408, dlon=-63.558, s=43.601, z=1.458

annular 25.04.-3224 09:35:13.5 0.9979/0.9987/0.9958
0 min 14.87 sec 08:14:13.2 09:35:06.0 09:35:20.9 11:04:41.1
alt=50.715, lon=-173.232, dlon=117.801, s=43.489, z=2.709

annular 30.08.-3222 17:49:50.7 0.9355/0.9674/0.8751
4 min 15.14 sec 16:43:11.3 17:47:43.4 17:51:58.5 -
alt=9.590, lon=179.447, dlon=110.480, s=43.432, z=2.544

total 24.02.-3221 15:57:11.6 1.0152/1.0075/1.0307
1 min 0.34 sec 14:42:12.3 15:56:41.6 15:57:41.9 17:03:41.0
alt=22.916, lon=62.928, dlon=-6.039, s=43.404, z=0.139

partial 19.08.-3221 08:34:24.1 0.9997/0.9997/0.9995
0 min 0.00 sec 07:16:04.1 - - 10:05:35.2
alt=42.179, lon=-21.968, dlon=-90.935, s=43.404, z=2.095

annular 19.06.-3218 06:40:11.3 0.9908/0.9952/0.9817
0 min 39.78 sec 05:38:06.4 06:39:51.3 06:40:31.1 07:50:47.2
alt=19.951, lon=160.277, dlon=91.310, s=43.320, z=2.108

annular 3.02.-3211 16:20:34.4 0.9413/0.9705/0.8861
5 min 1.37 sec 14:49:54.6 16:18:03.9 16:23:05.2 17:35:59.4
alt=15.486, lon=-3.094, dlon=-72.061, s=43.124, z=1.671

total 19.07.-3210 16:58:54.1 1.0452/1.0225/1.0924
2 min 40.39 sec 15:53:05.7 16:57:33.9 17:00:14.3 17:57:17.8
alt=20.310, lon=-29.475, dlon=-98.442, s=43.096, z=2.284

total 22.11.-3208 11:12:09.2 1.0438/1.0217/1.0896
3 min 28.48 sec 09:52:35.7 11:10:25.0 11:13:53.5 12:36:48.4
alt=52.325, lon=116.071, dlon=47.105, s=43.040, z=1.094

total 7.05.-3206 09:46:08.2 1.0025/1.0011/1.0051
0 min 8.51 sec 08:25:09.1 09:46:03.9 09:46:12.4 11:15:41.4
alt=56.155, lon=85.514, dlon=16.548, s=42.984, z=0.385

annular 9.09.-3204 17:24:53.7 0.9363/0.9678/0.8767
4 min 23.81 sec 16:14:46.1 17:22:42.1 17:27:05.9 18:27:39.0
alt=14.181, lon=54.691, dlon=-14.275, s=42.928, z=0.333

total 6.03.-3203 15:51:05.4 1.0154/1.0075/1.0310
1 min 1.60 sec 14:35:26.9 15:50:34.7 15:51:36.3 16:58:27.6
alt=25.740, lon=-52.093, dlon=-121.060, s=42.900, z=2.822

annular 29.08.-3203 06:51:00.3 0.9939/0.9968/0.9878
0 min 28.58 sec 05:46:46.2 06:50:45.9 06:51:14.4 08:04:29.6
alt=17.537, lon=-166.027, dlon=125.006, s=42.900, z=2.914

annular 29.06.-3200 05:10:03.3 0.9794/0.9891/0.9592
1 min 13.19 sec - 05:09:26.7 05:10:39.9 06:09:27.6
alt=0.634, lon=30.402, dlon=-38.564, s=42.816, z=0.901

total 16.04.-3196 15:52:39.6 1.0608/1.0300/1.1253
4 min 3.76 sec 14:38:22.9 15:50:37.5 15:54:41.2 16:58:34.1
alt=29.748, lon=-40.549, dlon=-109.515, s=42.705, z=2.564

annular 11.10.-3196 09:18:49.3 0.9142/0.9568/0.8357
9 min 26.70 sec 07:43:39.7 09:14:06.5 09:23:33.2 11:11:48.5
alt=46.440, lon=134.964, dlon=65.997, s=42.705, z=1.545

annular 15.02.-3193 07:03:21.9 0.9380/0.9689/0.8799
4 min 45.06 sec - 07:00:59.3 07:05:44.4 08:23:32.2
alt=2.312, lon=158.041, dlon=89.075, s=42.621, z=2.090

total 30.07.-3192 08:33:29.6 1.0452/1.0224/1.0924
3 min 14.32 sec 07:23:44.7 08:31:52.7 08:35:07.0 09:53:55.5
alt=43.750, lon=125.785, dlon=56.819, s=42.593, z=1.334

total 29.07.-3192 15:38:20.8 1.0448/1.0223/1.0916
3 min 6.18 sec 14:20:32.4 15:36:47.7 15:39:53.8 16:45:52.2
alt=38.993, lon=-166.612, dlon=124.421, s=42.593, z=2.921

total 3.12.-3190 10:38:02.7 1.0437/1.0217/1.0893
3 min 24.28 sec 09:20:44.8 10:36:20.6 10:39:44.9 12:02:31.8
alt=46.054, lon=-24.250, dlon=-93.217, s=42.538, z=2.191

total 17.05.-3188 09:53:48.1 1.0064/1.0031/1.0128
0 min 28.53 sec 08:32:40.0 09:53:33.8 09:54:02.3 11:24:00.6
alt=60.486, lon=-17.116, dlon=-86.082, s=42.482, z=2.026

total 17.03.-3185 15:49:19.0 1.0148/1.0071/1.0298
0 min 59.67 sec 14:33:09.7 15:48:49.3 15:49:48.9 16:57:23.0
alt=27.6732 lat=22.0667, lon=-163.9257, dlon=127.1077, s=42.399, z=2.998
at lat=22.23333:
total 17.03.-3185 15:49:26.4 1.0148/1.0030/1.0298
0 min 46.42 sec 14:33:20.1 15:49:03.2 15:49:49.6 16:57:28.3

annular 10.09.-3185 05:45:54.5 0.9896/0.9946/0.9793
0 min 40.65 sec - 05:45:34.0 05:46:14.7 06:49:31.5
alt=1.612, lon=52.570, dlon=-16.397, s=42.399, z=0.387

total 10.09.-3185 10:08:50.1 1.0037/1.0015/1.0074
0 min 15.22 sec 08:40:46.6 10:08:42.5 10:08:57.7 11:42:53.3
alt=61.886, lon=103.974, dlon=35.008, s=42.399, z=0.826

total 27.04.-3178 13:27:58.1 1.0710/1.0353/1.1471
5 min 49.05 sec 11:59:57.1 13:25:03.3 13:30:52.3 14:50:04.2
alt=61.615, lon=-177.291, dlon=113.742, s=42.205, z=2.695

annular 22.10.-3178 08:18:42.2 0.9101/0.9547/0.8282
8 min 43.22 sec 06:54:38.7 08:14:21.1 08:23:04.3 09:59:37.6
alt=31.596, lon=2.712, dlon=-66.254, s=42.205, z=1.570

annular 25.02.-3175 07:14:20.7 0.9398/0.9697/0.8833
4 min 46.70 sec - 07:11:57.3 07:16:44.0 08:37:47.2
alt=5.706, lon=52.870, dlon=-16.097, s=42.121, z=0.382

annular 25.02.-3175 13:05:17.7 0.9501/0.9749/0.9027
6 min 4.04 sec 11:04:56.5 13:02:15.7 13:08:19.8 14:52:49.9
alt=48.429, lon=108.196, dlon=39.229, s=42.121, z=0.931

total 10.08.-3174 08:32:14.9 1.0392/1.0193/1.0799
2 min 51.25 sec 07:21:29.7 08:30:49.5 08:33:40.7 09:54:04.4
alt=42.470, lon=3.256, dlon=-65.711, s=42.094, z=1.561

total 10.08.-3174 14:12:09.0 1.0432/1.0215/1.0883
3 min 30.25 sec 12:42:03.4 14:10:23.9 14:13:54.1 15:30:52.9
alt=59.233, lon=55.862, dlon=-13.104, s=42.094, z=0.311

annular 1.10.-3168 16:24:31.1 0.9397/0.9695/0.8830
4 min 42.48 sec 15:04:46.6 16:22:10.1 16:26:52.6 17:34:55.1
alt=24.752, lon=156.975, dlon=88.008, s=41.928, z=2.099

total 28.03.-3167 15:58:56.4 1.0130/1.0062/1.0262
0 min 51.90 sec 14:43:12.3 15:58:30.6 15:59:22.5 17:06:45.9
alt=26.815, lon=88.478, dlon=19.511, s=41.900, z=0.466

total 20.09.-3167 09:50:23.8 1.0035/1.0014/1.0069
0 min 13.30 sec 08:26:22.3 09:50:17.1 09:50:30.4 11:21:05.3
alt=56.412, lon=-26.771, dlon=-95.738, s=41.900, z=2.285

total 8.05.-3160 11:25:00.6 1.0748/1.0373/1.1551
6 min 17.11 sec 09:59:40.5 11:21:52.1 11:28:09.2 12:54:01.9
alt=74.668, lon=52.200, dlon=-16.766, s=41.707, z=0.402

annular 8.03.-3157 08:18:42.8 0.9445/0.9720/0.8921
5 min 8.21 sec 06:57:46.0 08:16:08.7 08:21:16.9 09:57:03.1
alt=21.120, lon=-38.660, dlon=-107.626, s=41.624, z=2.586

total 25.12.-3154 09:36:13.4 1.0440/1.0218/1.0899
3 min 14.29 sec 08:24:02.2 09:34:36.5 09:37:50.8 10:57:53.0
alt=33.198, lon=59.487, dlon=-9.480, s=41.542, z=0.228

total 8.06.-3152 10:06:33.8 1.0120/1.0059/1.0241
0 min 58.61 sec 08:43:42.8 10:06:04.4 10:07:03.1 11:40:06.1
alt=66.645, lon=134.023, dlon=65.056, s=41.487, z=1.568

annular 12.10.-3150 15:50:43.6 0.9422/0.9707/0.8877
4 min 50.37 sec 14:25:12.4 15:48:18.6 15:53:09.0 17:06:02.4
alt=30.254, lon=25.255, dlon=-43.712, s=41.432, z=1.055

total 8.04.-3149 16:23:02.3 1.0097/1.0045/1.0195
0 min 36.78 sec 15:08:57.8 16:22:44.0 16:23:20.8 17:29:18.9
alt=22.389, lon=-14.205, dlon=-83.172, s=41.404, z=2.009

annular 28.03.-3148 08:47:33.5 0.9588/0.9790/0.9194
3 min 49.98 sec 07:24:14.3 08:45:38.4 08:49:28.4 10:22:52.3
alt=32.127, lon=163.585, dlon=94.619, s=41.377, z=2.287

annular 13.11.-3142 06:36:09.5 0.9038/0.9516/0.8169
7 min 24.55 sec - 06:32:27.5 06:39:52.1 07:54:54.8
alt=5.632, lon=96.339, dlon=27.373, s=41.212, z=0.664

total 1.09.-3138 09:01:07.4 1.0290/1.0142/1.0588
2 min 16.41 sec 07:44:43.0 08:59:59.3 09:02:15.7 10:28:55.1
alt=47.113, lon=117.663, dlon=48.697, s=41.103, z=1.185

total 19.06.-3134 10:13:46.0 1.0138/1.0067/1.0277
1 min 9.78 sec 08:49:10.9 10:13:11.0 10:14:20.8 11:49:50.5
alt=68.785, lon=27.154, dlon=-41.813, s=40.993, z=1.020

total   12.10.-3131   08:53:10.8   1.0028/1.0011/1.0056
0 min 8.76 sec   07:38:57.5   08:53:06.4   08:53:15.2   10:15:12.8
alt=40.652, lon=62.307, dlon=-6.659, s=40.911, z=0.163

annular  8.04.-3130   09:25:01.1   0.9604/0.9798/0.9223
3 min 50.07 sec   07:57:43.4   09:23:05.9   09:26:56.0   11:02:38.4
alt=43.144, lon=70.085, dlon=1.119, s=40.884, z=0.027

annular 11.08.-3128   18:38:35.9   0.9553/0.9635/0.9126
2 min 2.83 sec   17:39:45.2   18:37:34.7   18:39:37.5   -
alt=-0.0524 lat=23.1354, lon=96.7021, dlon=27.7355, s=40.830, z=0.679
at lat=22.23333:
partial 11.08.-3128   18:39:39.4   0.9465/0.9465/0.9069
0 min 0.00 sec   17:40:59.9   -   -   -

annular 31.07.-3127   10:11:01.6   0.9360/0.9677/0.8762
7 min 58.37 sec   08:22:48.9   10:07:02.7   10:15:01.0   12:15:03.0
alt=65.8397 lat=22.1815, lon=-34.5050, dlon=-103.4717, s=40.802, z=2.536
at lat=22.23333:
annular 31.07.-3127   10:11:01.2   0.9360/0.9668/0.8762
7 min 57.83 sec   08:22:50.7   10:07:02.7   10:15:00.5   12:14:59.2

total   30.05.-3124   07:47:05.0   1.0687/1.0341/1.1422
4 min 18.94 sec   06:44:53.2   07:44:55.9   07:49:14.9   08:57:06.6
alt=33.496, lon=150.050, dlon=81.084, s=40.720, z=1.991

total   16.01.-3117   08:47:48.1   1.0452/1.0224/1.0924
3 min 8.60 sec   07:39:50.2   08:46:14.1   08:49:22.7   10:05:37.8
alt=22.720, lon=151.422, dlon=82.455, s=40.530, z=2.034

total   29.06.-3116   17:28:42.9   1.0017/1.0008/1.0033
0 min 3.11 sec   16:20:46.0   17:28:41.6   17:28:44.7   -
alt=12.260, lon=-10.529, dlon=-79.496, s=40.503, z=1.963

annular  3.11.-3114   14:40:26.0   0.9487/0.9739/0.9000
4 min 56.15 sec   13:03:42.3   14:37:58.2   14:42:54.3   16:07:05.0
alt=39.941, lon=119.064, dlon=50.097, s=40.448, z=1.239

annular 18.04.-3112   09:44:43.3   0.9604/0.9799/0.9224
3 min 52.57 sec   08:16:01.7   09:42:46.9   09:46:39.5   11:23:02.0
alt=50.622, lon=-25.113, dlon=-94.080, s=40.394, z=2.329

annular 22.08.-3110   18:35:07.4   0.9492/0.9633/0.9010
2 min 42.72 sec   17:35:25.0   18:33:46.2   18:36:28.9   -
alt=-0.046, lon=-20.545, dlon=-89.511, s=40.340, z=2.219

total   15.02.-3109   17:44:22.8   1.0330/1.0164/1.0670
1 min 46.50 sec   16:45:25.3   17:43:29.7   17:45:16.2   -
alt=0.0453 lat=21.4289, lon=-2.7742, dlon=-71.7409, s=40.313, z=1.780
at lat=22.23333:
partial 15.02.-3109   17:44:29.8   0.9920/0.9920/0.9943
0 min 0.00 sec   16:45:36.3   -   -   -

annular 11.08.-3109 07:27:58.6 0.9254/0.9626/0.8563
6 min 42.21 sec 06:09:48.6 07:24:37.7 07:31:19.9 09:03:16.7
alt=27.786, lon=-170.660, dlon=120.373, s=40.313, z=2.986

total 10.06.-3106 06:07:44.5 1.0619/1.0306/1.1276
3 min 15.74 sec 05:14:56.6 06:06:06.9 06:09:22.6 07:05:43.2
alt=12.099, lon=14.623, dlon=-54.343, s=40.231, z=1.351

annular 29.03.-3102 16:48:38.4 0.9433/0.9713/0.8898
4 min 32.61 sec 15:25:05.2 16:46:22.2 16:50:54.8 18:00:07.1
alt=16.009, lon=93.522, dlon=24.555, s=40.123, z=0.612

total 26.01.-3099 08:32:17.6 1.0463/1.0229/1.0947
3 min 10.01 sec 07:25:28.0 08:30:42.8 08:33:52.8 09:48:56.8
alt=19.546, lon=21.949, dlon=-47.018, s=40.042, z=1.174

total 26.01.-3099 15:52:30.9 1.0469/1.0234/1.0959
3 min 12.79 sec 14:35:41.2 15:50:54.4 15:54:07.2 16:59:27.7
alt=19.849, lon=92.794, dlon=23.828, s=40.042, z=0.595

total 11.07.-3098 10:41:41.5 1.0161/1.0077/1.0325
1 min 28.53 sec 09:10:47.4 10:40:57.3 10:42:25.8 12:23:43.7
alt=74.395, lon=168.643, dlon=99.677, s=40.015, z=2.491

annular 13.11.-3096 14:05:16.9 0.9526/0.9758/0.9074
4 min 50.59 sec 12:24:17.7 14:02:51.9 14:07:42.5 15:37:50.6
alt=43.426, lon=-14.517, dlon=-83.484, s=39.961, z=2.089

total 3.11.-3095 07:39:37.7 1.0022/1.0008/1.0045
0 min 5.09 sec 06:35:42.2 07:39:35.1 07:39:40.2 08:50:33.3
alt=21.154, lon=142.354, dlon=73.387, s=39.934, z=1.838

annular 22.08.-3091 06:05:37.3 0.9170/0.9584/0.8409
6 min 15.21 sec - 06:02:29.8 06:08:45.0 07:23:25.1
alt=8.247, lon=60.074, dlon=-8.893, s=39.826, z=0.223

annular 22.08.-3091 11:45:16.8 0.9295/0.9644/0.8639
8 min 49.14 sec 09:46:30.1 11:40:52.0 11:49:41.1 13:38:10.2
alt=85.463, lon=117.847, dlon=48.881, s=39.826, z=1.227

annular 8.04.-3084 14:32:33.1 0.9532/0.9763/0.9086
4 min 53.28 sec 12:44:40.9 14:30:06.6 14:34:59.9 16:04:43.1
alt=46.345, lon=-30.054, dlon=-99.021, s=39.637, z=2.498

total 6.02.-3081 14:29:46.5 1.0532/1.0265/1.1093
4 min 12.16 sec 13:02:09.4 14:27:40.3 14:31:52.5 15:46:45.3
alt=35.219, lon=-46.372, dlon=-115.338, s=39.557, z=2.916

total 21.07.-3080 11:25:16.4 1.0169/1.0081/1.0341
1 min 38.43 sec 09:47:29.6 11:24:27.2 11:26:05.6 13:08:52.7
alt=83.437, lon=59.680, dlon=-9.286, s=39.530, z=0.235

total   21.07.-3080   13:47:52.5   1.0148/1.0071/1.0298
1 min 19.59 sec   12:06:32.0   13:47:12.8   13:48:32.3   15:16:44.9
alt=63.533, lon=80.186, dlon=11.219, s=39.530, z=0.284

total   14.11.-3077   06:59:04.8   1.0022/1.0008/1.0045
0 min 4.60 sec   -   06:59:02.5   06:59:07.0   08:04:16.9
alt=10.572, lon=0.099, dlon=-68.868, s=39.449, z=1.746

annular 10.05.-3076   10:08:58.2   0.9584/0.9791/0.9185
4 min 10.76 sec   08:38:12.2   10:06:52.7   10:11:03.4   11:50:13.8
alt=62.135, lon=144.839, dlon=75.872, s=39.422, z=1.925

annular 13.09.-3074   18:08:26.8   0.9391/0.9691/0.8819
3 min 53.29 sec   17:04:05.1   18:06:30.4   18:10:23.7   -
alt=3.705, lon=94.631, dlon=25.665, s=39.369, z=0.652

total   9.03.-3073   17:51:42.8   1.0437/1.0178/1.0893
2 min 16.43 sec   16:53:59.9   17:50:34.5   17:52:50.9   -
alt=0.0328 lat=22.1955, lon=124.1500, dlon=55.1834, s=39.342, z=1.403
at lat=22.23333:
total   9.03.-3073   17:51:43.5   1.0437/1.0166/1.0893
2 min 14.69 sec   16:54:00.7   17:50:36.0   17:52:50.7   -

annular  2.09.-3073   11:37:26.4   0.9259/0.9627/0.8573
9 min 3.19 sec   09:41:54.2   11:32:54.6   11:41:57.8   13:28:45.2
alt=81.922, lon=3.241, dlon=-65.725, s=39.342, z=1.671

total   27.02.-3072   11:09:56.1   1.0665/1.0328/1.1374
5 min 29.04 sec   09:45:27.5   11:07:11.8   11:12:40.8   12:36:01.9
alt=47.202, lon=157.554, dlon=88.588, s=39.315, z=2.253

total   17.02.-3063   08:40:08.2   1.0508/1.0251/1.1041
3 min 36.07 sec   07:30:58.9   08:38:20.5   08:41:56.6   09:59:36.2
alt=22.332, lon=136.621, dlon=67.654, s=39.074, z=1.731

total   17.02.-3063   12:42:45.2   1.0578/1.0287/1.1190
5 min 6.95 sec   11:09:30.8   12:40:11.7   12:45:18.7   14:11:24.0
alt=47.735, lon=174.919, dlon=105.952, s=39.074, z=2.712

annular  5.12.-3060   13:04:22.3   0.9614/0.9803/0.9244
4 min 15.88 sec   11:19:11.0   13:02:14.6   13:06:30.5   14:46:46.3
alt=45.867, lon=81.496, dlon=12.530, s=38.994, z=0.321

annular  5.12.-3060   17:23:59.3   0.9497/0.9739/0.9019
3 min 41.38 sec   16:07:52.8   17:22:08.8   17:25:50.1   -
alt=0.0419 lat=21.4880, lon=126.8988, dlon=57.9321, s=38.994, z=1.486
at lat=22.23333:
annular  5.12.-3060   17:23:03.8   0.9497/0.9589/0.9019
2 min 53.85 sec   16:06:50.7   17:21:37.1   17:24:30.9   -

annular 21.05.-3058   10:19:33.5   0.9565/0.9782/0.9150
4 min 28.70 sec   08:46:55.5   10:17:19.1   10:21:47.8   12:03:51.1
alt=67.008, lon=50.347, dlon=-18.620, s=38.941, z=0.478

annular 23.09.-3056 17:46:58.3 0.9351/0.9672/0.8744
4 min 22.37 sec 16:38:46.7 17:44:47.3 17:49:09.7 -
alt=6.847, lon=-32.426, dlon=-101.393, s=38.887, z=2.607

total 9.03.-3054 11:19:54.7 1.0693/1.0343/1.1434
5 min 35.79 sec 09:56:34.4 11:17:06.9 11:22:42.7 12:43:59.0
alt=51.362, lon=40.611, dlon=-28.356, s=38.834, z=0.730

annular 30.04.-3048 10:20:29.1 0.9613/0.9805/0.9241
4 min 17.37 sec 08:41:58.4 10:18:20.3 10:22:37.7 12:12:23.5
alt=61.653, lon=98.732, dlon=29.766, s=38.674, z=0.770

annular 16.12.-3042 12:52:02.2 0.9664/0.9828/0.9340
3 min 48.24 sec 11:05:12.1 12:50:08.3 12:53:56.5 14:37:08.0
alt=45.3584 lat=21.4812, lon=-46.5408, dlon=-115.5075, s=38.515, z=2.999
at lat=22.23333:
annular 16.12.-3042 12:50:59.2 0.9663/0.9685/0.9338
2 min 1.16 sec 11:04:28.7 12:49:58.8 12:52:00.0 14:35:56.7

annular 16.12.-3042 16:40:27.6 0.9570/0.9783/0.9158
3 min 26.04 sec 15:16:47.6 16:38:44.9 16:42:10.9 -
alt=8.477, lon=-8.671, dlon=-77.637, s=38.515, z=2.016

annular 31.05.-3040 10:30:12.1 0.9541/0.9770/0.9104
4 min 53.75 sec 08:54:53.0 10:27:45.2 10:32:38.9 12:18:36.0
alt=71.260, lon=-44.920, dlon=-113.887, s=38.462, z=2.961

annular 24.09.-3037 10:59:14.2 0.9196/0.9596/0.8457
9 min 21.61 sec 09:12:02.5 10:54:33.2 11:03:54.8 12:49:01.5
alt=70.145, lon=124.915, dlon=55.948, s=38.382, z=1.458

total 13.07.-3033 09:56:45.7 1.0508/1.0252/1.1042
4 min 20.51 sec 08:33:30.0 09:54:35.8 09:58:56.3 11:30:24.9
alt=63.946, lon=63.152, dlon=-5.815, s=38.276, z=0.152

total 13.07.-3033 12:41:06.7 1.0527/1.0259/1.1081
4 min 44.82 sec 11:05:04.1 12:38:44.3 12:43:29.1 14:10:16.2
alt=78.141, lon=87.347, dlon=18.381, s=38.276, z=0.480

annular 11.05.-3030 08:17:26.9 0.9594/0.9794/0.9204
3 min 36.56 sec 06:58:40.9 08:15:38.5 08:19:15.1 09:50:43.1
alt=37.349, lon=-19.176, dlon=-88.143, s=38.197, z=2.308

annular 26.12.-3024 12:15:09.3 0.9718/0.9855/0.9444
3 min 12.86 sec 10:30:26.3 12:13:32.9 12:16:45.8 14:03:02.1
alt=43.8299 lat=23.0999, lon=-176.9190, dlon=114.1144, s=38.038, z=3.000
at lat=22.23333:
partial 26.12.-3024 12:16:00.3 0.9693/0.9693/0.9434
0 min 0.00 sec 10:30:55.3 - - 14:04:08.7

annular 15.10.-3020 16:56:15.8 0.9292/0.9642/0.8634
5 min 27.16 sec 15:37:38.2 16:53:32.3 16:58:59.5 -
alt=14.262, lon=68.208, dlon=-0.759, s=37.933, z=0.020

annular 4.10.-3019 10:32:51.8 0.9170/0.9583/0.8408
9 min 21.42 sec 08:50:40.1 10:28:11.1 10:37:32.5 12:21:22.5
alt=62.734, lon=2.017, dlon=-66.950, s=37.906, z=1.766

total 31.03.-3018 11:28:19.3 1.0729/1.0362/1.1511
5 min 41.31 sec 10:07:32.3 11:25:28.7 11:31:10.1 12:49:55.2
alt=60.004, lon=170.773, dlon=101.807, s=37.880, z=2.688

total 23.07.-3015 13:17:38.3 1.0462/1.0228/1.0945
3 min 58.03 sec 11:43:44.7 13:15:39.2 13:19:37.3 14:41:29.1
alt=70.622, lon=-25.349, dlon=-94.316, s=37.801, z=2.495

annular 16.01.-3014 10:04:07.5 0.9631/0.9813/0.9275
4 min 2.39 sec 08:28:22.8 10:02:06.3 10:06:08.7 11:56:12.0
alt=34.664, lon=-8.887, dlon=-77.854, s=37.775, z=2.061

total 23.08.-3007 18:34:11.5 1.0384/1.0028/1.0782
0 min 54.97 sec 17:41:11.2 18:33:44.0 18:34:38.9 -
alt=-0.0449 lat=22.2663, lon=154.0285, dlon=85.0619, s=37.591, z=2.263
at lat=22.23333:
total 23.08.-3007 18:34:13.4 1.0384/1.0020/1.0782
0 min 45.54 sec 17:41:13.4 18:33:50.6 18:34:36.1 -

annular 7.01.-3005 12:50:26.2 0.9774/0.9883/0.9554
2 min 36.33 sec 11:01:22.8 12:49:08.2 12:51:44.6 14:35:31.0
alt=42.602, lon=64.589, dlon=-4.377, s=37.538, z=0.117

annular 22.06.-3004 11:03:41.6 0.9483/0.9739/0.8993
6 min 8.53 sec 09:18:38.8 11:00:37.5 11:06:46.1 13:02:47.2
alt=80.275, lon=123.631, dlon=54.664, s=37.512, z=1.457

total 10.04.-3000 11:30:27.8 1.0735/1.0366/1.1524
5 min 41.58 sec 10:10:27.4 11:27:37.0 11:33:18.6 12:51:44.2
alt=64.535, lon=57.774, dlon=-11.192, s=37.407, z=0.299

total 4.08.-2997 06:33:54.7 1.0275/1.0137/1.0558
1 min 38.51 sec 05:34:51.1 06:33:05.4 06:34:44.0 07:40:34.6
alt=16.517, lon=147.062, dlon=78.095, s=37.329, z=2.092

total 3.09.-2989 17:38:53.2 1.0397/1.0195/1.0810
2 min 7.37 sec 16:40:16.0 17:37:49.6 17:39:56.9 18:32:17.4
alt=11.490, lon=11.940, dlon=-57.027, s=37.120, z=1.536

annular 3.07.-2986 11:41:06.3 0.9451/0.9722/0.8931
7 min 1.18 sec 09:46:54.3 11:37:36.0 11:44:37.2 13:43:39.1
alt=88.222, lon=28.374, dlon=-40.593, s=37.042, z=1.096

annular 3.07.-2986 15:43:16.1 0.9391/0.9694/0.8820
5 min 48.28 sec 14:01:09.4 15:40:22.0 15:46:10.2 17:05:59.1
alt=36.049, lon=64.093, dlon=-4.873, s=37.042, z=0.132

annular 6.11.-2984 16:04:42.3 0.9257/0.9625/0.8570
6 min 36.72 sec 14:33:03.4 16:01:23.9 16:08:00.6 17:23:22.8
alt=21.184, lon=166.874, dlon=97.907, s=36.990, z=2.647

annular 26.10.-2983 09:30:09.7 0.9128/0.9562/0.8332
8 min 55.87 sec 07:59:19.5 09:25:42.0 09:34:37.9 11:12:41.6
alt=45.793, lon=110.302, dlon=41.336, s=36.963, z=1.118

total 14.08.-2979 05:23:25.0 1.0163/1.0079/1.0330
0 min 51.05 sec - 05:22:59.5 05:23:50.5 06:21:45.7
alt=-0.0491 lat=22.1226, lon=8.1875, dlon=-60.7792, s=36.859, z=1.649
at lat=22.23333:
total 14.08.-2979 05:23:27.9 1.0164/1.0053/1.0330
0 min 47.50 sec - 05:23:04.3 05:23:51.8 06:21:49.0

total 14.08.-2979 13:15:46.4 1.0342/1.0169/1.0695
2 min 51.59 sec 11:44:09.5 13:14:20.7 13:17:12.3 14:38:01.5
alt=72.443, lon=92.705, dlon=23.738, s=36.859, z=0.644

annular 7.02.-2978 06:53:10.5 0.9670/0.9827/0.9351
2 min 23.98 sec - 06:51:58.5 06:54:22.5 08:08:55.8
alt=0.0491 lat=21.6904, lon=82.3121, dlon=13.3454, s=36.833, z=0.362
at lat=22.23333:
annular 7.02.-2978 06:53:44.3 0.9670/0.9712/0.9351
1 min 39.07 sec - 06:52:54.8 06:54:33.9 08:09:33.1

annular 7.02.-2978 12:35:33.0 0.9777/0.9885/0.9559
2 min 28.43 sec 10:47:24.5 12:34:18.9 12:36:47.3 14:15:18.2
alt=45.914, lon=138.752, dlon=69.785, s=36.833, z=1.895

total 1.04.-2972 15:03:27.8 1.0032/1.0013/1.0064
0 min 11.55 sec 13:32:30.7 15:03:22.2 15:03:33.8 16:22:24.2
alt=39.243, lon=142.597, dlon=73.630, s=36.678, z=2.007

annular 17.11.-2966 15:52:41.3 0.9243/0.9618/0.8544
7 min 3.70 sec 14:16:09.2 15:49:09.3 15:56:13.0 17:14:34.4
alt=21.579, lon=39.189, dlon=-29.778, s=36.522, z=0.815

annular 17.11.-2966 17:28:50.1 0.9191/0.9325/0.8448
4 min 38.91 sec 16:09:52.0 17:26:30.7 17:31:09.6 -
alt=0.0307 lat=22.6099, lon=59.2262, dlon=-9.7405, s=36.522, z=0.267
at lat=22.23333:
annular 17.11.-2966 17:29:24.2 0.9191/0.9249/0.8448
3 min 16.76 sec 16:10:32.6 17:27:46.1 17:31:02.9 -

annular 6.11.-2965 08:55:03.2 0.9112/0.9554/0.8303
8 min 31.54 sec 07:30:14.8 08:50:47.8 08:59:19.3 10:32:31.2
alt=36.526, lon=-17.895, dlon=-86.861, s=36.496, z=2.380

total 25.08.-2961 13:01:18.1 1.0284/1.0140/1.0575
2 min 22.73 sec 11:30:03.7 13:00:06.9 13:02:29.7 14:24:26.2
alt=75.744, lon=-32.971, dlon=-101.938, s=36.393, z=2.801

annular 18.02.-2960 12:39:00.4 0.9846/0.9920/0.9694
1 min 39.84 sec 10:54:47.3 12:38:10.6 12:39:50.5 14:15:14.0
alt=48.208, lon=25.525, dlon=-43.442, s=36.367, z=1.195

total 12.04.-2954 13:03:16.8 1.0049/1.0023/1.0098
0 min 24.08 sec 11:21:22.0 13:03:05.0 13:03:29.1 14:38:33.7
alt=62.615, lon=17.712, dlon=-51.254, s=36.212, z=1.415

total 25.09.-2953 15:37:45.7 1.0429/1.0211/1.0877
2 min 52.15 sec 14:23:43.6 15:36:19.6 15:39:11.7 16:43:35.2
alt=36.377, lon=83.871, dlon=14.905, s=36.186, z=0.412

total 13.05.-2946 11:41:42.9 1.0700/1.0348/1.1449
5 min 34.52 sec 10:20:19.4 11:38:55.7 11:44:30.3 13:05:55.6
alt=78.135, lon=85.279, dlon=16.312, s=36.006, z=0.453

total 23.06.-2939 10:10:27.8 1.0264/1.0130/1.0534
2 min 23.23 sec 08:42:25.1 10:09:16.2 10:11:39.5 11:50:33.7
alt=67.935, lon=87.455, dlon=18.489, s=35.826, z=0.516

total 23.06.-2939 14:57:17.3 1.0218/1.0106/1.0442
1 min 43.24 sec 13:27:21.6 14:56:25.7 14:58:09.0 16:13:53.0
alt=45.834, lon=130.386, dlon=61.419, s=35.826, z=1.714

annular 28.11.-2929 07:43:16.8 0.9097/0.9546/0.8275
7 min 30.70 sec 06:29:41.7 07:39:31.7 07:47:02.4 09:08:22.3
alt=17.705, lon=84.498, dlon=15.532, s=35.570, z=0.437

total 23.05.-2928 11:50:14.7 1.0671/1.0333/1.1386
5 min 29.41 sec 10:26:51.1 11:47:30.1 11:52:59.5 13:16:36.3
alt=81.983, lon=-24.493, dlon=-93.460, s=35.544, z=2.629

total 16.09.-2925 12:16:43.8 1.0169/1.0083/1.0340
1 min 24.93 sec 10:46:27.0 12:16:01.6 12:17:26.5 13:42:55.9
alt=79.090, lon=67.952, dlon=-1.015, s=35.468, z=0.029

annular 11.03.-2924 12:41:26.1 0.9985/0.9991/0.9969
0 min 13.39 sec 11:04:32.8 12:41:19.6 12:41:33.0 14:12:29.1
alt=54.460, lon=164.249, dlon=95.282, s=35.442, z=2.688

total 4.07.-2921 15:22:02.3 1.0216/1.0106/1.0437
1 min 35.31 sec 13:58:08.9 15:21:14.7 15:22:50.0 16:33:48.7
alt=40.956, lon=22.460, dlon=-46.507, s=35.366, z=1.315

annular 4.05.-2918 09:02:20.4 0.9953/0.9974/0.9906
0 min 28.90 sec 07:41:57.1 09:02:05.9 09:02:34.8 10:35:25.1
alt=46.050, lon=133.213, dlon=64.246, s=35.289, z=1.821

total 17.10.-2917 13:41:49.2 1.0444/1.0220/1.0908
3 min 34.43 sec 12:15:04.4 13:40:02.0 13:43:36.4 15:01:41.2
alt=55.878, lon=155.542, dlon=86.575, s=35.264, z=2.455

total 22.03.-2906 12:43:10.1 1.0051/1.0025/1.0102
0 min 23.58 sec 11:09:08.6 12:42:58.6 12:43:22.2 14:12:28.9
alt=57.986, lon=56.357, dlon=-12.610, s=34.984, z=0.360

annular 9.01.-2902 09:53:40.5 0.9391/0.9693/0.8819
6 min 54.50 sec 08:15:49.8 09:50:13.5 09:57:08.0 11:51:29.1
alt=33.638, lon=142.225, dlon=73.258, s=34.883, z=2.100

annular 9.01.-2902 12:55:19.8 0.9413/0.9703/0.8860
7 min 18.44 sec 10:53:11.9 12:51:40.4 12:58:58.8 14:44:50.4
alt=42.296, lon=167.132, dlon=98.165, s=34.883, z=2.814

annular 14.05.-2900 06:57:44.3 0.9851/0.9923/0.9704
1 min 5.06 sec 05:53:14.0 06:57:11.6 06:58:16.7 08:11:15.9
alt=19.724, lon=5.902, dlon=-63.065, s=34.832, z=1.811

total 27.10.-2899 12:45:20.2 1.0444/1.0220/1.0908
3 min 45.83 sec 11:16:29.5 12:43:27.4 12:47:13.2 14:11:05.2
alt=60.141, lon=11.356, dlon=-57.611, s=34.807, z=1.655

total 14.06.-2892 12:34:14.3 1.0585/1.0288/1.1204
5 min 7.88 sec 11:03:45.5 12:31:40.4 12:36:48.3 14:04:11.8
alt=78.410, lon=118.588, dlon=49.621, s=34.630, z=1.433

total 14.06.-2892 16:53:57.5 1.0468/1.0233/1.0958
2 min 53.20 sec 15:45:17.2 16:52:30.9 16:55:24.1 17:54:37.5
alt=18.885, lon=163.943, dlon=94.976, s=34.630, z=2.743

total 8.10.-2889 11:17:53.5 1.0058/1.0028/1.0117
0 min 26.43 sec 09:50:43.1 11:17:40.2 11:18:06.6 12:46:35.2
alt=68.607, lon=160.713, dlon=91.747, s=34.554, z=2.655

total 26.07.-2885 05:30:58.9 1.0132/1.0065/1.0266
0 min 41.42 sec - 05:30:38.1 05:31:19.5 06:30:24.6
alt=3.735, lon=48.737, dlon=-20.229, s=34.453, z=0.587

total 26.07.-2885 15:22:51.3 1.0226/1.0112/1.0457
1 min 35.53 sec 14:02:58.0 15:22:03.6 15:23:39.2 16:32:09.1
alt=42.357, lon=151.943, dlon=82.977, s=34.453, z=2.408

annular 20.01.-2884 08:24:41.9 0.9362/0.9680/0.8765
6 min 2.22 sec 07:02:28.0 08:21:40.9 08:27:43.1 10:05:34.9
alt=18.291, lon=10.603, dlon=-58.364, s=34.428, z=1.695

annular 20.01.-2884 13:03:06.7 0.9422/0.9707/0.8876
7 min 0.83 sec 11:02:12.9 12:59:36.1 13:06:36.9 14:49:27.9
alt=42.294, lon=51.224, dlon=-17.742, s=34.428, z=0.515

total 13.03.-2878 15:54:57.2 1.0594/1.0294/1.1224
3 min 54.73 sec 14:41:45.5 15:52:59.6 15:56:54.3 16:59:54.8
alt=26.252, lon=142.461, dlon=73.495, s=34.277, z=2.144

annular 26.08.-2877 16:48:22.7 0.9431/0.9713/0.8895
4 min 19.09 sec 15:29:28.2 16:46:13.4 16:50:32.5 17:56:22.7
alt=23.465, lon=139.280, dlon=70.314, s=34.252, z=2.053

total 25.06.-2874 14:06:39.2 1.0510/1.0251/1.1045
4 min 17.58 sec 12:34:35.0 14:04:30.2 14:08:47.8 15:28:56.1
alt=57.5165 lat=21.4098, lon=19.3481, dlon=-49.6186, s=34.176, z=1.452
at lat=22.23333:
partial 25.06.-2874 14:06:45.4 0.9984/0.9984/0.9995
0 min 0.00 sec 12:35:13.6 - - 15:28:41.5

total 18.10.-2871 10:44:19.1 1.0005/1.0001/1.0009
0 min 0.04 sec 09:19:51.7 10:44:18.2 10:44:18.2 12:13:08.7
alt=60.645, lon=24.554, dlon=-44.413, s=34.101, z=1.302

total 5.08.-2867 15:11:38.9 1.0232/1.0115/1.0469
1 min 38.45 sec 13:51:51.3 15:10:49.9 15:12:28.3 16:21:20.5
alt=45.490, lon=31.128, dlon=-37.839, s=34.001, z=1.113

total 18.11.-2863 10:54:39.3 1.0427/1.0213/1.0872
3 min 35.55 sec 09:31:03.2 10:52:51.6 10:56:27.1 12:24:48.5
alt=51.662, lon=83.001, dlon=14.034, s=33.901, z=0.414

total 23.03.-2860 14:14:12.2 1.0691/1.0343/1.1429
5 min 17.88 sec 12:49:59.0 14:11:33.0 14:16:50.9 15:30:15.4
alt=47.377, lon=8.584, dlon=-60.383, s=33.826, z=1.785

annular 5.09.-2859 15:39:47.7 0.9462/0.9729/0.8953
4 min 41.73 sec 14:08:17.5 15:37:27.1 15:42:08.8 16:57:03.7
alt=38.422, lon=7.689, dlon=-61.277, s=33.801, z=1.813

annular 25.06.-2855 05:08:19.0 0.9786/0.9885/0.9577
1 min 13.83 sec - 05:07:42.1 05:08:55.9 06:05:47.3
alt=0.097, lon=-7.724, dlon=-76.691, s=33.701, z=2.276

total 23.04.-2852 12:55:59.3 1.0219/1.0108/1.0443
1 min 52.15 sec 11:25:51.5 12:55:03.4 12:56:55.5 14:23:35.3
alt=66.789, lon=98.304, dlon=29.338, s=33.626, z=0.872

annular 5.06.-2845 13:07:40.3 0.9497/0.9745/0.9020
6 min 19.20 sec 11:04:34.2 13:04:30.8 13:10:50.0 14:58:30.9
alt=70.280, lon=75.541, dlon=6.574, s=33.452, z=0.197

annular 9.11.-2835 09:32:16.9 0.9904/0.9951/0.9810
0 min 50.98 sec 08:15:08.5 09:31:51.2 09:32:42.2 10:57:47.0
alt=42.749, lon=109.589, dlon=40.623, s=33.204, z=1.223

total 4.05.-2834 13:07:47.5 1.0261/1.0127/1.0528
2 min 14.46 sec 11:37:19.4 13:06:40.3 13:08:54.8 14:35:26.6
alt=67.081, lon=-5.878, dlon=-74.845, s=33.179, z=2.256

total 27.08.-2831 14:34:22.3 1.0244/1.0121/1.0494
1 min 47.37 sec 13:12:47.1 14:33:28.8 14:35:16.1 15:46:55.9
alt=54.162, lon=139.635, dlon=70.669, s=33.105, z=2.135

annular 21.02.-2830 13:03:10.1 0.9464/0.9730/0.8957
6 min 0.92 sec 11:10:40.4 13:00:09.6 13:06:10.5 14:43:27.0
alt=48.181, lon=77.619, dlon=8.653, s=33.080, z=0.262

annular 15.06.-2827 16:05:49.4 0.9407/0.9702/0.8849
5 min 13.73 sec 14:31:44.6 16:03:12.6 16:08:26.3 17:22:58.2
alt=29.869, lon=6.532, dlon=-62.434, s=33.006, z=1.892

total 10.12.-2827 09:05:50.2 1.0393/1.0196/1.0802
2 min 53.36 sec 07:54:08.6 09:04:23.6 09:07:17.0 10:27:40.5
alt=30.917, lon=155.011, dlon=86.044, s=33.006, z=2.607

total 14.04.-2824 10:33:20.1 1.0776/1.0386/1.1611
6 min 11.03 sec 09:13:15.3 10:30:15.0 10:36:26.0 11:59:27.9
alt=59.015, lon=106.267, dlon=37.300, s=32.932, z=1.133

annular 27.09.-2823 13:27:40.6 0.9511/0.9754/0.9046
5 min 19.78 sec 11:38:15.7 13:25:01.0 13:30:20.7 15:05:00.0
alt=64.237, lon=103.208, dlon=34.241, s=32.907, z=1.041

annular 17.07.-2819 05:10:24.6 0.9664/0.9750/0.9340
1 min 43.67 sec - 05:09:32.7 05:11:16.4 06:09:36.0
alt=-0.055, lon=137.737, dlon=68.771, s=32.809, z=2.096

annular 20.11.-2817 08:55:19.0 0.9858/0.9928/0.9718
1 min 10.29 sec 07:42:16.5 08:54:43.7 08:55:54.0 10:17:28.1
alt=33.416, lon=-28.139, dlon=-97.105, s=32.760, z=2.964

total 7.09.-2813 14:09:26.0 1.0250/1.0124/1.0507
1 min 53.08 sec 12:46:28.2 14:08:29.6 14:10:22.7 15:24:15.2
alt=59.080, lon=9.202, dlon=-59.764, s=32.661, z=1.830

annular 3.03.-2812 13:03:04.3 0.9480/0.9739/0.8987
5 min 42.51 sec 11:13:35.1 13:00:13.1 13:05:55.6 14:41:56.1
alt=51.208, lon=-27.897, dlon=-96.863, s=32.637, z=2.968

total 21.12.-2809 08:11:43.7 1.0372/1.0185/1.0758
2 min 29.27 sec 07:06:16.9 08:10:29.1 08:12:58.4 09:26:27.3
alt=19.097, lon=11.385, dlon=-57.582, s=32.563, z=1.768

total   21.12.-2809   17:02:40.7   1.0328/1.0163/1.0667
1 min 56.05 sec   15:57:07.1   17:01:42.8   17:03:38.8   -
alt=3.7642 lat=22.1125, lon=100.8568, dlon=31.8901, s=32.563, z=0.979
at lat=22.23333:
total   21.12.-2809   17:02:36.8   1.0328/1.0129/1.0667
1 min 53.18 sec   15:57:03.0   17:01:40.1   17:03:33.3   -

total   25.04.-2806   08:32:21.9   1.0746/1.0370/1.1548
5 min 0.88 sec   07:25:42.3   08:29:52.0   08:34:52.9   09:47:09.7
alt=37.247, lon=-27.566, dlon=-96.533, s=32.490, z=2.971

annular 11.02.-2802   17:34:52.9   0.9315/0.9653/0.8678
5 min 1.78 sec   16:18:58.7   17:32:22.0   17:37:23.8   -
alt=1.646, lon=88.463, dlon=19.496, s=32.392, z=0.602

total   26.05.-2798   14:11:03.9   1.0306/1.0149/1.0622
2 min 35.52 sec   12:39:34.3   14:09:46.1   14:12:21.6   15:34:43.7
alt=55.303, lon=149.725, dlon=80.758, s=32.294, z=2.501

annular  7.07.-2791   06:23:17.8   0.9318/0.9657/0.8682
5 min 5.88 sec   05:16:38.6   06:20:44.9   06:25:50.8   07:40:59.7
alt=16.119, lon=73.547, dlon=4.581, s=32.123, z=0.143

annular  7.08.-2783   18:01:12.6   0.9573/0.9784/0.9165
2 min 44.45 sec   16:55:32.2   17:59:50.6   18:02:35.0   -
alt=7.733, lon=56.225, dlon=-12.742, s=31.928, z=0.399

annular 12.12.-2781   07:40:42.9   0.9776/0.9887/0.9558
1 min 36.87 sec   06:35:43.2   07:39:54.2   07:41:31.1   08:54:14.1
alt=14.567, lon=56.886, dlon=-12.081, s=31.879, z=0.379

total   26.05.-2779   07:13:50.5   1.0681/1.0338/1.1408
3 min 52.14 sec   06:16:53.2   07:11:54.8   07:15:46.9   08:16:23.1
alt=25.449, lon=97.421, dlon=28.455, s=31.831, z=0.894

total   29.09.-2777   13:11:20.5   1.0264/1.0131/1.0534
2 min 5.30 sec   11:46:23.5   13:10:18.0   13:12:23.3   14:31:18.8
alt=66.745, lon=101.444, dlon=32.478, s=31.782, z=1.022

annular 25.03.-2776   13:07:48.9   0.9505/0.9752/0.9034
5 min 16.83 sec   11:22:43.2   13:05:10.7   13:10:27.6   14:45:09.4
alt=57.393, lon=129.476, dlon=60.509, s=31.758, z=1.905

annular 18.07.-2773   16:43:45.4   0.9307/0.9653/0.8663
5 min 25.00 sec   15:22:12.6   16:41:03.1   16:46:28.1   17:53:14.3
alt=23.833, lon=72.830, dlon=3.863, s=31.685, z=0.122

annular 30.10.-2769   10:28:40.4   0.9548/0.9773/0.9116
4 min 51.61 sec   08:52:23.4   10:26:14.5   10:31:06.1   12:16:18.0
alt=54.723, lon=60.049, dlon=-8.918, s=31.588, z=0.282

total 6.06.-2761 07:21:14.1 1.0688/1.0342/1.1424
3 min 57.44 sec 06:23:43.5 07:19:15.7 07:23:13.1 08:24:40.2
alt=28.370, lon=-13.448, dlon=-82.414, s=31.395, z=2.625

annular 5.04.-2758 13:13:48.0 0.9511/0.9755/0.9046
5 min 11.29 sec 11:29:39.5 13:11:12.6 13:16:23.8 14:51:08.1
alt=59.813, lon=31.779, dlon=-37.187, s=31.323, z=1.187

total 22.01.-2754 15:38:34.8 1.0442/1.0220/1.0903
2 min 58.36 sec 14:23:33.5 15:37:05.6 15:40:04.0 16:44:34.3
alt=22.154, lon=53.991, dlon=-14.975, s=31.226, z=0.480

annular 15.03.-2748 12:50:30.9 0.9584/0.9792/0.9186
4 min 53.96 sec 10:55:22.9 12:48:04.2 12:52:58.1 14:36:48.9
alt=55.806, lon=80.865, dlon=11.899, s=31.082, z=0.383

annular 29.08.-2747 15:40:10.9 0.9529/0.9762/0.9080
4 min 4.20 sec 14:09:22.7 15:38:09.0 15:42:13.2 16:56:41.9
alt=38.815, lon=154.517, dlon=85.551, s=31.058, z=2.755

total 28.05.-2733 11:56:21.7 1.0571/1.0283/1.1174
5 min 10.90 sec 10:23:58.6 11:53:46.4 11:58:57.3 13:30:12.2
alt=83.340, lon=24.851, dlon=-44.115, s=30.723, z=1.436

total 28.05.-2733 16:47:44.4 1.0455/1.0225/1.0931
2 min 48.70 sec 15:38:50.8 16:46:20.0 16:49:08.6 17:48:27.2
alt=19.338, lon=74.587, dlon=5.620, s=30.723, z=0.183

annular 21.11.-2733 08:43:16.5 0.9564/0.9780/0.9147
3 min 53.32 sec 07:24:07.3 08:41:19.8 08:45:13.1 10:16:30.5
alt=30.944, lon=146.676, dlon=77.710, s=30.723, z=2.529

annular 9.09.-2729 14:30:39.2 0.9500/0.9748/0.9024
4 min 59.50 sec 12:46:38.4 14:28:09.5 14:33:09.0 15:58:27.6
alt=53.900, lon=24.220, dlon=-44.747, s=30.628, z=1.461

total 28.06.-2725 07:22:42.1 1.0666/1.0332/1.1377
3 min 53.46 sec 06:24:34.4 07:20:45.6 07:24:39.1 08:27:26.4
alt=29.459, lon=118.602, dlon=49.636, s=30.532, z=1.626

total 31.10.-2723 11:28:48.8 1.0287/1.0142/1.0582
2 min 19.15 sec 10:06:29.0 11:27:39.1 11:29:58.3 12:54:09.2
alt=60.178, lon=46.755, dlon=-22.212, s=30.485, z=0.729

annular 19.08.-2719 16:15:37.8 0.9236/0.9616/0.8531
6 min 13.21 sec 14:51:30.7 16:12:31.2 16:18:44.4 17:28:00.4
alt=31.081, lon=106.996, dlon=38.029, s=30.389, z=1.251

total 13.02.-2718 15:02:05.8 1.0505/1.0252/1.1034
3 min 31.85 sec 13:44:37.2 15:00:19.8 15:03:51.6 16:11:01.8
alt=31.821, lon=158.707, dlon=89.740, s=30.366, z=2.955

annular 1.12.-2715 07:53:05.6 0.9575/0.9786/0.9168
3 min 24.23 sec 06:41:32.0 07:51:23.4 07:54:47.7 09:16:48.3
alt=18.877, lon=9.101, dlon=-59.866, s=30.295, z=1.976

total 8.07.-2707 07:18:42.3 1.0640/1.0319/1.1321
3 min 45.24 sec 06:20:27.7 07:16:50.0 07:20:35.2 08:23:50.4
alt=28.214, lon=1.196, dlon=-67.770, s=30.105, z=2.251

annular 7.05.-2704 14:11:52.4 0.9496/0.9744/0.9017
5 min 22.71 sec 12:25:36.6 14:09:11.2 14:14:33.9 15:47:47.3
alt=54.212, lon=112.640, dlon=43.673, s=30.034, z=1.454

annular 26.04.-2703 07:06:34.4 0.9538/0.9766/0.9098
3 min 28.78 sec 05:58:22.8 07:04:49.9 07:08:18.7 08:23:52.9
alt=17.958, lon=27.406, dlon=-41.561, s=30.010, z=1.385

annular 30.08.-2701 15:57:59.5 0.9219/0.9607/0.8499
6 min 35.14 sec 14:31:07.7 15:54:41.9 16:01:17.1 17:12:51.2
alt=34.604, lon=-7.983, dlon=-76.950, s=29.963, z=2.568

total 24.02.-2700 14:49:02.7 1.0530/1.0264/1.1087
3 min 44.78 sec 13:31:06.1 14:47:10.2 14:50:55.0 15:58:59.3
alt=36.083, lon=35.606, dlon=-33.361, s=29.940, z=1.114

total 19.06.-2697 07:59:04.5 1.0400/1.0199/1.0816
2 min 44.69 sec 06:52:04.2 07:57:42.3 08:00:27.0 09:16:06.4
alt=37.647, lon=124.289, dlon=55.322, s=29.869, z=1.852

annular 1.10.-2693 12:17:39.9 0.9422/0.9711/0.8878
6 min 50.78 sec 10:24:31.0 12:14:14.6 12:21:05.4 14:06:07.6
alt=72.742, lon=123.009, dlon=54.043, s=29.775, z=1.815

total 19.07.-2689 17:56:49.8 1.0549/1.0273/1.1129
2 min 51.18 sec 16:59:48.0 17:55:24.2 17:58:15.4 -
alt=8.081, lon=-3.618, dlon=-72.584, s=29.680, z=2.446

total 22.11.-2687 10:15:52.8 1.0306/1.0152/1.0621
2 min 20.96 sec 08:59:30.5 10:14:42.3 10:17:03.3 11:39:43.0
alt=45.838, lon=126.204, dlon=57.238, s=29.634, z=1.931

annular 18.05.-2686 15:57:52.3 0.9441/0.9717/0.8913
5 min 8.14 sec 14:21:49.5 15:55:18.4 16:00:26.5 17:18:52.8
alt=30.418, lon=35.136, dlon=-33.831, s=29.610, z=1.143

total 29.06.-2679 06:26:13.2 1.0286/1.0141/1.0579
1 min 39.17 sec 05:28:46.2 06:25:23.6 06:27:02.8 07:30:34.8
alt=16.888, lon=-7.360, dlon=-76.326, s=29.446, z=2.592

total 29.06.-2679 17:36:15.4 1.0281/1.0140/1.0569
1 min 33.32 sec 16:34:51.8 17:35:28.9 17:37:02.3 -
alt=10.993, lon=111.252, dlon=42.285, s=29.446, z=1.436

annular 11.10.-2675 11:15:15.0 0.9376/0.9687/0.8791
7 min 23.56 sec 09:27:16.7 11:11:33.1 11:18:56.7 13:08:44.9
alt=66.487, lon=-8.396, dlon=-77.363, s=29.352, z=2.636

annular 15.02.-2672 16:29:38.6 0.9776/0.9886/0.9557
1 min 44.53 sec 15:09:03.6 16:28:46.6 16:30:31.2 17:38:49.9
alt=15.780, lon=128.010, dlon=59.043, s=29.282, z=2.016

total 30.07.-2671 07:04:14.3 1.0567/1.0283/1.1166
3 min 19.52 sec 06:06:12.7 07:02:34.7 07:05:54.2 08:09:24.4
alt=23.365, lon=119.318, dlon=50.352, s=29.259, z=1.721

total 3.12.-2669 09:39:17.4 1.0317/1.0158/1.0643
2 min 19.95 sec 08:26:36.3 09:38:07.4 09:40:27.3 11:00:33.2
alt=37.735, lon=-14.340, dlon=-83.307, s=29.212, z=2.852

annular 21.09.-2665 15:11:53.4 0.9197/0.9595/0.8458
7 min 27.08 sec 13:37:18.1 15:08:09.9 15:15:36.9 16:34:07.7
alt=42.577, lon=112.982, dlon=44.016, s=29.119, z=1.512

total 10.07.-2661 17:33:08.2 1.0226/1.0112/1.0458
1 min 15.02 sec 16:31:39.0 17:32:30.9 17:33:45.9 18:28:30.4
alt=12.570, lon=-2.952, dlon=-71.919, s=29.026, z=2.478

annular 25.02.-2654 15:03:46.7 0.9818/0.9908/0.9640
1 min 41.41 sec 13:27:59.0 15:02:56.3 15:04:37.7 16:25:04.6
alt=33.936, lon=-1.467, dlon=-70.434, s=28.863, z=2.440

total 10.08.-2653 06:53:34.5 1.0523/1.0260/1.1073
3 min 2.45 sec 05:56:01.7 06:52:03.4 06:55:05.9 07:58:09.5
alt=19.908, lon=-5.636, dlon=-74.603, s=28.840, z=2.587

total 10.08.-2653 15:22:20.2 1.0588/1.0293/1.1210
4 min 2.12 sec 14:05:29.6 15:20:18.9 15:24:21.1 16:29:37.3
alt=43.247, lon=79.853, dlon=10.887, s=28.840, z=0.377

annular 29.05.-2649 08:19:57.5 0.9657/0.9827/0.9326
2 min 51.49 sec 07:05:08.6 08:18:31.6 08:21:23.1 09:46:10.8
alt=41.063, lon=109.198, dlon=40.231, s=28.747, z=1.399

annular 1.10.-2647 14:43:59.4 0.9192/0.9593/0.8450
7 min 55.17 sec 13:04:57.9 14:40:01.8 14:47:56.9 16:11:05.8
alt=46.648, lon=-10.550, dlon=-79.517, s=28.701, z=2.771

total 28.03.-2646 14:34:06.3 1.0563/1.0279/1.1157
4 min 3.76 sec 13:15:35.9 14:32:04.3 14:36:08.1 15:46:07.8
alt=44.944, lon=44.529, dlon=-24.438, s=28.678, z=0.852

total 8.05.-2639 12:55:12.5 1.0393/1.0194/1.0801
3 min 35.78 sec 11:19:11.0 12:53:24.6 12:57:00.4 14:26:57.1
alt=70.443, lon=52.082, dlon=-16.885, s=28.516, z=0.592

annular 2.11.-2639 09:21:34.6 0.9279/0.9638/0.8611
7 min 28.16 sec 07:50:53.6 09:17:50.7 09:25:18.8 11:08:37.2
alt=42.221, lon=86.530, dlon=17.563, s=28.516, z=0.616

total 25.12.-2633 08:30:06.1 1.0346/1.0172/1.0704
2 min 18.02 sec 07:24:42.6 08:28:57.1 08:31:15.2 09:44:12.3
alt=21.767, lon=67.316, dlon=-1.651, s=28.378, z=0.058

annular 8.06.-2631 08:29:13.8 0.9678/0.9838/0.9366
2 min 44.67 sec 07:13:13.1 08:27:51.3 08:30:35.9 09:57:40.9
alt=44.147, lon=11.501, dlon=-57.466, s=28.332, z=2.028

annular 1.10.-2628 06:15:27.9 0.9506/0.9750/0.9036
3 min 25.53 sec - 06:13:45.0 06:17:10.6 07:26:21.0
alt=5.692, lon=103.999, dlon=35.032, s=28.263, z=1.240

total 1.08.-2625 17:15:12.1 1.0114/1.0055/1.0229
0 min 37.62 sec 16:11:48.7 17:14:53.5 17:15:31.1 18:12:15.0
alt=17.683, lon=121.928, dlon=52.961, s=28.194, z=1.878

annular 19.03.-2618 11:27:09.8 0.9844/0.9920/0.9690
1 min 47.07 sec 09:43:44.2 11:26:16.1 11:28:03.2 13:14:04.7
alt=56.519, lon=107.616, dlon=38.649, s=28.034, z=1.379

total 1.09.-2617 06:24:44.7 1.0422/1.0209/1.0862
2 min 22.11 sec - 06:23:33.8 06:25:55.9 07:26:41.3
alt=11.080, lon=95.999, dlon=27.033, s=28.011, z=0.965

annular 23.10.-2611 13:42:33.3 0.9198/0.9596/0.8460
8 min 44.98 sec 11:56:06.9 13:38:10.9 13:46:55.9 15:20:51.8
alt=52.786, lon=97.569, dlon=28.602, s=27.874, z=1.026

annular 12.10.-2610 06:51:34.9 0.9537/0.9765/0.9095
3 min 21.59 sec - 06:49:53.9 06:53:15.5 08:05:45.8
alt=12.9014 lat=22.1006, lon=-14.2206, dlon=-83.1873, s=27.851, z=2.987
at lat=22.23333:
annular 12.10.-2610 06:51:31.4 0.9537/0.9732/0.9095
3 min 19.15 sec - 06:49:51.8 06:53:11.0 08:05:40.4

total 11.08.-2607 17:01:05.2 1.0057/1.0027/1.0115
0 min 17.99 sec 15:55:51.7 17:00:56.4 17:01:14.4 17:59:41.3
alt=20.926, lon=0.699, dlon=-68.268, s=27.782, z=2.457

annular 4.02.-2606 16:43:15.5 0.9887/0.9942/0.9775
0 min 49.42 sec 15:31:17.4 16:42:51.1 16:43:40.5 -
alt=11.661, lon=72.343, dlon=3.376, s=27.760, z=0.122

total 11.09.-2599 11:15:53.3 1.0532/1.0264/1.1093
4 min 36.09 sec 09:48:03.5 11:13:35.3 11:18:11.4 12:45:51.1
alt=75.375, lon=20.089, dlon=-48.877, s=27.600, z=1.771

total   29.04.-2592   15:33:26.3   1.0495/1.0243/1.1014
3 min 28.47 sec   14:16:18.6   15:31:41.9   15:35:10.3   16:42:51.5
alt=35.396, lon=81.136, dlon=12.169, s=27.441, z=0.443

total   10.06.-2585   07:11:17.3   1.0388/1.0192/1.0791
2 min 24.52 sec   06:10:11.9   07:10:05.1   07:12:29.7   08:20:24.7
alt=26.417, lon=27.204, dlon=-41.763, s=27.283, z=1.531

annular  5.12.-2585   06:52:05.6   0.9160/0.9577/0.8391
6 min 27.62 sec   -   06:48:52.0   06:55:19.6   08:11:23.5
alt=5.541, lon=45.543, dlon=-23.424, s=27.283, z=0.859

total   26.01.-2578   07:05:35.6   1.0412/1.0205/1.0842
2 min 23.05 sec   -   07:04:24.1   07:06:47.2   08:09:40.4
alt=2.436, lon=22.527, dlon=-46.440, s=27.125, z=1.712

total   26.01.-2578   16:51:57.2   1.0428/1.0213/1.0875
2 min 36.09 sec   15:44:25.2   16:50:39.2   16:53:15.3   -
alt=8.725, lon=123.444, dlon=54.477, s=27.125, z=2.008

annular 11.07.-2577   08:48:55.9   0.9707/0.9852/0.9422
2 min 41.92 sec   07:28:07.5   08:47:34.8   08:50:16.7   10:26:00.7
alt=48.274, lon=64.797, dlon=-4.170, s=27.102, z=0.154

annular 11.07.-2577   17:19:01.8   0.9621/0.9810/0.9257
2 min 42.33 sec   16:04:47.7   17:17:40.9   17:20:23.3   18:23:18.7
alt=15.747, lon=146.835, dlon=77.868, s=27.102, z=2.873

annular  3.11.-2574   06:07:08.0   0.9543/0.9735/0.9108
2 min 54.95 sec   -   06:05:40.5   06:08:35.5   07:12:37.5
alt=0.0191 lat=21.2915, lon=78.6891, dlon=9.7224, s=27.035, z=0.360
at lat=22.23333:
partial  3.11.-2574   06:06:48.7   0.9458/0.9458/0.9054
0 min 0.00 sec   -   -   -   07:12:08.9

annular 30.04.-2573   08:19:53.8   0.9906/0.9950/0.9813
0 min 47.13 sec   07:07:33.9   08:19:30.1   08:20:17.2   09:41:16.5
alt=35.836, lon=86.261, dlon=17.294, s=27.012, z=0.640

annular  2.09.-2571   16:23:01.1   0.9949/0.9972/0.9899
0 min 23.64 sec   15:12:07.3   16:22:49.5   16:23:13.2   17:26:24.6
alt=28.480, lon=110.525, dlon=41.558, s=26.967, z=1.541

total   3.10.-2563   08:35:19.7   1.0400/1.0197/1.0816
2 min 50.86 sec   07:25:24.7   08:33:54.5   08:36:45.3   09:54:09.2
alt=37.647, lon=90.804, dlon=21.838, s=26.788, z=0.815

annular 21.07.-2559   15:47:42.2   0.9674/0.9837/0.9359
2 min 48.59 sec   14:16:21.5   15:46:18.2   15:49:06.8   17:03:44.8
alt=36.709, lon=19.567, dlon=-49.400, s=26.698, z=1.850

annular 25.11.-2557    12:04:44.3    0.9242/0.9618/0.8541
9 min 2.18 sec    10:16:37.4    12:00:13.6    12:09:15.8    13:58:32.5
alt=51.410, lon=73.900, dlon=4.934, s=26.653, z=0.185

total 8.03.-2552    16:14:14.4    1.0112/1.0054/1.0226
0 min 42.65 sec    15:01:16.7    16:13:53.2    16:14:35.8    17:19:36.1
alt=22.084, lon=81.046, dlon=12.079, s=26.542, z=0.455

annular 20.04.-2545    15:14:53.1    0.9451/0.9722/0.8933
5 min 28.20 sec    13:30:23.6    15:12:09.1    15:17:37.3    16:42:10.8
alt=39.105, lon=54.660, dlon=-14.307, s=26.386, z=0.542

annular 13.09.-2534    05:45:10.5    0.9272/0.9629/0.8597
5 min 5.50 sec    -    05:42:37.8    05:47:43.3    06:56:36.0
alt=-0.0269 lat=21.2569, lon=18.9786, dlon=-49.9880, s=26.141, z=1.912
at lat=22.23333:
annular 13.09.-2534    05:45:13.4    0.9272/0.9362/0.8598
3 min 23.57 sec    -    05:43:31.5    05:46:55.1    06:56:31.1

annular 13.09.-2534    06:05:31.1    0.9284/0.9640/0.8620
5 min 12.23 sec    -    06:02:54.9    06:08:07.2    07:20:06.3
alt=5.318, lon=23.940, dlon=-45.027, s=26.141, z=1.722

annular 13.09.-2534    08:56:43.4    0.9377/0.9685/0.8793
6 min 16.28 sec    07:27:33.1    08:53:35.3    08:59:51.5    10:39:03.2
alt=44.755, lon=58.378, dlon=-10.589, s=26.141, z=0.405

total 9.03.-2533    09:24:57.0    1.0614/1.0303/1.1267
4 min 34.93 sec    08:10:51.0    09:22:40.0    09:27:14.9    10:46:09.0
alt=35.432, lon=37.345, dlon=-31.621, s=26.119, z=1.211

total 28.02.-2524    06:44:11.3    1.0527/1.0261/1.1082
2 min 57.68 sec    -    06:42:42.7    06:45:40.3    07:46:22.0
alt=0.2551 lat=21.3706, lon=7.7067, dlon=-61.2600, s=25.920, z=2.363
at lat=22.23333:
total 28.02.-2524    06:44:57.8    1.0527/1.0021/1.1081
1 min 2.66 sec    -    06:44:26.7    06:45:29.4    07:47:11.6

total 28.02.-2524    12:41:02.4    1.0673/1.0335/1.1392
5 min 45.05 sec    11:10:42.1    12:38:09.9    12:43:55.0    14:07:11.1
alt=51.784, lon=70.059, dlon=1.093, s=25.920, z=0.042

annular 12.08.-2523    10:07:36.0    0.9730/0.9862/0.9467
2 min 59.45 sec    08:30:40.9    10:06:06.3    10:09:05.8    11:59:44.8
alt=63.811, lon=103.993, dlon=35.026, s=25.898, z=1.352

annular 5.10.-2517    15:04:07.7    0.9809/0.9901/0.9621
1 min 36.49 sec    13:39:59.0    15:03:19.7    15:04:56.2    16:19:34.7
alt=41.160, lon=78.951, dlon=9.985, s=25.766, z=0.388

total 5.11.-2509 06:07:22.0 1.0220/1.0106/1.0446
1 min 10.65 sec - 06:06:46.7 06:07:57.3 07:06:29.4
alt=0.0215 lat=21.7431, lon=15.4842, dlon=-53.4825, s=25.590, z=2.090
at lat=22.23333:
partial 5.11.-2509 06:07:23.3 0.9957/0.9957/0.9972
0 min 0.00 sec - - - 07:06:28.9

annular 27.12.-2503 10:41:14.2 0.9329/0.9662/0.8704
7 min 47.01 sec 09:00:23.8 10:37:21.2 10:45:08.2 12:39:55.0
alt=40.435, lon=55.462, dlon=-13.505, s=25.459, z=0.530

annular 27.12.-2503 16:59:21.7 0.9239/0.9619/0.8536
6 min 13.95 sec 15:33:23.2 16:56:14.8 17:02:28.7 -
alt=4.523, lon=113.868, dlon=44.902, s=25.459, z=1.764

annular 12.06.-2501 08:58:14.8 0.9775/0.9887/0.9556
2 min 0.32 sec 07:39:14.6 08:57:14.4 08:59:14.7 10:30:22.9
alt=50.969, lon=47.545, dlon=-21.422, s=25.415, z=0.843

total 10.04.-2498 18:02:25.3 1.0217/1.0083/1.0439
1 min 9.59 sec 17:01:35.6 18:01:50.4 18:03:00.0 -
alt=0.0012 lat=22.1377, lon=133.3068, dlon=64.3401, s=25.349, z=2.538
at lat=22.23333:
total 10.04.-2498 18:02:26.7 1.0217/1.0052/1.0439
1 min 0.35 sec 17:01:37.7 18:01:56.5 18:02:56.8 -

annular 22.05.-2491 08:22:11.6 0.9454/0.9725/0.8938
5 min 4.02 sec 07:00:39.7 08:19:39.6 08:24:43.7 10:00:19.2
alt=40.831, lon=66.552, dlon=-2.415, s=25.197, z=0.096

annular 15.10.-2480 08:02:41.7 0.9225/0.9609/0.8509
6 min 49.78 sec 06:44:21.5 07:59:16.8 08:06:06.6 09:32:30.5
alt=28.665, lon=46.615, dlon=-22.352, s=24.957, z=0.896

total 10.04.-2479 10:14:33.7 1.0763/1.0379/1.1585
5 min 36.36 sec 09:00:07.0 10:11:45.8 10:17:22.2 11:33:38.6
alt=55.011, lon=59.649, dlon=-9.318, s=24.936, z=0.374

annular 6.11.-2463 13:28:55.5 0.9703/0.9848/0.9415
2 min 58.64 sec 11:51:33.2 13:27:26.4 13:30:25.0 15:01:15.3
alt=49.942, lon=36.745, dlon=-32.222, s=24.590, z=1.310

partial 24.08.-2459 18:32:10.6 0.9996/0.9996/0.9999
0 min 0.00 sec 17:39:20.8 - - -
alt=-0.042, lon=50.834, dlon=-18.132, s=24.504, z=0.740

annular 18.02.-2458 17:10:09.7 0.9269/0.9632/0.8592
5 min 29.56 sec 15:53:13.0 17:07:25.0 17:12:54.6 -
alt=8.096, lon=58.589, dlon=-10.378, s=24.482, z=0.424

total 14.08.-2458 06:27:45.3 1.0476/1.0237/1.0975
2 min 44.33 sec 05:30:46.6 06:26:23.2 06:29:07.6 07:31:25.9
alt=13.589, lon=29.244, dlon=-39.723, s=24.482, z=1.623

total 14.08.-2458 11:48:40.3 1.0621/1.0307/1.1281
5 min 16.24 sec 10:19:46.2 11:46:02.3 11:51:18.5 13:14:49.8
alt=86.729, lon=85.869, dlon=16.902, s=24.482, z=0.690

total 1.04.-2451 17:18:27.7 1.0373/1.0182/1.0759
2 min 11.68 sec 16:13:19.5 17:17:21.8 17:19:33.5 -
alt=10.050, lon=127.070, dlon=58.103, s=24.332, z=2.388

annular 29.01.-2448 10:41:22.9 0.9480/0.9737/0.8988
6 min 11.32 sec 08:57:33.2 10:38:17.5 10:44:28.8 12:41:32.6
alt=39.798, lon=62.383, dlon=-6.583, s=24.268, z=0.271

annular 29.01.-2448 12:49:16.5 0.9487/0.9741/0.9000
6 min 25.76 sec 10:48:45.6 12:46:03.7 12:52:29.4 14:41:06.0
alt=44.522, lon=79.684, dlon=10.718, s=24.268, z=0.442

annular 14.07.-2447 09:27:17.9 0.9627/0.9811/0.9267
3 min 49.10 sec 07:58:05.7 09:25:23.3 09:29:12.4 11:15:13.1
alt=56.658, lon=101.611, dlon=32.644, s=24.246, z=1.346

total 24.09.-2432 17:10:40.6 1.0175/1.0084/1.0354 saros 5/17
1 min 0.53 sec 16:06:02.8 17:10:10.4 17:11:10.9 18:08:46.4
alt=14.103, lon=118.496, dlon=49.529, s=23.926, z=2.070

annular 25.07.-2429 09:53:47.5 0.9579/0.9786/0.9175
4 min 40.39 sec 08:17:29.4 09:51:27.3 09:56:07.7 11:49:18.7
alt=61.912, lon=-0.794, dlon=-69.761, s=23.862, z=2.924

annular 25.07.-2429 14:18:46.8 0.9578/0.9788/0.9173
4 min 32.26 sec 12:25:40.3 14:16:30.8 14:21:03.1 15:51:57.6
alt=57.159, lon=36.174, dlon=-32.793, s=23.862, z=1.374

annular 28.11.-2427 12:26:02.7 0.9652/0.9822/0.9315
3 min 47.05 sec 10:44:47.6 12:24:09.3 12:27:56.3 14:09:12.0
alt=49.423, lon=129.164, dlon=60.197, s=23.820, z=2.527

annular 17.11.-2426 06:17:52.9 0.9099/0.9479/0.8278
6 min 19.56 sec - 06:14:43.2 06:21:02.8 07:29:24.6
alt=0.0328 lat=22.2230, lon=14.2247, dlon=-54.7419, s=23.799, z=2.300
at lat=22.23333:
annular 17.11.-2426 06:17:52.7 0.9099/0.9476/0.8278
6 min 19.18 sec - 06:14:43.2 06:21:02.4 07:29:24.2

total 13.05.-2425 10:27:26.1 1.0823/1.0411/1.1713
6 min 3.07 sec 09:13:09.6 10:24:24.8 10:30:27.9 11:47:27.3
alt=67.576, lon=84.772, dlon=15.806, s=23.777, z=0.665

annular 1.03.-2421 10:33:34.4 0.9513/0.9753/0.9051 saros 1/26
5 min 27.75 sec 08:51:40.8 10:30:50.5 10:36:18.2 12:22:44.5
alt=44.841, lon=135.643, dlon=66.677, s=23.693, z=2.814

total 26.09.-2405 17:46:17.1 1.0269/1.0130/1.0545
1 min 25.97 sec 16:48:01.8 17:45:34.1 17:47:00.1 -
alt=5.534, lon=14.668, dlon=-54.299, s=23.355, z=2.325

annular 22.03.-2404 17:57:59.1 0.9312/0.9598/0.8672
4 min 44.99 sec 16:46:52.2 17:55:36.7 18:00:21.7 -
alt=0.0170 lat=21.8166, lon=122.3340, dlon=53.3674, s=23.334, z=2.287
at lat=22.23333:
annular 22.03.-2404 17:58:08.2 0.9312/0.9477/0.8671
4 min 8.05 sec 16:47:06.1 17:56:04.3 18:00:12.3 -

total 15.09.-2404 11:10:28.7 1.0486/1.0240/1.0995
3 min 56.10 sec 09:47:11.7 11:08:30.9 11:12:27.0 12:34:25.3
alt=73.198, lon=60.177, dlon=-8.790, s=23.334, z=0.377

annular 11.03.-2403 10:52:07.5 0.9574/0.9784/0.9167 saros 1/27
4 min 39.51 sec 09:11:10.8 10:49:47.7 10:54:27.2 12:37:29.6
alt=50.655, lon=32.663, dlon=-36.303, s=23.313, z=1.557

total 4.05.-2397 10:38:46.1 1.0437/1.0218/1.0893
3 min 47.52 sec 09:12:59.3 10:36:52.4 10:40:39.9 12:12:20.7
alt=67.480, lon=87.868, dlon=18.901, s=23.187, z=0.815

annular 15.07.-2382 07:56:42.7 0.9793/0.9896/0.9589
1 min 46.96 sec 06:41:32.5 07:55:49.0 07:57:36.0 09:26:44.5
alt=36.084, lon=133.958, dlon=64.992, s=22.873, z=2.841

total 27.10.-2378 14:03:48.5 1.0281/1.0137/1.0570 saros 5/20
2 min 17.59 sec 12:34:47.0 14:02:39.7 14:04:57.3 15:24:26.0
alt=47.180, lon=44.499, dlon=-24.468, s=22.790, z=1.074

annular 31.12.-2373 11:15:48.9 0.9607/0.9800/0.9229
4 min 29.25 sec 09:34:16.1 11:13:34.3 11:18:03.6 13:09:06.9
alt=42.673, lon=99.415, dlon=30.449, s=22.686, z=1.342

total 14.06.-2371 10:50:13.1 1.0799/1.0397/1.1661
6 min 20.93 sec 09:30:42.8 10:47:03.0 10:53:23.9 12:16:48.6
alt=76.847, lon=110.606, dlon=41.639, s=22.645, z=1.839

total 18.10.-2369 16:53:12.8 1.0285/1.0138/1.0578
1 min 41.68 sec 15:47:43.9 16:52:22.0 16:54:03.7 17:52:36.0
alt=13.253, lon=96.389, dlon=27.422, s=22.603, z=1.213

annular 25.07.-2364 06:25:22.5 0.9744/0.9871/0.9494
1 min 48.20 sec 05:22:13.6 06:24:28.2 06:26:16.4 07:38:01.6
alt=14.975, lon=4.393, dlon=-64.573, s=22.500, z=2.870

annular 25.07.-2364 14:01:06.9 0.9832/0.9914/0.9667
1 min 40.47 sec 12:19:08.4 14:00:16.9 14:01:57.3 15:27:43.5
alt=61.266, lon=78.311, dlon=9.345, s=22.500, z=0.415

annular 25.08.-2356 18:30:07.0 0.9164/0.9321/0.8398 saros 7/14
4 min 18.13 sec 17:24:12.0 18:27:58.1 18:32:16.2 -
alt=-0.0406 lat=22.4214, lon=6.1261, dlon=-62.8405, s=22.334, z=2.814
at lat=22.23333:
annular 25.08.-2356 18:30:20.3 0.9164/0.9282/0.8398 saros 7/14
3 min 51.10 sec 17:24:28.2 18:28:24.9 18:32:16.0 -

annular 10.01.-2354 14:35:59.8 0.9586/0.9791/0.9188
4 min 20.13 sec 12:46:39.4 14:33:49.9 14:38:10.0 16:07:14.1
alt=31.528, lon=4.883, dlon=-64.084, s=22.293, z=2.875

total 25.06.-2353 16:38:07.7 1.0664/1.0331/1.1373
4 min 3.04 sec 15:29:56.9 16:36:05.9 16:40:08.9 17:38:23.6
alt=23.747, lon=53.897, dlon=-15.070, s=22.273, z=0.677

total 18.10.-2350 09:43:32.6 1.0342/1.0169/1.0695
2 min 31.98 sec 08:29:21.3 09:42:16.7 09:44:48.6 11:03:35.1
alt=49.503, lon=10.979, dlon=-57.988, s=22.211, z=2.611

annular 13.04.-2349 11:19:40.7 0.9739/0.9869/0.9485 saros 1/30
2 min 41.26 sec 09:44:06.6 11:18:20.0 11:21:01.2 12:59:00.8
alt=66.287, lon=90.264, dlon=21.298, s=22.190, z=0.960

partial 5.06.-2343 05:14:22.7 0.9969/0.9969/0.9980
0 min 0.00 sec - - - 06:10:33.6
alt=-0.0443 lat=22.3978, lon=58.0007, dlon=-10.9660, s=22.067, z=0.497
at lat=22.23333:
partial 5.06.-2343 05:14:12.5 0.9931/0.9931/0.9941
0 min 0.00 sec - - - 06:10:21.9

total 18.11.-2342 12:03:17.1 1.0329/1.0162/1.0669 saros 5/22
2 min 57.00 sec 10:31:56.0 12:01:48.5 12:04:45.5 13:35:50.6
alt=53.202, lon=116.290, dlon=47.323, s=22.047, z=2.146

total 23.03.-2339 15:25:55.3 1.0333/1.0163/1.0677
2 min 26.17 sec 14:04:24.3 15:24:42.1 15:27:08.3 16:37:38.4
alt=34.328, lon=17.366, dlon=-51.601, s=21.985, z=2.347

annular 10.02.-2327 07:08:46.6 0.9684/0.9840/0.9379 saros 3/28
2 min 22.44 sec - 07:07:35.2 07:09:57.6 08:27:02.4
alt=3.615, lon=5.553, dlon=-63.414, s=21.740, z=2.917

annular 10.02.-2327 11:20:05.2 0.9795/0.9893/0.9593 saros 3/28
2 min 17.42 sec 09:37:14.7 11:18:56.4 11:21:13.8 13:04:30.3
alt=45.601, lon=48.408, dlon=-20.558, s=21.740, z=0.946

total 28.11.-2324 16:50:34.4 1.0226/1.0111/1.0457 saros 5/23
1 min 22.96 sec 15:41:51.4 16:49:53.0 16:51:15.9 -
alt=6.840, lon=30.268, dlon=-38.699, s=21.679, z=1.785

annular 16.09.-2320 16:20:41.9 0.9189/0.9591/0.8444 saros 7/16
6 min 54.88 sec 14:52:02.4 16:17:14.4 16:24:09.3 17:35:42.3
alt=26.884, lon=107.480, dlon=38.513, s=21.598, z=1.783

total   19.11.-2315    15:37:08.8    1.0336/1.0164/1.0684
2 min 22.37 sec    14:19:11.8    15:35:57.5    15:38:19.9    16:46:35.1
alt=23.338, lon=34.240, dlon=-34.726, s=21.496, z=1.615

total   9.11.-2314    08:30:54.6    1.0246/1.0121/1.0499
1 min 38.23 sec    07:24:37.1    08:30:05.5    08:31:43.7    09:44:14.8
alt=30.528, lon=89.399, dlon=20.432, s=21.476, z=0.951

annular 27.08.-2310    13:34:56.0    0.9844/0.9922/0.9691
1 min 30.26 sec    11:58:45.4    13:34:11.1    13:35:41.4    15:00:25.9
alt=67.561, lon=88.645, dlon=19.679, s=21.395, z=0.920

total   14.04.-2303    11:43:40.0    1.0508/1.0253/1.1041
4 min 29.56 sec    10:13:41.3    11:41:25.1    11:45:54.7    13:15:40.9
alt=68.957, lon=118.995, dlon=50.028, s=21.254, z=2.354

annular 26.06.-2288    10:37:02.9    0.9651/0.9823/0.9314    saros 0/38
4 min 11.26 sec    08:51:37.3    10:34:57.2    10:39:08.5    12:36:47.5
alt=73.518, lon=47.555, dlon=-21.412, s=20.953, z=1.022

annular 26.06.-2288    13:23:28.8    0.9650/0.9822/0.9312    saros 0/38
4 min 5.75 sec    11:24:36.5    13:21:26.0    13:25:31.8    15:05:33.2
alt=68.094, lon=70.123, dlon=1.156, s=20.953, z=0.055

total   20.12.-2288    09:06:33.3    1.0359/1.0179/1.0732    saros 5/25
2 min 41.85 sec    07:53:33.2    09:05:12.4    09:07:54.3    10:30:30.9
alt=28.562, lon=45.413, dlon=-23.554, s=20.953, z=1.124

total   20.12.-2288    15:40:34.3    1.0330/1.0163/1.0670    saros 5/25
2 min 17.55 sec    14:22:29.5    15:39:25.5    15:41:43.0    16:48:27.2
alt=19.860, lon=107.768, dlon=38.801, s=20.953, z=1.852

annular 26.05.-2277    12:07:57.5    0.9892/0.9943/0.9785    saros 1/34
1 min 12.53 sec    10:28:15.8    12:07:21.2    12:08:33.7    13:51:16.0
alt=82.446, lon=55.050, dlon=-13.916, s=20.733, z=0.671

annular 15.03.-2273    11:35:23.2    0.9806/0.9900/0.9616    saros 3/31
2 min 2.28 sec    09:57:00.1    11:34:22.1    11:36:24.4    13:13:36.4
alt=56.564, lon=75.268, dlon=6.301, s=20.653, z=0.305

annular 19.10.-2266    13:01:48.2    0.9226/0.9611/0.8512    saros 7/19
9 min 28.07 sec    11:03:31.3    12:57:04.2    13:06:32.2    14:50:57.0
alt=59.660, lon=75.495, dlon=6.528, s=20.514, z=0.318

total   11.12.-2260    06:32:19.4    1.0121/1.0060/1.0244
0 min 38.54 sec    -    06:32:00.1    06:32:38.6    07:32:35.9
alt=0.0488 lat=22.1704, lon=21.8291, dlon=-47.1375, s=20.396, z=2.311
at lat=22.23333:
total   11.12.-2260    06:32:18.9    1.0121/1.0042/1.0244
0 min 36.30 sec    -    06:32:00.9    06:32:37.1    07:32:35.4

partial 26.05.-2258 05:19:38.3 0.9959/0.9959/0.9977 saros 11/14
0 min 0.00 sec - - - 06:13:41.2
alt=-0.0393 lat=22.9903, lon=67.9821, dlon=-0.9846, s=20.356, z=0.048
at lat=22.23333:
partial 26.05.-2258 05:18:41.5 0.9812/0.9812/0.9826 saros 11/14
0 min 0.00 sec - - - 06:12:36.2

annular 28.09.-2256 12:21:45.9 0.9865/0.9932/0.9732
1 min 20.41 sec 10:48:21.2 12:21:06.0 12:22:26.4 13:52:05.5
alt=72.049, lon=68.626, dlon=-0.341, s=20.317, z=0.017

total 11.01.-2251 07:10:11.6 1.0361/1.0180/1.0735 saros 5/27
2 min 10.41 sec - 07:09:06.4 07:11:16.8 08:17:14.4
alt=4.074, lon=119.395, dlon=50.429, s=20.218, z=2.494

total 17.05.-2249 05:57:00.7 1.0471/1.0232/1.0963
2 min 29.04 sec - 05:55:46.3 05:58:15.4 06:54:49.4
alt=6.752, lon=82.926, dlon=13.960, s=20.179, z=0.692

annular 5.03.-2245 16:28:57.2 0.9308/0.9651/0.8665
5 min 54.29 sec 14:59:34.1 16:26:00.0 16:31:54.3 17:44:17.4
alt=18.889, lon=45.155, dlon=-23.812, s=20.100, z=1.185

annular 29.07.-2234 05:18:40.8 0.9355/0.9565/0.8752 saros 0/41
3 min 57.91 sec - 05:16:41.9 05:20:39.8 06:25:31.6
alt=-0.0533 lat=22.4425, lon=34.4451, dlon=-34.5215, s=19.884, z=1.736
at lat=22.23333:
annular 29.07.-2234 05:18:32.5 0.9355/0.9512/0.8751 saros 0/41
3 min 38.80 sec - 05:16:43.1 05:20:21.9 06:25:21.7

annular 29.07.-2234 14:34:17.4 0.9482/0.9740/0.8991 saros 0/41
5 min 5.09 sec 12:50:43.4 14:31:44.9 14:36:50.0 16:00:19.1
alt=54.0561 lat=23.0687, lon=128.5860, dlon=59.6193, s=19.884, z=2.998
at lat=22.23333:
annular 29.07.-2234 14:35:57.0 0.9481/0.9557/0.8989 saros 0/41
3 min 38.49 sec 12:52:21.8 14:34:07.8 14:37:46.3 16:01:47.6

total 22.01.-2233 14:27:11.3 1.0490/1.0243/1.1004 saros 5/28
3 min 42.26 sec 13:03:23.4 14:25:20.1 14:29:02.3 15:41:09.4
alt=34.155, lon=63.197, dlon=-5.769, s=19.865, z=0.290

annular 29.08.-2226 16:33:05.5 0.9943/0.9969/0.9886 saros 9/20
0 min 26.93 sec 15:19:36.9 16:32:52.2 16:33:19.2 17:37:30.1
alt=26.259, lon=83.791, dlon=14.824, s=19.728, z=0.751

annular 16.04.-2219 11:46:07.5 0.9787/0.9893/0.9579 saros 3/34
2 min 12.11 sec 10:09:50.5 11:45:01.3 11:47:13.4 13:24:31.4
alt=70.124, lon=124.536, dlon=55.569, s=19.592, z=2.836

annular 8.08.-2216 14:37:50.7 0.9431/0.9715/0.8894 saros 0/42
5 min 29.79 sec 12:56:34.8 14:35:05.9 14:40:35.6 16:02:47.0
alt=53.477, lon=21.652, dlon=-47.315, s=19.534, z=2.422

annular 20.11.-2212 10:04:32.7 0.9239/0.9619/0.8537 saros 7/22
8 min 40.47 sec 08:25:43.5 10:00:12.9 10:08:53.4 12:01:41.8
alt=44.026, lon=40.876, dlon=-28.091, s=19.456, z=1.444

total 27.06.-2204 05:54:22.1 1.0389/1.0193/1.0794 saros 11/17
2 min 1.77 sec - 05:53:21.3 05:55:23.0 06:51:21.3
alt=9.726, lon=106.103, dlon=37.136, s=19.302, z=1.924

annular 31.10.-2202 10:42:16.3 0.9894/0.9946/0.9789
1 min 1.46 sec 09:17:08.6 10:41:45.4 10:42:46.8 12:13:50.5
alt=55.086, lon=27.277, dlon=-41.690, s=19.263, z=2.164

annular 27.04.-2201 11:53:40.1 0.9771/0.9884/0.9547 saros 3/35
2 min 24.19 sec 10:16:18.3 11:52:27.8 11:54:52.0 13:33:49.9
alt=74.592, lon=25.212, dlon=-43.754, s=19.244, z=2.274

annular 6.04.-2191 10:52:08.4 0.9466/0.9732/0.8961
6 min 21.13 sec 09:05:37.4 10:48:57.8 10:55:18.9 12:49:03.1
alt=60.644, lon=51.767, dlon=-17.199, s=19.052, z=0.903

total 23.02.-2179 13:42:17.7 1.0642/1.0320/1.1325 saros 5/31
4 min 50.93 sec 12:20:05.3 13:39:52.2 13:44:43.1 14:57:40.7
alt=46.573, lon=42.641, dlon=-26.325, s=18.822, z=1.399

annular 30.09.-2172 13:14:17.6 0.9837/0.9917/0.9677 saros 9/23
1 min 41.83 sec 11:32:45.0 13:13:26.9 13:15:08.7 14:47:07.3
alt=64.086, lon=37.097, dlon=-31.870, s=18.689, z=1.705

annular 22.11.-2166 09:28:09.8 0.9921/0.9960/0.9842
0 min 42.80 sec 08:11:49.3 09:27:48.3 09:28:31.1 10:54:15.2
alt=38.065, lon=112.814, dlon=43.847, s=18.575, z=2.361

annular 10.09.-2162 13:53:31.4 0.9301/0.9650/0.8651 saros 0/45
7 min 10.21 sec 12:09:36.2 13:49:56.2 13:57:06.5 15:24:56.1
alt=61.389, lon=39.852, dlon=-29.114, s=18.499, z=1.574

total 29.06.-2158 16:02:27.7 1.0650/1.0324/1.1343 saros 2/40
4 min 6.34 sec 14:51:42.7 16:00:24.3 16:04:30.6 17:04:41.1
alt=32.186, lon=90.482, dlon=21.515, s=18.424, z=1.168

annular 23.12.-2158 16:54:46.4 0.9241/0.9620/0.8539 saros 7/25
6 min 0.28 sec 15:32:16.1 16:51:46.3 16:57:46.6 -
alt=5.273, lon=94.383, dlon=25.416, s=18.424, z=1.380

total 14.02.-2151 17:39:24.1 1.0153/1.0070/1.0308
0 min 51.47 sec 16:35:44.1 17:38:58.4 17:39:49.9 -
alt=1.670, lon=96.354, dlon=27.388, s=18.292, z=1.497

total 30.07.-2150 05:38:25.9 1.0365/1.0182/1.0743 saros 11/20
1 min 52.83 sec - 05:37:29.4 05:39:22.2 06:34:51.6
alt=4.247, lon=114.943, dlon=45.976, s=18.273, z=2.516

annular 29.05.-2147 12:57:52.9 0.9685/0.9839/0.9380 saros 3/38
3 min 36.91 sec 11:08:57.9 12:56:04.6 12:59:41.5 14:43:44.7
alt=72.826, lon=97.564, dlon=28.598, s=18.217, z=1.570

total 9.08.-2132 16:22:08.2 1.0423/1.0209/1.0863 saros 11/21
2 min 38.82 sec 15:12:23.1 16:20:48.7 16:23:27.5 17:23:45.4
alt=29.675, lon=109.330, dlon=40.364, s=17.936, z=2.250

annular 9.06.-2129 14:50:23.2 0.9617/0.9805/0.9248 saros 3/39
3 min 58.85 sec 13:02:15.7 14:48:23.9 14:52:22.8 16:21:05.3
alt=47.2960 lat=21.3700, lon=15.3756, dlon=-53.5911, s=17.880, z=2.997
at lat=22.23333:
partial 9.06.-2129 14:50:30.9 0.9549/0.9549/0.9207 saros 3/39
0 min 0.00 sec 13:03:09.2 - - 16:20:50.5

total 28.03.-2125 13:23:21.7 1.0755/1.0376/1.1567 saros 5/34
5 min 37.71 sec 12:03:26.3 13:20:32.7 13:26:10.4 14:39:12.1
alt=57.784, lon=45.904, dlon=-23.063, s=17.806, z=1.295

annular 24.12.-2112 07:35:13.1 0.9981/0.9990/0.9962
0 min 10.99 sec - 07:35:07.4 07:35:18.4 08:46:25.7
alt=11.014, lon=58.754, dlon=-10.213, s=17.565, z=0.581

annular 12.10.-2108 12:37:19.3 0.9203/0.9600/0.8470 saros 0/48
8 min 57.54 sec 10:50:14.8 12:32:50.7 12:41:48.2 14:20:54.8
alt=64.566, lon=36.254, dlon=-32.712, s=17.491, z=1.870

total 31.07.-2104 15:53:59.1 1.0527/1.0263/1.1083 saros 2/43
3 min 18.37 sec 14:44:22.6 15:52:19.9 15:55:38.2 16:55:53.9
alt=35.956, lon=97.531, dlon=28.565, s=17.417, z=1.640

annular 24.01.-2103 15:35:54.4 0.9432/0.9716/0.8897 saros 7/28
5 min 0.26 sec 14:03:22.5 15:33:24.4 15:38:24.7 16:53:52.4
alt=23.488, lon=81.691, dlon=12.724, s=17.399, z=0.731

total 19.03.-2097 13:09:12.6 1.0284/1.0142/1.0577
2 min 33.29 sec 11:32:56.8 13:07:56.1 13:10:29.4 14:38:37.7
alt=56.970, lon=56.092, dlon=-12.875, s=17.288, z=0.745

annular 19.06.-2092 06:39:06.2 0.9397/0.9697/0.8830 saros 13/26
4 min 22.02 sec 05:33:51.7 06:36:55.1 06:41:17.1 07:53:38.9
alt=19.445, lon=85.918, dlon=16.952, s=17.197, z=0.986

total 30.05.-2082 10:02:07.6 1.0001/1.0000/1.0003 saros 4/37
0 min 4.15 sec 08:32:25.5 10:02:05.3 10:02:09.5 11:45:57.8
alt=64.934, lon=114.385, dlon=45.419, s=17.014, z=2.669

annular 24.11.-2082 08:38:22.4 0.9574/0.9785/0.9165 saros 9/28
3 min 46.00 sec 07:20:00.2 08:36:29.3 08:40:15.3 10:10:49.8
alt=28.665, lon=74.327, dlon=5.360, s=17.014, z=0.315

total 11.09.-2078 12:30:36.7 1.0475/1.0237/1.0973 saros 11/24
4 min 6.37 sec 10:59:24.2 12:28:33.6 12:32:39.9 13:57:24.4
alt=77.100, lon=54.868, dlon=-14.098, s=16.941, z=0.832

total 29.04.-2071 13:40:19.9 1.0794/1.0393/1.1650 saros 5/37
6 min 1.84 sec 12:19:06.2 13:37:18.8 13:43:20.6 14:57:41.7
alt=61.114, lon=67.781, dlon=-1.185, s=16.814, z=0.070

annular 9.06.-2064 17:58:07.3 0.9881/0.9940/0.9764 saros 4/38
0 min 46.18 sec 16:53:59.6 17:57:44.4 17:58:30.6 -
alt=5.236, lon=91.139, dlon=22.172, s=16.688, z=1.329

total 2.09.-2050 15:04:57.4 1.0393/1.0195/1.0802 saros 2/46
2 min 40.43 sec 13:50:07.0 15:03:37.2 15:06:17.6 16:12:16.9
alt=46.054, lon=81.195, dlon=12.228, s=16.436, z=0.744

annular 26.02.-2049 14:53:59.4 0.9637/0.9818/0.9288 saros 7/31
3 min 15.51 sec 13:21:39.0 14:52:21.9 14:55:37.4 16:14:39.5
alt=36.680, lon=95.871, dlon=26.905, s=16.418, z=1.639

total 20.04.-2043 06:47:46.7 1.0121/1.0057/1.0244
0 min 42.79 sec - 06:47:25.2 06:48:08.0 07:55:41.6
alt=13.0447 lat=22.4352, lon=20.3220, dlon=-48.6447, s=16.310, z=2.982
at lat=22.23333:
total 20.04.-2043 06:47:29.5 1.0121/1.0017/1.0243
0 min 26.88 sec - 06:47:16.1 06:47:43.0 07:55:22.6

annular 1.07.-2028 05:08:07.1 0.9915/0.9938/0.9830 saros 4/40
0 min 28.39 sec - 05:07:52.9 05:08:21.3 06:06:31.7
alt=-0.0553 lat=22.7581, lon=96.6238, dlon=27.6572, s=16.043, z=1.724
at lat=22.23333:
partial 1.07.-2028 05:07:40.3 0.9812/0.9812/0.9722 saros 4/40
0 min 0.00 sec - - - 06:06:00.5

annular 1.08.-2020 06:55:17.2 0.9348/0.9673/0.8739 saros 13/30
5 min 6.42 sec 05:45:48.2 06:52:43.9 06:57:50.3 08:17:25.8
alt=20.599, lon=44.267, dlon=-24.699, s=15.902, z=1.553

total 27.02.-2003 13:45:52.0 1.0419/1.0209/1.0856
3 min 32.29 sec 12:13:56.5 13:44:05.9 13:47:38.2 15:08:47.0
alt=47.499, lon=91.743, dlon=22.776, s=15.602, z=1.460

total 1.06.-1998 07:36:58.6 1.0228/1.0112/1.0462 saros 15/32
1 min 26.79 sec 06:33:51.5 07:36:15.2 07:37:42.0 08:47:45.4
alt=31.622, lon=54.030, dlon=-14.937, s=15.515, z=0.963

total 4.10.-1996 13:48:04.5 1.0263/1.0128/1.0532 saros 2/49
2 min 1.36 sec 12:24:55.6 13:47:03.9 13:49:05.3 15:05:34.7
alt=56.137, lon=43.925, dlon=-25.041, s=15.480, z=1.618

annular 11.05.-1988 12:58:41.8 0.9655/0.9825/0.9321 saros 6/39
4 min 8.19 sec 11:03:09.6 12:56:37.9 13:00:46.1 14:46:48.4
alt=71.296, lon=26.015, dlon=-42.951, s=15.341, z=2.800

annular 11.05.-1988 17:24:40.8 0.9542/0.9768/0.9105 saros 6/39
3 min 21.56 sec 16:08:15.6 17:23:00.3 17:26:21.8 -
alt=10.800, lon=72.912, dlon=3.945, s=15.341, z=0.257

total 4.11.-1988 07:16:08.2 1.0313/1.0153/1.0636 saros 11/29
1 min 53.47 sec 06:16:16.7 07:15:11.5 07:17:05.0 08:23:00.2
alt=15.251, lon=59.113, dlon=-9.853, s=15.341, z=0.642

annular 10.04.-1977 15:08:31.3 0.9872/0.9933/0.9747 saros 7/35
1 min 8.59 sec 13:40:16.0 15:07:57.2 15:09:05.8 16:27:26.9
alt=40.353, lon=32.662, dlon=-36.305, s=15.150, z=2.396

annular 3.09.-1966 07:09:27.0 0.9306/0.9651/0.8661 saros 13/33
5 min 44.16 sec 05:56:36.9 07:06:35.0 07:12:19.2 08:36:21.7
alt=20.669, lon=76.028, dlon=7.061, s=14.960, z=0.472

annular 3.09.-1966 10:50:28.9 0.9391/0.9693/0.8820 saros 13/33
7 min 32.71 sec 08:59:41.8 10:46:42.6 10:54:15.3 12:49:58.9
alt=71.178, lon=113.079, dlon=44.112, s=14.960, z=2.949

annular 7.01.-1963 08:27:07.4 0.9145/0.9572/0.8364 saros 0/56
8 min 3.69 sec 07:05:37.0 08:23:06.1 08:31:09.8 10:07:08.1
alt=19.331, lon=110.957, dlon=41.991, s=14.909, z=2.816

total 10.04.-1958 08:39:27.1 1.0453/1.0223/1.0926 saros 17/27
3 min 8.06 sec 07:30:49.5 08:37:53.2 08:41:01.3 09:55:12.9
alt=36.103, lon=49.679, dlon=-19.287, s=14.823, z=1.301

total 1.04.-1949 06:36:18.5 1.0467/1.0231/1.0957
2 min 38.64 sec - 06:34:59.4 06:37:38.0 07:38:40.4
alt=5.6760 lat=22.2970, lon=28.8618, dlon=-40.1049, s=14.669, z=2.734
at lat=22.23333:
total 1.04.-1949 06:36:13.7 1.0467/1.0221/1.0957
2 min 38.37 sec - 06:34:54.8 06:37:33.1 07:38:35.2

annular 18.01.-1945 16:22:52.7 0.9162/0.9580/0.8394 saros 0/57
7 min 32.60 sec 14:47:32.3 16:19:06.1 16:26:38.7 -
alt=13.948, lon=66.498, dlon=-2.469, s=14.601, z=0.169

total 3.07.-1944 07:46:19.4 1.0074/1.0036/1.0148 saros 15/35
0 min 27.85 sec 06:39:26.0 07:46:05.3 07:46:33.2 09:03:24.9
alt=34.060, lon=93.392, dlon=24.425, s=14.584, z=1.675

total 14.08.-1937 08:56:37.5 1.0537/1.0265/1.1102 saros 14/35
4 min 5.39 sec 07:41:55.8 08:54:35.1 08:58:40.5 10:20:41.7
alt=46.9910 lat=22.1805, lon=81.4371, dlon=12.4704, s=14.465, z=0.862
at lat=22.23333:
total 14.08.-1937 08:56:36.9 1.0537/1.0254/1.1102 saros 14/35
4 min 5.00 sec 07:41:56.2 08:54:34.8 08:58:39.8 10:20:39.7

annular 13.06.-1934 06:38:12.4 0.9472/0.9734/0.8971 saros 6/42
3 min 54.38 sec 05:31:50.9 06:36:15.0 06:40:09.4 07:55:08.8
alt=19.051, lon=31.482, dlon=-37.485, s=14.415, z=2.600

annular 14.07.-1926 17:18:15.8 0.9979/0.9988/0.9959 saros 15/36
0 min 11.15 sec 16:09:13.8 17:18:10.5 17:18:21.6 18:18:56.0
alt=16.625, lon=79.001, dlon=10.034, s=14.280, z=0.703

total 28.11.-1906 11:03:48.7 1.0082/1.0038/1.0164 saros 2/54
0 min 39.51 sec 09:38:03.9 11:03:28.9 11:04:08.4 12:37:17.5
alt=47.689, lon=76.356, dlon=7.389, s=13.945, z=0.530

total 12.05.-1904 09:10:49.3 1.0603/1.0300/1.1242 saros 17/30
4 min 12.39 sec 08:01:32.1 09:08:43.3 09:12:55.7 10:27:31.8
alt=50.896, lon=84.469, dlon=15.503, s=13.911, z=1.114

annular 19.02.-1891 11:42:31.3 0.9348/0.9672/0.8738 saros 0/60
8 min 31.06 sec 09:43:41.7 11:38:15.7 11:46:46.7 13:43:55.0
alt=50.185, lon=50.060, dlon=-18.907, s=13.696, z=1.380

total 15.09.-1883 09:58:21.0 1.0500/1.0247/1.1026 saros 14/38
3 min 52.91 sec 08:40:25.8 09:56:24.7 10:00:17.6 11:21:06.7
alt=58.112, lon=74.754, dlon=5.787, s=13.564, z=0.427

total 3.05.-1876 12:03:26.0 1.0771/1.0384/1.1602 saros 8/40
6 min 33.09 sec 10:35:54.4 12:00:09.6 12:06:42.7 13:31:51.5
alt=77.688, lon=98.786, dlon=29.819, s=13.449, z=2.217

annular 15.08.-1872 12:25:12.7 0.9895/0.9946/0.9792 saros 15/39
1 min 13.57 sec 10:36:23.8 12:24:36.1 12:25:49.7 14:07:12.3
alt=83.681, lon=49.192, dlon=-19.774, s=13.383, z=1.478

annular 22.03.-1864 08:32:09.1 0.9371/0.9682/0.8782 saros 19/27
5 min 54.60 sec 07:08:45.2 08:29:11.8 08:35:06.4 10:08:44.8
alt=29.513, lon=99.051, dlon=30.084, s=13.253, z=2.270

annular 30.12.-1852 17:13:15.2 0.9936/0.9966/0.9873 saros 2/57
0 min 28.61 sec 16:02:24.1 17:13:01.1 17:13:29.7 -
alt=1.942, lon=103.116, dlon=34.150, s=13.058, z=2.615

total 17.10.-1848 15:22:36.1 1.0038/1.0014/1.0075 saros 4/50
0 min 12.71 sec 14:02:32.4 15:22:29.8 15:22:42.5 16:34:37.7
alt=32.593, lon=85.612, dlon=16.646, s=12.993, z=1.281

annular 13.04.-1847 16:19:10.5 0.9542/0.9767/0.9105 saros 9/41
3 min 48.80 sec 14:53:18.5 16:17:16.3 16:21:05.1 17:33:54.2
alt=24.791, lon=88.496, dlon=19.530, s=12.977, z=1.505

total 24.06.-1832 17:48:00.6 1.0534/1.0266/1.1097 saros 17/34
2 min 53.56 sec 16:48:15.6 17:46:33.8 17:49:27.3 -
alt=8.935, lon=88.748, dlon=19.781, s=12.736, z=1.553

total 10.02.-1825 17:29:59.1 1.0462/1.0228/1.0944 saros 11/38
2 min 29.41 sec 16:30:59.7 17:28:44.3 17:31:13.8 -
alt=3.4863 lat=22.0813, lon=58.7352, dlon=-10.2315, s=12.624, z=0.810
at lat=22.23333:
total 10.02.-1825 17:30:00.9 1.0461/1.0186/1.0944 saros 11/38
2 min 26.46 sec 16:31:02.1 17:28:47.5 17:31:13.9 -

total 5.06.-1822 06:32:58.5 1.0577/1.0286/1.1186 saros 8/43
3 min 12.33 sec 05:37:36.3 06:31:22.5 06:34:34.9 07:34:22.6
alt=17.434, lon=65.133, dlon=-3.834, s=12.576, z=0.305

annular 16.08.-1807 12:23:18.5 0.9488/0.9742/0.9002 saros 16/37
5 min 53.52 sec 10:29:51.4 12:20:21.7 12:26:15.2 14:06:43.7
alt=83.920, lon=81.649, dlon=12.682, s=12.339, z=1.028

total 1.02.-1797 13:47:31.8 1.0034/1.0016/1.0068 saros 2/60
0 min 14.59 sec 12:05:27.9 13:47:24.7 13:47:39.3 15:17:19.3
alt=41.422, lon=47.499, dlon=-21.468, s=12.181, z=1.762

total 9.11.-1793 07:27:10.3 1.0339/1.0167/1.0689 saros 14/43
2 min 0.34 sec 06:28:06.5 07:26:10.1 07:28:10.5 08:32:06.2
alt=16.887, lon=102.922, dlon=33.955, s=12.119, z=2.802

annular 4.05.-1792 09:54:23.6 0.9522/0.9760/0.9068 saros 19/31
4 min 45.69 sec 08:24:53.0 09:52:00.7 09:56:46.3 11:35:47.4
alt=59.301, lon=83.686, dlon=14.719, s=12.103, z=1.216

total 14.04.-1782 12:48:10.8 1.0048/1.0023/1.0096 saros 10/39
0 min 24.05 sec 11:06:21.6 12:47:59.0 12:48:23.0 14:25:45.8
alt=67.864, lon=86.079, dlon=17.112, s=11.947, z=1.432

total 14.03.-1771 17:21:38.9 1.0549/1.0271/1.1127 saros 11/41
3 min 2.01 sec 16:21:11.4 17:20:07.8 17:23:09.8 -
alt=8.715, lon=54.290, dlon=-14.676, s=11.776, z=1.246

total 20.12.-1767 10:38:32.4 1.0062/1.0029/1.0125 saros 23/22
0 min 31.36 sec 09:07:34.0 10:38:16.7 10:38:48.1 12:19:55.9
alt=40.665, lon=68.025, dlon=-0.942, s=11.715, z=0.080

total 20.12.-1767 13:39:39.8 1.0053/1.0023/1.0106 saros 23/22
0 min 24.97 sec 11:59:16.2 13:39:27.4 13:39:52.4 15:08:36.1
alt=38.593, lon=94.224, dlon=25.257, s=11.715, z=2.156

annular 8.10.-1763 17:53:50.2 0.9083/0.9492/0.8250 saros 25/16
6 min 35.51 sec 16:40:13.4 17:50:32.3 - -
alt=0.001, lon=79.457, dlon=10.490, s=11.653, z=0.900

annular 18.09.-1753 11:45:06.1 0.9462/0.9730/0.8954 saros 16/40
5 min 50.36 sec 10:01:34.8 11:42:11.0 11:48:01.3 13:26:38.4
alt=75.426, lon=93.976, dlon=25.009, s=11.499, z=2.175

annular 18.07.-1731 08:14:20.9 0.9893/0.9945/0.9787 saros 18/39
0 min 58.30 sec 06:57:15.2 08:13:51.6 08:14:49.9 09:46:16.7
alt=39.249, lon=60.036, dlon=-8.930, s=11.165, z=0.800

annular 18.07.-1731 12:31:43.2 0.9959/0.9976/0.9918 saros 18/39
0 min 31.31 sec 10:43:04.4 12:31:27.6 12:31:58.9 14:10:58.7
alt=81.701, lon=98.752, dlon=29.786, s=11.165, z=2.668

total 16.05.-1728 07:05:56.9 1.0103/1.0048/1.0206 saros 10/42
0 min 37.29 sec 06:03:14.0 07:05:38.1 07:06:15.4 08:17:07.8
alt=22.808, lon=72.523, dlon=3.556, s=11.120, z=0.320

annular 16.06.-1720 11:02:02.7 0.9585/0.9790/0.9188 saros 19/35
4 min 51.22 sec 09:18:31.5 10:59:37.2 11:04:28.4 12:59:40.9
alt=79.194, lon=67.884, dlon=-1.083, s=11.000, z=0.098

total 22.01.-1712 13:01:39.3 1.0225/1.0109/1.0455 saros 23/25
1 min 59.87 sec 11:25:13.7 13:00:39.4 13:02:39.2 14:29:44.4
alt=43.633, lon=62.153, dlon=-6.814, s=10.880, z=0.626

annular 10.11.-1709 16:44:29.3 0.9055/0.9525/0.8200 saros 25/19
8 min 6.73 sec 15:14:44.4 16:40:25.5 16:48:32.2 -
alt=9.648, lon=58.948, dlon=-10.019, s=10.835, z=0.925

annular 10.11.-1709 17:23:48.7 0.9033/0.9272/0.8160 saros 25/19
6 min 34.38 sec 16:02:46.1 17:20:31.3 17:27:05.7 -
alt=0.0320 lat=23.1068, lon=67.9202, dlon=-1.0465, s=10.835, z=0.097
at lat=22.23333:
annular 10.11.-1709 17:24:48.7 0.9033/0.9066/0.8160 saros 25/19
2 min 53.78 sec 16:03:58.9 17:23:22.1 17:26:15.9 -

total 29.08.-1705 17:16:23.0 1.0323/1.0158/1.0657 saros 27/17
1 min 49.76 sec 16:13:56.4 17:15:28.2 17:17:17.9 18:12:41.2
alt=15.911, lon=79.630, dlon=10.664, s=10.775, z=0.990

annular 20.10.-1699 10:22:27.2 0.9451/0.9725/0.8932 saros 16/43
5 min 31.65 sec 08:50:48.3 10:19:41.3 10:25:12.9 12:02:20.9
alt=54.880, lon=77.669, dlon=8.702, s=10.686, z=0.814

total 23.02.-1658 12:30:50.6 1.0422/1.0209/1.0863 saros 23/28
3 min 32.58 sec 11:02:07.6 12:29:04.4 12:32:37.0 13:55:19.5
alt=52.746, lon=48.147, dlon=-20.820, s=10.087, z=2.064

annular 22.11.-1645 08:35:23.9 0.9460/0.9729/0.8948 saros 16/46
4 min 35.18 sec 07:19:25.4 08:33:06.2 08:37:41.4 10:03:01.4
alt=28.146, lon=42.120, dlon=-26.847, s=9.900, z=2.712

total 18.05.-1644 10:53:37.3 1.0136/1.0067/1.0274 saros 21/36
1 min 10.01 sec 09:26:17.8 10:53:02.2 10:54:12.2 12:29:15.1
alt=75.203, lon=73.250, dlon=4.283, s=9.885, z=0.433

total 29.06.-1637 08:45:02.7 1.0701/1.0349/1.1451 saros 20/37
5 min 4.06 sec 07:34:16.9 08:42:31.1 08:47:35.2 10:06:19.4
alt=47.285, lon=42.100, dlon=-26.866, s=9.785, z=2.746

total 29.06.-1637 14:22:04.8 1.0714/1.0354/1.1479 saros 20/37
5 min 25.69 sec 12:57:02.4 14:19:21.4 14:24:47.1 15:36:32.8
alt=55.368, lon=94.411, dlon=25.444, s=9.785, z=2.600

annular 3.01.-1618 07:56:26.4 0.9117/0.9558/0.8313 saros 25/24
8 min 12.21 sec - 07:52:20.8 08:00:33.0 09:35:12.9
alt=13.834, lon=89.494, dlon=20.528, s=9.516, z=2.157

total 27.03.-1604 12:15:08.0 1.0606/1.0302/1.1249 saros 23/31
4 min 48.50 sec 10:52:21.9 12:12:43.8 12:17:32.3 13:36:55.5
alt=64.702, lon=54.956, dlon=-14.010, s=9.320, z=1.503

total 18.03.-1576 14:22:05.2 1.0610/1.0303/1.1257 saros 14/55
4 min 41.91 sec 12:57:32.7 14:19:44.1 14:24:26.0 15:38:11.9
alt=47.253, lon=65.165, dlon=-3.801, s=8.933, z=0.426

total 11.09.-1557 13:29:43.1 1.0123/1.0061/1.0248 saros 29/19
1 min 2.91 sec 11:53:57.5 13:29:11.8 13:30:14.7 14:56:03.9
alt=65.381, lon=65.991, dlon=-2.976, s=8.674, z=0.343

total 29.04.-1550 12:20:33.5 1.0736/1.0366/1.1527 saros 23/34
5 min 50.60 sec 10:58:23.6 12:17:38.2 12:23:28.8 13:43:25.6
alt=75.872, lon=77.090, dlon=8.123, s=8.579, z=0.947

total 2.09.-1529 14:00:08.2 1.0585/1.0292/1.1205 saros 20/43
4 min 13.61 sec 12:41:22.4 13:58:01.3 14:02:14.9 15:12:06.3
alt=60.3653 lat=22.4100, lon=93.8387, dlon=24.8721, s=8.299, z=2.997
at lat=22.23333:
total 2.09.-1529 14:00:29.0 1.0585/1.0258/1.1205 saros 20/43
4 min 11.69 sec 12:41:42.6 13:58:22.9 14:02:34.6 15:12:26.0

annular 25.11.-1515 08:58:38.0 0.9292/0.9646/0.8635 saros 18/51
6 min 32.07 sec 07:36:57.5 08:55:22.0 09:01:54.0 10:34:09.0
alt=31.523, lon=80.829, dlon=11.862, s=8.114, z=1.462

annular 26.12.-1507 16:31:56.1 0.9927/0.9962/0.9854 saros 27/28
0 min 34.02 sec 15:17:25.4 16:31:39.3 16:32:13.3 -
alt=10.069, lon=72.687, dlon=3.720, s=8.009, z=0.465

annular 19.03.-1492 13:12:51.0 0.9466/0.9733/0.8961 saros 25/31
5 min 41.44 sec 11:28:02.0 13:10:00.5 13:15:41.9 14:50:15.8
alt=58.253, lon=83.678, dlon=14.712, s=7.814, z=1.883

annular 27.02.-1482 14:30:00.6 0.9959/0.9978/0.9918 saros 16/55
0 min 26.66 sec 12:53:35.8 14:29:47.4 14:30:14.1 15:53:47.9
alt=41.983, lon=71.352, dlon=2.385, s=7.685, z=0.310

total 4.10.-1475 12:48:14.7 1.0501/1.0249/1.1028 saros 20/46
3 min 53.16 sec 11:26:37.5 12:46:18.2 12:50:11.3 14:07:10.6
alt=64.762, lon=56.925, dlon=-12.041, s=7.595, z=1.585

total 4.11.-1467 08:09:39.2 1.0087/1.0041/1.0175 saros 29/24
0 min 34.15 sec 07:01:13.2 08:09:22.0 08:09:56.2 09:27:40.8
alt=26.432, lon=89.423, dlon=20.456, s=7.493, z=2.730

annular 23.08.-1463 14:40:10.4 0.9302/0.9650/0.8652 saros 31/20
7 min 18.40 sec 12:49:55.5 14:36:31.0 14:43:49.4 16:10:50.1
alt=52.272, lon=85.544, dlon=16.577, s=7.443, z=2.227

annular 28.12.-1461 07:10:44.6 0.9209/0.9604/0.8480 saros 18/54
6 min 5.57 sec - 07:07:41.9 07:13:47.4 08:30:20.4
alt=5.380, lon=49.205, dlon=-19.762, s=7.417, z=2.664

annular 13.08.-1435 16:28:19.6 0.9581/0.9788/0.9180 saros 22/42
3 min 6.33 sec 15:11:57.8 16:26:46.7 16:29:53.0 17:35:23.8
alt=28.007, lon=48.651, dlon=-20.316, s=7.092, z=2.865

total 3.07.-1423 06:37:16.1 1.0458/1.0228/1.0938 saros 33/32
2 min 34.25 sec 05:41:32.2 06:35:59.0 06:38:33.2 07:39:08.5
alt=18.333, lon=54.518, dlon=-14.449, s=6.943, z=2.081

annular 1.05.-1420 14:05:50.8 0.9611/0.9802/0.9238 saros 25/35
4 min 6.31 sec 12:21:11.0 14:03:47.8 14:07:54.1 15:41:15.6
alt=56.554, lon=53.265, dlon=-15.702, s=6.906, z=2.274

annular 25.09.-1409 10:21:42.1 0.9221/0.9609/0.8503 saros 31/23
9 min 26.90 sec 08:35:03.1 10:16:58.9 10:26:25.8 12:21:19.1
alt=60.839, lon=72.245, dlon=3.279, s=6.772, z=0.484

total 14.07.-1405 18:02:15.9 1.0385/1.0190/1.0784 saros 33/33
2 min 2.26 sec 17:04:02.3 18:01:14.8 18:03:17.1 -
alt=7.436, lon=64.280, dlon=-4.686, s=6.723, z=0.697

total 28.11.-1385 10:01:50.5 1.0366/1.0182/1.0746 saros 20/51
2 min 47.17 sec 08:46:47.7 10:00:26.9 10:03:14.1 11:25:21.2
alt=40.651, lon=81.172, dlon=12.205, s=6.483, z=1.883

annular 15.09.-1381 15:43:19.5 0.9591/0.9792/0.9199 saros 22/45
3 min 17.96 sec 14:20:46.3 15:41:40.7 15:44:58.7 16:56:17.2
alt=34.378, lon=55.104, dlon=-13.862, s=6.435, z=2.154

total 5.08.-1369 06:28:56.1 1.0280/1.0139/1.0568 saros 33/35
1 min 37.05 sec 05:31:36.8 06:28:07.6 06:29:44.6 07:33:13.8
alt=13.870, lon=68.219, dlon=-0.748, s=6.293, z=0.119

total 15.09.-1362 08:23:37.5 1.0183/1.0088/1.0370 saros 32/34
1 min 19.01 sec 07:11:49.2 08:22:58.0 08:24:17.0 09:43:49.5
alt=36.455, lon=73.075, dlon=4.108, s=6.210, z=0.662

annular 15.07.-1359 17:10:01.0 0.9673/0.9835/0.9356 saros 24/44
2 min 15.21 sec 15:59:08.9 17:08:53.6 17:11:08.8 18:12:23.4
alt=18.842, lon=51.722, dlon=-17.245, s=6.175, z=2.793

annular 2.04.-1344 13:57:08.8 0.9994/0.9995/0.9988 saros 27/37
0 min -0.05 sec 12:25:26.4 13:57:05.4 13:57:05.3 15:22:04.1
alt=55.029, lon=52.860, dlon=-16.107, s=6.001, z=2.684

total 14.05.-1337 17:55:19.1 1.0635/1.0316/1.1311 saros 26/38
3 min 20.86 sec 16:57:15.2 17:53:38.5 17:56:59.4 -
alt=4.648, lon=75.578, dlon=6.611, s=5.920, z=1.117

total 6.09.-1315 06:23:56.5 1.0084/1.0040/1.0169 saros 33/38
0 min 28.02 sec - 06:23:42.4 06:24:10.5 07:29:54.7
alt=9.590, lon=66.960, dlon=-2.007, s=5.669, z=0.354

annular 13.04.-1307 06:49:58.7 0.9422/0.9707/0.8877 saros 37/28
4 min 17.38 sec - 06:47:49.9 06:52:07.3 08:05:55.6
alt=12.874, lon=60.373, dlon=-8.594, s=5.579, z=1.540

total 10.02.-1304 16:21:44.1 1.0398/1.0197/1.0812 saros 29/33
2 min 26.51 sec 15:14:11.9 16:20:30.8 16:22:57.3 17:22:33.5
alt=18.137, lon=71.686, dlon=2.719, s=5.546, z=0.490

total 1.02.-1276 15:02:55.2 1.0380/1.0190/1.0775 saros 20/57
2 min 51.87 sec 13:38:45.9 15:01:29.3 15:04:21.2 16:16:14.8
alt=31.354, lon=55.867, dlon=-13.099, s=5.236, z=2.502

total 27.07.-1257 13:52:19.6 1.0340/1.0169/1.0692 saros 35/35
2 min 56.99 sec 12:16:22.1 13:50:51.0 13:53:48.0 15:16:26.0
alt=63.980, lon=61.220, dlon=-7.747, s=5.031, z=1.540

total 14.03.-1250 15:47:21.6 1.0578/1.0286/1.1189 saros 29/36
3 min 42.98 sec 14:36:52.1 15:45:29.9 15:49:12.9 16:51:28.1
alt=29.959, lon=61.644, dlon=-7.323, s=4.956, z=1.478

total 4.03.-1249 06:33:56.1 1.0426/1.0199/1.0870 saros 39/27
2 min 24.75 sec - 06:32:43.9 06:35:08.7 07:36:23.4
alt=0.0252 lat=21.4459, lon=71.1418, dlon=2.1751, s=4.945, z=0.440
at lat=22.23333:
total 4.03.-1249 06:34:59.7 1.0426/1.0049/1.0870 saros 39/27
1 min 29.63 sec - 06:34:15.1 06:35:44.7 07:37:33.1

annular 26.05.-1235 08:27:45.9 0.9475/0.9736/0.8977 saros 37/32
4 min 37.13 sec 07:09:32.9 08:25:27.2 08:30:04.4 09:59:29.0
alt=42.851, lon=56.601, dlon=-12.365, s=4.797, z=2.578

annular 12.01.-1182 11:05:29.8 0.9910/0.9951/0.9820 saros 22/56
1 min 1.71 sec 09:28:20.7 11:04:58.9 11:06:00.6 12:52:40.6
alt=42.4694 lat=21.5124, lon=56.2234, dlon=-12.7432, s=4.252, z=2.997
at lat=22.23333:
partial 12.01.-1182 11:05:35.1 0.9788/0.9788/0.9690 saros 22/56
0 min 0.00 sec 09:28:37.5 - - 12:52:27.9

annular 12.01.-1182 13:39:05.8 0.9899/0.9947/0.9799 saros 22/56
1 min 6.64 sec 11:53:17.7 13:38:32.7 13:39:39.3 15:12:56.7
alt=39.713, lon=77.947, dlon=8.980, s=4.252, z=2.112

total 19.08.-1156 11:39:16.0 1.0240/1.0117/1.0486 saros 36/40
2 min 8.44 sec 10:05:46.4 11:38:11.9 11:40:20.3 13:10:20.3
alt=82.220, lon=61.708, dlon=-7.258, s=3.995, z=1.817

total 28.06.-1116 11:19:03.6 1.0444/1.0219/1.0909 saros 38/35
4 min 13.83 sec 09:43:46.1 11:16:56.7 11:21:10.5 12:57:54.0
alt=81.9198 lat=21.9647, lon=75.0601, dlon=6.0934, s=3.612, z=1.687
at lat=22.23333:
total 28.06.-1116 11:19:03.4 1.0444/1.0137/1.0909 saros 38/35
3 min 53.07 sec 09:43:55.9 11:17:06.9 11:21:00.0 12:57:42.5

total 20.06.-1069 10:25:34.0 1.0460/1.0227/1.0940 saros 39/37
3 min 55.90 sec 09:02:04.7 10:23:36.3 10:27:32.2 11:59:29.5
alt=70.148, lon=70.874, dlon=1.907, s=3.182, z=0.599

total 29.04.-1029 11:10:03.7 1.0367/1.0183/1.0747 saros 41/32
3 min 3.70 sec 09:46:21.4 11:08:31.7 11:11:35.4 12:39:15.1
alt=74.297, lon=66.405, dlon=-2.561, s=2.834, z=0.904

total 20.04.-1001 10:09:05.0 1.0778/1.0388/1.1617 saros 32/54
5 min 59.61 sec 08:52:19.6 10:06:05.6 10:12:05.2 11:33:27.4
alt=59.952, lon=66.751, dlon=-2.215, s=2.600, z=0.852

total 26.12.-986 15:43:46.0 1.0295/1.0146/1.0598 saros 45/26
2 min 0.35 sec 14:27:17.6 15:42:45.8 15:44:46.2 16:50:27.6
alt=19.374, lon=72.194, dlon=3.227, s=2.478, z=1.302

annular 12.08.-960 17:30:45.9 0.9499/0.9746/0.9023 saros 49/17
3 min 28.23 sec 16:19:27.8 17:29:01.9 17:32:30.2 18:33:26.7
alt=13.732, lon=71.246, dlon=2.279, s=2.272, z=1.003

annular 4.11.-946 08:57:52.6 0.9677/0.9837/0.9363 saros 47/21
2 min 56.12 sec 07:37:17.3 08:56:24.4 08:59:20.5 10:32:03.4
alt=35.541, lon=73.086, dlon=4.120, s=2.164, z=1.904

total 4.07.-856 15:37:55.8 1.0242/1.0120/1.0490 saros 42/41
1 min 41.84 sec 14:18:20.5 15:37:04.9 15:38:46.8 16:46:38.2
alt=39.216, lon=70.690, dlon=1.724, s=1.519, z=1.135

total 4.08.-848 05:27:33.7 1.0512/1.0102/1.1051 saros 51/32
2 min 1.54 sec - 05:26:33.1 05:28:34.7 06:22:06.7
alt=-0.0476 lat=23.1360, lon=70.9336, dlon=1.9669, s=1.466, z=1.341
at lat=22.23333:
partial 4.08.-848 05:26:58.1 0.9847/0.9847/0.9882 saros 51/32
0 min 0.00 sec - - - 06:21:24.8

annular 5.05.-750 05:58:35.3 0.9684/0.9839/0.9378 saros 55/29
2 min 0.07 sec - 05:57:35.0 05:59:35.1 07:02:36.1
alt=6.2875 lat=22.3184, lon=66.6821, dlon=-2.2845, s=0.877, z=2.604
at lat=22.23333:
annular 5.05.-750 05:58:27.5 0.9684/0.9830/0.9378 saros 55/29
1 min 59.79 sec - 05:57:27.5 05:59:27.3 07:02:27.4

total 8.10.-740 07:14:14.5 1.0311/1.0152/1.0633 saros 51/38
1 min 55.15 sec 06:13:13.9 07:13:17.0 07:15:12.1 08:22:34.8
alt=17.855, lon=68.877, dlon=-0.090, s=0.824, z=0.109

annular 18.09.-711 05:54:54.7 0.9225/0.9610/0.8510 saros 52/38
5 min 33.01 sec - 05:52:08.1 05:57:41.1 07:07:43.2
alt=1.5922 lat=23.1694, lon=67.0927, dlon=-1.8740, s=0.675, z=2.775
at lat=22.23333:
annular 18.09.-711 05:55:02.8 0.9225/0.9337/0.8509 saros 52/38
3 min 57.07 sec - 05:53:04.1 05:57:01.2 07:07:58.6

annular 27.06.-660 18:37:16.0 0.9524/0.9728/0.9071 saros 55/34
2 min 56.80 sec 17:33:29.8 18:35:47.7 18:38:44.5 -
alt=-0.0555 lat=22.6567, lon=67.6793, dlon=-1.2874, s=0.442, z=2.914
at lat=22.23333:
annular 27.06.-660 18:37:36.2 0.9524/0.9626/0.9070 saros 55/34
2 min 27.86 sec 17:33:53.6 18:36:22.4 18:38:50.2 -

total 22.05.-426 05:58:07.4 1.0557/1.0275/1.1144 saros 50/44
2 min 53.55 sec - 05:56:40.8 05:59:34.3 06:55:05.5
alt=8.9077 lat=23.2178, lon=68.5788, dlon=-0.3879, s=0.137, z=2.838
at lat=22.23333:
total 22.05.-426 05:57:02.5 1.0555/1.0040/1.1141 saros 50/44
1 min 25.16 sec - 05:56:20.1 05:57:45.3 06:53:52.5

annular 7.08.-197 05:33:03.6 0.9393/0.9587/0.8823 saros 71/28
3 min 44.30 sec - 05:31:11.5 05:34:55.8 06:40:26.0
alt=-0.0425 lat=22.5385, lon=69.4904, dlon=0.5237, s=1.182, z=0.443
at lat=22.23333:
annular 7.08.-197 05:32:50.9 0.9393/0.9508/0.8822 saros 71/28
3 min 9.59 sec - 05:31:16.1 05:34:25.7 06:40:11.1

annular 17.05.-165 13:06:15.7 0.9575/0.9784/0.9168 saros 64/38
5 min 15.70 sec 11:05:36.0 13:03:37.9 13:08:53.6 14:56:14.9
alt=72.0534 lat=23.0141, lon=64.8282, dlon=-4.1384, s=1.382, z=2.995
at lat=22.23333:
partial 17.05.-165 13:05:59.4 0.9548/0.9548/0.9158 saros 64/38
0 min 0.00 sec 11:04:35.5 - - 14:56:32.8

annular 17.05.-165 14:04:06.0 0.9561/0.9777/0.9142 saros 64/38
5 min 1.29 sec 12:06:15.5 14:01:35.3 14:06:36.6 15:43:37.8
alt=58.8394 lat=23.2015, lon=73.0937, dlon=4.1270, s=1.382, z=2.987
at lat=22.23333:
partial 17.05.-165 14:04:20.1 0.9484/0.9484/0.9095 saros 64/38
0 min 0.00 sec 12:05:36.2 - - 15:44:14.4

total 19.08.-114 07:53:54.1 1.0579/1.0286/1.1191 saros 72/35
3 min 52.21 sec 06:47:57.0 07:51:58.3 07:55:50.5 09:08:00.0
alt=30.9355 lat=21.5772, lon=70.7424, dlon=1.7758, s=1.724, z=1.030
at lat=22.23333:
total 19.08.-114 07:53:45.4 1.0579/1.0073/1.1191 saros 72/35
2 min 31.15 sec 06:47:56.4 07:52:30.1 07:55:01.3 09:07:37.5

annular 18.06.-111 05:57:19.6 0.9408/0.9702/0.8850 saros 64/41
4 min 5.81 sec - 05:55:16.5 05:59:22.3 07:08:34.3
alt=9.3713 lat=22.7852, lon=63.7374, dlon=-5.2293, s=1.745, z=2.996
at lat=22.23333:
annular 18.06.-111 05:56:45.5 0.9407/0.9576/0.8849 saros 64/41
3 min 42.65 sec - 05:54:54.2 05:58:36.8 07:07:54.9

total 18.05.-081 07:39:38.6 1.0621/1.0309/1.1281 saros 75/30
3 min 42.22 sec 06:40:16.0 07:37:47.6 07:41:29.9 08:45:31.8
alt=31.170, lon=63.983, dlon=-4.983, s=1.961, z=2.541

annular 25.02.-068 07:17:16.3 0.9268/0.9631/0.8589 saros 58/59
6 min 0.76 sec - 07:14:16.0 07:20:16.8 08:43:13.5
alt=9.976, lon=64.464, dlon=-4.502, s=2.058, z=2.188

total 20.09.-060 08:59:42.6 1.0535/1.0264/1.1098 saros 72/38
3 min 45.94 sec 07:49:29.4 08:57:49.9 09:01:35.8 10:16:13.3
alt=43.157, lon=74.106, dlon=5.139, s=2.118, z=2.426

annular 21.08.-049 11:00:25.7 0.9807/0.9901/0.9617 saros 73/37
2 min 12.87 sec 09:17:03.3 10:59:19.1 11:01:32.0 12:49:18.7
alt=73.050, lon=68.289, dlon=-0.678, s=2.202, z=0.308

total 1.11.-034 14:03:49.3 1.0028/1.0010/1.0056 saros 81/17
0 min 9.96 sec 12:27:14.5 14:03:44.4 14:03:54.4 15:29:26.0
alt=40.560, lon=69.425, dlon=0.458, s=2.319, z=0.197

annular 11.08.-021 18:10:40.3 0.9266/0.9630/0.8587 saros 64/46
4 min 49.82 sec 17:04:18.2 18:08:15.5 18:13:05.3 -
alt=4.2776 lat=21.9189, lon=61.9535, dlon=-7.0132, s=2.422, z=2.896
at lat=22.23333:
annular 11.08.-021 18:10:12.8 0.9267/0.9576/0.8588 saros 64/46
4 min 46.46 sec 17:03:46.3 18:07:49.6 18:12:36.0 -

total 30.06.-009 17:00:34.0 1.0642/1.0320/1.1325 saros 75/34
3 min 43.40 sec 15:55:58.6 16:58:42.1 17:02:25.5 17:58:06.3
alt=21.266, lon=75.281, dlon=6.314, s=2.518, z=2.508

# M: Two Eclipses in a Month in the New Moon Calendar

The Mahābhārata mentions that the war was announced by two eclipses within one month. Since it is clear from the context that the lunar eclipse took place *before* the solar eclipse, if follows that a new moon calendar was used and that there was a lunar eclipse in the middle of the month and a solar eclipse at the end of the month. The following list contains all double eclipses of this type that occurred between 3500 BCE and 1 BCE and were potentially observable from Kurukṣetra. The events are marked by a + in order to distinguish them from the events listed in Appendix N.

Attention: *Here, the lunar eclipse precedes the solar eclipse.* In appendix N, it is the other way round.

The abbreviation *su* is followed by information on the solar eclipse: date (Julian with astronomical counting of years), ecliptic longitude and lunar mansion in the Lahiri zodiac as well as the magnitude of the eclipse in %. The abbreviation *mo* is followed by the same information for the lunar eclipse. The value *dt* is the number of days between the end of the partial phase of the lunar eclipse and the beginning of the solar eclipse. Eclipses are considered valid if the entire disc of the Moon or the Sun is above the horizon. However, it must be kept in mind that the full moon is usually not visible when she touches the horizon. This problem in particular concerns double eclipses that are marked with an * (explained below).

An *x* at the beginning of a line indicates that the eclipses occurred approximately in the sky area which is demanded by epic. The solar eclipse should be near Jyeṣṭhā, the lunar eclipse in Kṛttikā or Rohiṇī, so that they can be assigned to the month of Kārttika. The calculations are based on the Lahiri *ayanāṃśa*. Unfortunately, it is unknown what definition of the lunar mansions underlies the information given in the Mahābhārata.

An * after the + indicates that the solar eclipse may have been, as requested by the epic, dated to the 13th of the half-month. Since there are at least 13.8 days between a lunar and a solar eclipse, a solar eclipse on the 13th could have only come about as follows: A lunar eclipse occurred at sunrise, the Vedic start of the day and the moment at which the date changes. Let us suppose it would have been January 1. As the eclipse had not ended by the beginning of the day, 1st January may have been considered the eclipse day. Hence, day number 1 in the Vedic day count might have been 2nd January. The solar eclipse occurred 14 days after the lunar eclipse, also at sunrise, on January 15. Since it had started before sunrise, it may have been dated to the previous day and thus would have fallen on the 13th day. Note, however, that this explanation is speculative.

The uncertainty of ΔT for the remote past affects especially eclipses before 1000 BCE. For the more remote past, there are more double eclipses with a smaller observation probability, whereas for the more recent past there are less double eclipses with a higher observation probability. The estimated standard error in ΔT is given in the list as the value *s* (sigma), however not as a difference in time, but as a shift in geographic longitude. The value *l* specifies at what geographic longitudes the eclipse was visible, under the condition that the error of ΔT is assumed as 0. Finally, the value *z* provides the deviation in longitude from Kurukṣetra in units of *s*. Eclipses, where | z |> 3, have an estimated probability less than 0.3% and are not included in this list.

\+ su 7.2.-3499 343.66 UBh 44%-46%; mo 24.1.-3499 149.92 UPh 2%-8%;
dt=13.92 s=51.5 l=159-161 z=1.6
+* su 7.2.-3499 343.66 UBh 1%-56%; mo 24.1.-3499 149.92 UPh 11%-29%;
dt=13.91 s=51.5 l=133-158 z=1.1-1.6
\+ su 27.1.-3498 333.23 PBh 1%-34%; mo 12.1.-3498 138.75 PPh 157%;
dt=14.49 s=51.5 l=-77--4 z=-3.0--1.6
\+ su 26.11.-3496 270.95 UAs 5%-74%; mo 11.11.-3496 75.75 Ard 2%-35%;
dt=14.94 s=51.5 l=139-152 z=1.2-1.5
\+ su 15.11.-3495 259.43 PAs 1%-9%; mo 1.11.-3495 64.82 Mrg 7%-154%;
dt=14.24 s=51.4 l=108-137 z=0.6-1.2
\+ su 3.9.-3491 185.40 Cit 0%-17%; mo 19.8.-3491 349.82 Rev 124%;
dt=15.57 s=51.3 l=25-55 z=-1.0--0.4
\+ su 2.7.-3488 123.17 Mag 4%-70%; mo 18.6.-3488 289.82 Sra 2%-38%;
dt=13.91 s=51.2 l=106-141 z=0.6-1.3
\+ su 22.6.-3487 112.77 Asl 1%-14%; mo 8.6.-3487 279.20 UAs 174%;
dt=13.99 s=51.2 l=158-172 z=1.6-1.9
+* su 22.6.-3487 112.77 Asl 3%-20%; mo 8.6.-3487 279.20 UAs 174%;
dt=13.99 s=51.2 l=141-157 z=1.3-1.6
\+ su 21.4.-3484 54.26 Mrg 1%-80%; mo 5.4.-3484 219.70 Anu 107%;
dt=15.21 s=51.1 l=-4-83 z=-1.6-0.1
\+ su 18.2.-3481 354.10 Rev 28%-32%; mo 4.2.-3481 160.45 Has 1%-19%;
dt=13.95 s=51.0 l=38-47 z=-0.7--0.6

+* su 18.2.-3481 354.10 Rev 5%-39%; mo 4.2.-3481 160.45 Has 19%-20%;
dt=13.94 s=51.0 l=16-37 z=-1.2--0.8
+ su 8.2.-3480 343.74 UBh 1%-43%; mo 24.1.-3480 149.34 UPh 21%-150%;
dt=14.52 s=51.0 l=148-228 z=1.4-3.0
+ su 7.12.-3478 281.84 Sra 3%-85%; mo 22.11.-3478 86.73 Pun 3%-35%;
dt=14.89 s=50.9 l=1-29 z=-1.5--0.9
+ su 26.11.-3477 270.37 UAs 0%-11%; mo 12.11.-3477 75.82 Ard 4%-154%;
dt=14.20 s=50.9 l=-26-5 z=-2.0--1.4
+ su 1.4.-3474 34.62 Krt 1%-9%; mo 18.3.-3474 200.80 Vis 7%;
dt=14.61 s=50.8 l=159-182 z=1.6-2.1
+ su 14.9.-3473 196.23 Sva 1%-15%; mo 30.8.-3473 0.55 Asv 120%;
dt=15.55 s=50.8 l=-75--71 z=-3.0--2.9
+ su 13.7.-3470 133.56 PPh 1%-94%; mo 29.6.-3470 300.13 Dha 1%-26%;
dt=13.91 s=50.7 l=0-33 z=-1.5--0.8
+ su 3.7.-3469 123.10 Mag 0%-17%; mo 19.6.-3469 289.43 Sra 160%;
dt=14.02 s=50.6 l=43-59 z=-0.6--0.3
+* su 3.7.-3469 123.10 Mag 2%-24%; mo 19.6.-3469 289.43 Sra 160%;
dt=14.03 s=50.6 l=25-42 z=-1.0--0.7
+ su 2.5.-3466 64.38 Mrg 1%-87%; mo 17.4.-3466 229.88 Jye 94%;
dt=15.17 s=50.5 l=-74--15 z=-3.0--1.8
+ su 28.2.-3463 4.47 Asv 15%; mo 14.2.-3463 170.89 Has -0%-10%;
dt=13.99 s=50.5 l=-74--66 z=-3.0--2.8
+ su 25.8.-3463 175.58 Cit 1%-3%; mo 10.8.-3463 340.61 UBh 2%-8%;
dt=15.02 s=50.5 l=122-125 z=0.9-1.0
+ su 18.2.-3462 354.20 Rev 2%-54%; mo 3.2.-3462 159.86 UPh 4%-141%;
dt=14.55 s=50.4 l=39-108 z=-0.7-0.6
+ su 18.12.-3460 292.68 Sra 68%-70%; mo 3.12.-3460 97.67 Pus 1%-12%;
dt=14.82 s=50.4 l=224-227 z=2.9-3.0
+ su 7.12.-3459 281.26 Sra 1%-14%; mo 23.11.-3459 86.79 Pun 58%-154%;
dt=14.14 s=50.3 l=202-226 z=2.5-3.0
+ su 25.9.-3455 207.11 Vis 0%-28%; mo 10.9.-3455 11.35 Asv 118%;
dt=15.57 s=50.2 l=108-159 z=0.6-1.6
+ su 13.7.-3451 133.51 PPh 1%-16%; mo 29.6.-3451 299.72 Dha 146%;
dt=14.06 s=50.1 l=-73--59 z=-3.0--2.7
+ su 13.5.-3448 74.51 Ard 4%-98%; mo 27.4.-3448 240.04 Mul 80%;
dt=15.16 s=50.0 l=149-226 z=1.5-3.0
+ su 5.9.-3445 186.32 Cit 0%-8%; mo 21.8.-3445 351.29 Rev 1%-7%;
dt=15.00 s=49.9 l=-11--1 z=-1.8--1.6
+ su 29.2.-3444 4.57 Asv 2%-66%; mo 14.2.-3444 170.29 Has 0%-131%;
dt=14.59 s=49.9 l=-65--12 z=-2.9--1.8
+ su 29.12.-3442 303.45 Dha 2%-95%; mo 14.12.-3442 108.57 Asl 2%-33%;
dt=14.74 s=49.8 l=90-150 z=0.3-1.5
+ su 18.12.-3441 292.10 Sra 1%-18%; mo 4.12.-3441 97.73 Pus 6%-154%;
dt=14.09 s=49.8 l=70-103 z=-0.1-0.5
x+ su 6.10.-3437 218.04 Anu 1%-30%; mo 20.9.-3437 22.21 Bha 117%;
dt=15.56 s=49.7 l=-30-28 z=-2.2--1.0
+ su 4.8.-3434 154.56 UPh 5%-64%; mo 21.7.-3434 320.94 PBh 1%-4%;
dt=13.95 s=49.6 l=147-164 z=1.4-1.8
+ su 25.7.-3433 143.98 PPh 0%-22%; mo 10.7.-3433 310.07 Sat 134%;
dt=14.11 s=49.6 l=151-180 z=1.5-2.1
+ su 24.5.-3430 84.65 Pun 0%-98%; mo 8.5.-3430 250.20 Mul 55%-67%;
dt=15.13 s=49.5 l=47-152 z=-0.6-1.5

+ su 12.3.-3426 14.90 Bha 13%-64%; mo 25.2.-3426 180.67 Cit 2%-119%;
dt=14.65 s=49.3 l=194-224 z=2.4-3.0
+ su 8.1.-3423 314.15 Sat 6%-96%; mo 24.12.-3424 119.41 Asl 1%-31%;
dt=14.67 s=49.3 l=-42-34 z=-2.4--0.9
+ su 28.12.-3423 302.88 Dha 0%-23%; mo 14.12.-3423 108.61 Asl 3%-152%;
dt=14.05 s=49.3 l=-62--25 z=-2.8--2.1
x+ su 17.10.-3419 229.01 Jye 1%-25%; mo 1.10.-3419 33.13 Krt 116%;
dt=15.54 s=49.1 l=192-223 z=2.4-3.0
+ su 4.8.-3415 154.53 UPh 1%-16%; mo 20.7.-3415 320.49 PBh 123%;
dt=14.15 s=49.0 l=32-55 z=-0.9--0.4
+ su 3.6.-3412 94.82 Pus 4%-97%; mo 18.5.-3412 260.38 PAs 1%-53%;
dt=15.10 s=48.9 l=-55-47 z=-2.7--0.6
+ su 22.3.-3408 25.16 Bha 1%-40%; mo 7.3.-3408 190.97 Sva 0%-95%;
dt=14.71 s=48.8 l=95-114 z=0.4-0.8
+ su 20.1.-3405 324.78 PBh 44%-54%; mo 5.1.-3405 130.18 Mag 0%-28%;
dt=14.61 s=48.7 l=189-222 z=2.3-3.0
+ su 9.1.-3404 313.60 Sat 0%-30%; mo 26.12.-3405 119.45 Asl 3%-150%;
dt=14.01 s=48.7 l=167-208 z=1.9-2.7
x+ su 28.10.-3401 239.99 Jye 1%-29%; mo 12.10.-3401 44.09 Roh 117%;
dt=15.53 s=48.6 l=54-122 z=-0.5-0.9
+ su 15.6.-3394 105.03 Pus 1%-59%; mo 31.5.-3394 270.57 UAs 40%;
dt=15.07 s=48.4 l=203-221 z=2.6-3.0
+ su 4.6.-3393 94.29 Pus 2%-10%; mo 20.5.-3393 260.46 PAs 92%-176%;
dt=14.37 s=48.4 l=199-221 z=2.5-3.0
+ su 2.4.-3390 35.38 Krt 0%-4%; mo 18.3.-3390 201.22 Vis 2%-13%;
dt=14.80 s=48.3 l=-2-0 z=-1.7--1.6
+ su 30.1.-3387 335.32 UBh 4%-96%; mo 15.1.-3387 140.88 PPh 2%-23%;
dt=14.56 s=48.2 l=64-173 z=-0.3-2.0
+ su 19.1.-3386 324.24 PBh 16%-37%; mo 5.1.-3386 130.21 Mag 2%-146%;
dt=13.95 s=48.2 l=51-83 z=-0.5-0.1
+* su 19.1.-3386 324.24 PBh 0%-15%; mo 5.1.-3386 130.21 Mag 146%;
dt=13.96 s=48.2 l=38-50 z=-0.8--0.5
+ su 7.11.-3383 250.97 Mul 3%-28%; mo 22.10.-3383 55.07 Mrg 117%;
dt=15.50 s=48.1 l=-67--12 z=-3.0--1.9
+ su 25.8.-3379 175.87 Cit 32%-34%; mo 11.8.-3379 341.55 UBh 6%-17%;
dt=14.36 s=47.9 l=-66--64 z=-3.0
+ su 25.6.-3376 115.29 Asl 0%-97%; mo 10.6.-3376 280.80 Sra 2%-28%;
dt=15.05 s=47.9 l=101-170 z=0.5-2.0
+ su 14.6.-3375 104.49 Pus 0%-19%; mo 30.5.-3375 270.66 UAs 149%-163%;
dt=14.33 s=47.8 l=96-132 z=0.4-1.2
+ su 10.2.-3369 345.80 UBh 3%-96%; mo 26.1.-3369 151.50 UPh 0%-17%;
dt=14.52 s=47.7 l=-59-67 z=-2.9--0.2
+ su 30.1.-3368 334.80 UBh 36%-46%; mo 16.1.-3368 140.91 PPh 0%-122%;
dt=13.91 s=47.6 l=-59--40 z=-2.9--2.5
+* su 30.1.-3368 334.80 UBh 29%-35%; mo 16.1.-3368 140.91 PPh 127%-141%;
dt=13.91 s=47.6 l=-66--60 z=-3.0--2.9
+ su 19.11.-3365 261.94 PAs 1%-29%; mo 3.11.-3365 66.06 Mrg 118%;
dt=15.48 s=47.5 l=139-215 z=1.3-2.9
+ su 6.9.-3361 186.65 Cit 0%-59%; mo 23.8.-3361 352.20 Rev 3%-99%;
dt=14.41 s=47.4 l=125-185 z=1.0-2.3
+ su 6.7.-3358 125.60 Mag 3%-86%; mo 21.6.-3358 291.08 Sra 1%-16%;
dt=15.02 s=47.3 l=-1-50 z=-1.6--0.5

+ su 25.6.-3357 114.73 Asl 0%-26%; mo 10.6.-3357 280.89 Sra 149%;
dt=14.28 s=47.3 l=-5-37 z=-1.7--0.8
+ su 24.4.-3354 55.73 Mrg 1%-49%; mo 9.4.-3354 221.58 Anu 2%-32%;
dt=14.82 s=47.2 l=27-34 z=-1.1--0.9
+ su 20.2.-3351 356.19 Rev 7%-84%; mo 6.2.-3351 162.05 Has 10%;
dt=14.60 s=47.1 l=-64--37 z=-3.0--2.4
+ su 20.2.-3351 356.19 Rev 3%-22%; mo 6.2.-3351 162.05 Has 9%-10%;
dt=14.60 s=47.1 l=188-217 z=2.4-3.0
+ su 10.2.-3350 345.28 UBh 52%-56%; mo 27.1.-3350 151.52 UPh 3%-50%;
dt=13.88 s=47.1 l=191-198 z=2.4-2.6
+* su 10.2.-3350 345.28 UBh 4%-52%; mo 27.1.-3350 151.52 UPh 57%-135%;
dt=13.88 s=47.1 l=165-190 z=1.9-2.4
+ su 29.11.-3347 272.89 UAs 0%-30%; mo 13.11.-3347 77.05 Ard 119%;
dt=15.46 s=47.0 l=2-83 z=-1.6-0.1
+ su 16.9.-3343 197.49 Sva 1%-67%; mo 2.9.-3343 2.92 Asv 45%-94%;
dt=14.44 s=46.9 l=-16-64 z=-2.0--0.3
+ su 5.7.-3339 125.05 Mag 0%; mo 20.6.-3339 291.17 Sra 137%;
dt=14.25 s=46.8 l=-63 z=-3.0
+ su 4.3.-3333 6.52 Asv 0%-5%; mo 17.2.-3333 172.52 Has 1%;
dt=14.46 s=46.6 l=87-104 z=0.2-0.6
+ su 4.3.-3333 6.52 Asv 1%-97%; mo 17.2.-3333 172.52 Has 1%;
dt=14.46 s=46.6 l=119-216 z=0.9-3.0
+* su 21.2.-3332 355.69 Rev 4%-66%; mo 7.2.-3332 162.05 Has 4%-127%;
dt=13.85 s=46.6 l=52-78 z=-0.5--0.0
+ su 10.12.-3329 283.79 Sra 2%-17%; mo 25.11.-3329 88.02 Pun 120%;
dt=15.49 s=46.5 l=-62--48 z=-3.0--2.7
+ su 28.9.-3325 208.40 Vis 0%-20%; mo 13.9.-3325 13.71 Bha 90%;
dt=14.46 s=46.4 l=201-215 z=2.7-3.0
+ su 17.7.-3321 135.42 PPh 1%-31%; mo 2.7.-3321 301.50 Dha 126%;
dt=14.21 s=46.3 l=150-194 z=1.6-2.5
+ su 16.5.-3318 76.05 Ard 2%-55%; mo 1.5.-3318 241.84 Mul 3%-31%;
dt=14.93 s=46.2 l=157-187 z=1.7-2.4
+ su 5.5.-3317 65.98 Mrg 0%-11%; mo 19.4.-3317 231.27 Jye 180%;
dt=15.35 s=46.1 l=-61--40 z=-3.0--2.5
+* su 3.3.-3314 6.04 Asv 0%-78%; mo 17.2.-3314 172.52 Has 1%-111%;
dt=13.83 s=46.1 l=-60--40 z=-3.0--2.5
+ su 21.12.-3311 294.63 Dha 1%-35%; mo 5.12.-3311 98.95 Pus 120%;
dt=15.40 s=46.0 l=91-183 z=0.3-2.3
x+ su 8.10.-3307 219.35 Anu 0%-74%; mo 23.9.-3307 24.56 Bha 88%;
dt=14.49 s=45.9 l=58-152 z=-0.4-1.6
+ su 27.7.-3303 145.87 PPh 0%-30%; mo 12.7.-3303 311.89 Sat 116%;
dt=14.17 s=45.7 l=45-87 z=-0.7-0.2
+ su 26.5.-3300 86.23 Pun 4%-57%; mo 11.5.-3300 251.97 Mul 2%-15%;
dt=14.99 s=45.6 l=43-82 z=-0.7-0.1
+ su 16.5.-3299 76.13 Ard 1%-24%; mo 30.4.-3299 241.41 Mul 139%-165%;
dt=15.36 s=45.6 l=175-212 z=2.2-3.0
+* su 14.3.-3296 16.32 Bha 4%-77%; mo 29.2.-3296 182.90 Cit 2%-72%;
dt=13.80 s=45.5 l=191-203 z=2.5-2.8
+ su 1.1.-3292 305.41 Dha 0%-40%; mo 16.12.-3293 109.83 Asl 119%;
dt=15.37 s=45.4 l=-44-53 z=-2.7--0.5
x+ su 19.10.-3289 230.33 Jye 4%-74%; mo 4.10.-3289 35.46 Krt 86%;
dt=14.51 s=45.3 l=-59-13 z=-3.0--1.4

+ su 7.8.-3285 156.39 UPh 1%-26%; mo 23.7.-3285 322.35 PBh 106%;
dt=14.14 s=45.2 l=-58--23 z=-3.0--2.2
+ su 27.5.-3281 86.30 Pun 1%-34%; mo 11.5.-3281 251.56 Mul 77%-150%;
dt=15.37 s=45.1 l=63-113 z=-0.3-0.8
+* su 25.3.-3278 26.55 Bha 6%-31%; mo 11.3.-3278 193.23 Sva 5%-29%;
dt=13.79 s=45.0 l=83-87 z=0.2
+ su 12.1.-3274 316.12 Sat 1%-31%; mo 27.12.-3275 120.66 Mag 117%;
dt=15.34 s=44.9 l=185-211 z=2.4-3.0
x+ su 30.10.-3271 241.33 Mul 1%-74%; mo 15.10.-3271 46.38 Roh 85%;
dt=14.54 s=44.8 l=129-210 z=1.2-3.0
+ su 18.8.-3267 167.00 Has 0%-20%; mo 3.8.-3267 332.90 PBh 99%;
dt=14.11 s=44.7 l=191-210 z=2.6-3.0
+ su 6.6.-3263 96.49 Pus 1%-43%; mo 21.5.-3263 261.72 PAs 19%-136%;
dt=15.38 s=44.6 l=-49-7 z=-2.8--1.6
+ su 23.1.-3256 326.74 PBh 0%-52%; mo 7.1.-3256 131.41 Mag 114%;
dt=15.30 s=44.4 l=64-164 z=-0.3-2.0
+ su 10.11.-3253 252.33 Mul 0%-75%; mo 26.10.-3253 57.34 Mrg 63%-85%;
dt=14.57 s=44.3 l=-17-95 z=-2.1-0.4
+ su 29.8.-3249 177.69 Cit 0%-7%; mo 15.8.-3249 343.52 UBh 92%;
dt=14.09 s=44.2 l=98-106 z=0.5-0.7
+* su 29.8.-3249 177.69 Cit 1%-13%; mo 15.8.-3249 343.52 UBh 92%;
dt=14.09 s=44.2 l=81-97 z=0.1-0.5
+ su 18.6.-3245 106.73 Asl 24%-41%; mo 2.6.-3245 271.90 UAs 1%-26%;
dt=15.38 s=44.1 l=204-208 z=2.9-3.0
+ su 5.4.-3241 36.63 Krt 0%-8%; mo 22.3.-3241 203.14 Vis 152%-159%;
dt=13.96 s=44.0 l=80-103 z=0.1-0.6
+* su 5.4.-3241 36.63 Krt 0%-8%; mo 22.3.-3241 203.14 Vis 159%;
dt=13.97 s=44.0 l=69-79 z=-0.2-0.1
+ su 2.2.-3238 337.30 UBh 1%-61%; mo 17.1.-3238 142.11 PPh 109%;
dt=15.26 s=43.9 l=-54-45 z=-3.0--0.7
+ su 20.11.-3235 263.32 PAs 10%-62%; mo 5.11.-3235 68.31 Ard 85%;
dt=14.67 s=43.8 l=-54--45 z=-3.0--2.8
+ su 20.11.-3235 263.32 PAs 9%-11%; mo 5.11.-3235 68.31 Ard 6%-16%;
dt=14.67 s=43.8 l=205-207 z=2.9-3.0
+ su 8.9.-3231 188.44 Sva 0%-3%; mo 25.8.-3231 354.20 Rev 87%;
dt=14.08 s=43.7 l=-19--15 z=-2.2--2.1
+* su 8.9.-3231 188.44 Sva 1%-7%; mo 25.8.-3231 354.20 Rev 87%;
dt=14.07 s=43.7 l=-31--20 z=-2.5--2.2
+ su 28.6.-3227 117.02 Asl 1%-53%; mo 12.6.-3227 282.12 Sra 5%-109%;
dt=15.38 s=43.6 l=99-150 z=0.5-1.7
+ su 15.4.-3223 46.81 Roh 1%-22%; mo 1.4.-3223 213.35 Anu 161%-173%;
dt=13.98 s=43.5 l=-31--1 z=-2.5--1.8
+* su 15.4.-3223 46.81 Roh 1%-23%; mo 1.4.-3223 213.35 Anu 173%;
dt=13.99 s=43.5 l=-49--32 z=-2.9--2.5
+ su 14.2.-3220 347.77 Rev 3%-58%; mo 29.1.-3220 152.71 UPh 104%;
dt=15.23 s=43.4 l=191-206 z=2.6-3.0
+ su 2.12.-3217 274.27 UAs 5%-79%; mo 17.11.-3217 79.26 Ard 1%-85%;
dt=14.61 s=43.3 l=79-178 z=0.1-2.4
+ su 9.7.-3209 127.36 Mag 1%-54%; mo 23.6.-3209 292.39 Sra 1%-97%;
dt=15.39 s=43.1 l=-9-39 z=-2.0--0.9
+ su 7.5.-3206 67.17 Ard 1%-20%; mo 23.4.-3206 234.05 Jye 4%-39%;
dt=13.88 s=43.0 l=148-185 z=1.7-2.5

+* su 27.4.-3205 56.96 Mrg 0%-36%; mo 13.4.-3205 223.51 Anu 177%;
dt=14.01 s=43.0 l=195-204 z=2.8-3.0
+ su 24.2.-3202 358.17 Rev 0%-81%; mo 8.2.-3202 163.25 Has 97%;
dt=15.20 s=42.9 l=79-180 z=0.1-2.4
+ su 12.12.-3199 285.19 Sra 3%-82%; mo 27.11.-3199 90.19 Pun 4%-84%;
dt=14.65 s=42.8 l=-44-42 z=-2.8--0.8
+ su 30.9.-3195 210.14 Vis 1%-10%; mo 16.9.-3195 15.80 Bha 5%-52%;
dt=14.09 s=42.7 l=148-157 z=1.7-1.9
+ su 19.7.-3191 137.77 PPh 0%-23%; mo 4.7.-3191 302.71 Dha 86%;
dt=15.55 s=42.6 l=23-54 z=-1.3--0.5
+ su 17.5.-3188 77.32 Ard 1%-41%; mo 3.5.-3188 244.20 Mul 1%-24%;
dt=13.88 s=42.5 l=47-85 z=-0.7-0.2
+ su 7.5.-3187 67.13 Ard 1%-47%; mo 23.4.-3187 233.65 Jye 161%;
dt=14.04 s=42.5 l=104-145 z=0.7-1.6
+* su 7.5.-3187 67.13 Ard 3%-51%; mo 23.4.-3187 233.65 Jye 161%;
dt=14.05 s=42.5 l=80-103 z=0.1-0.6
+ su 6.3.-3184 8.49 Asv 0%-93%; mo 19.2.-3184 173.71 Cit 88%;
dt=15.16 s=42.4 l=-31-73 z=-2.6--0.1
+ su 24.12.-3181 296.04 Dha 81%-85%; mo 9.12.-3181 101.09 Pus 4%-43%;
dt=14.69 s=42.3 l=194-202 z=2.8-3.0
x+ su 11.10.-3177 221.06 Anu 1%-15%; mo 27.9.-3177 26.68 Krt 2%-73%;
dt=14.05 s=42.2 l=13-29 z=-1.5--1.1
+ su 31.7.-3173 148.26 UPh 1%-46%; mo 15.7.-3173 313.11 Sat 5%-76%;
dt=15.39 s=42.1 l=130-171 z=1.3-2.3
+ su 28.5.-3170 87.48 Pun 2%-65%; mo 14.5.-3170 254.34 PAs 3%-8%;
dt=13.90 s=42.0 l=-49--17 z=-3.0--2.2
+ su 18.5.-3169 77.28 Ard 0%-58%; mo 4.5.-3169 243.77 Mul 144%;
dt=14.08 s=42.0 l=-9-37 z=-2.0--0.9
+* su 18.5.-3169 77.28 Ard 1%-64%; mo 3.5.-3169 243.77 Mul 144%;
dt=14.09 s=42.0 l=-35--10 z=-2.7--2.1
+ su 17.3.-3166 18.76 Bha 1%-30%; mo 2.3.-3166 184.11 Cit 73%-79%;
dt=15.20 s=41.9 l=-48--31 z=-3.0--2.6
+ su 3.1.-3162 306.84 Sat 6%-91%; mo 19.12.-3163 111.93 Asl 1%-81%;
dt=14.74 s=41.8 l=74-135 z=-0.1-1.4
+ su 10.8.-3155 158.82 UPh 1%-41%; mo 25.7.-3155 323.57 PBh 1%-68%;
dt=15.39 s=41.6 l=14-53 z=-1.5--0.6
+ su 10.8.-3155 158.82 UPh 0%-61%; mo 25.7.-3155 323.57 PBh 62%-68%;
dt=15.39 s=41.6 l=120-189 z=1.0-2.7
+ su 28.3.-3148 28.98 Krt 4%-98%; mo 13.3.-3148 194.43 Sva 68%;
dt=15.09 s=41.4 l=116-200 z=1.0-3.0
+ su 14.1.-3144 317.56 Sat 2%-83%; mo 30.12.-3145 122.71 Mag 4%-77%;
dt=14.80 s=41.3 l=-42-6 z=-2.9--1.7
x+ su 2.11.-3141 242.98 Mul 0%-24%; mo 19.10.-3141 48.59 Roh 1%-77%;
dt=14.00 s=41.2 l=99-129 z=0.5-1.3
+ su 21.8.-3137 169.46 Has 1%-74%; mo 5.8.-3137 334.11 UBh 57%-61%;
dt=15.51 s=41.1 l=-13-70 z=-2.2--0.2
+ su 9.6.-3133 97.67 Pus 1%-84%; mo 25.5.-3133 264.04 PAs 112%;
dt=14.17 s=41.0 l=96-176 z=0.5-2.4
+ su 8.4.-3130 39.15 Krt 4%-98%; mo 24.3.-3130 204.71 Vis 1%-56%;
dt=15.06 s=40.9 l=13-106 z=-1.6-0.7
+ su 28.3.-3129 28.45 Krt 0%; mo 13.3.-3129 194.52 Sva 186%;
dt=14.41 s=40.9 l=25-26 z=-1.3--1.2

+ su 12.11.-3123 253.95 PAs 4%-29%; mo 29.10.-3123 59.57 Mrg 2%-77%;
dt=13.97 s=40.7 l=-30--2 z=-2.6--1.9

+* su 12.11.-3123 253.95 PAs 1%-4%; mo 29.10.-3123 59.57 Mrg 77%;
dt=13.97 s=40.7 l=-36--31 z=-2.8--2.7

+ su 1.9.-3119 180.17 Cit 0%-26%; mo 16.8.-3119 344.72 UBh 3%-55%;
dt=15.39 s=40.6 l=134-174 z=1.4-2.4

+ su 19.6.-3115 107.93 Asl 2%-91%; mo 4.6.-3115 274.21 UAs 96%;
dt=14.22 s=40.5 l=-19-63 z=-2.4--0.3

+ su 18.4.-3112 49.29 Roh 62%-98%; mo 3.4.-3112 214.94 Anu 0%-44%;
dt=15.03 s=40.4 l=-44--13 z=-3.0--2.2

+ su 5.2.-3108 338.78 UBh 4%-12%; mo 21.1.-3108 144.08 PPh 8%-13%;
dt=14.81 s=40.3 l=-17--16 z=-2.3

+ su 5.2.-3108 338.78 UBh 0%-32%; mo 21.1.-3108 144.08 PPh 6%-66%;
dt=14.81 s=40.3 l=94-114 z=0.5-0.9

+* su 24.11.-3105 264.91 PAs 1%-3%; mo 10.11.-3105 70.56 Ard 77%;
dt=13.95 s=40.2 l=196-197 z=3.0

+ su 12.9.-3101 190.95 Sva 1%-18%; mo 27.8.-3101 355.42 Rev 13%-51%;
dt=15.38 s=40.1 l=11-52 z=-1.6--0.6

+ su 12.9.-3101 190.95 Sva 1%-92%; mo 27.8.-3101 355.42 Rev 50%-51%;
dt=15.38 s=40.1 l=75-185 z=-0.0-2.7

+ su 30.6.-3097 118.23 Asl 0%-8%; mo 16.6.-3097 284.42 Sra 2%-37%;
dt=14.42 s=40.0 l=27-34 z=-1.2--1.0

+ su 30.4.-3094 59.42 Mrg 3%-36%; mo 15.4.-3094 225.14 Anu 31%;
dt=15.00 s=39.9 l=172-196 z=2.4-3.0

+ su 19.4.-3093 48.75 Roh 2%-30%; mo 4.4.-3093 215.03 Anu 166%;
dt=14.28 s=39.9 l=164-196 z=2.2-3.0

+ su 15.2.-3090 349.28 Rev 1%-7%; mo 31.1.-3090 154.64 UPh 4%-25%;
dt=14.98 s=39.8 l=-14--9 z=-2.3--2.2

+ su 4.12.-3087 275.83 UAs 32%-40%; mo 20.11.-3087 81.55 Pun 4%-40%;
dt=13.91 s=39.7 l=90-97 z=0.3-0.5

+* su 4.12.-3087 275.83 UAs 1%-31%; mo 20.11.-3087 81.55 Pun 45%-77%;
dt=13.92 s=39.7 l=70-89 z=-0.2-0.3

+ su 22.9.-3083 201.80 Vis 2%-97%; mo 6.9.-3083 6.18 Asv 48%;
dt=15.42 s=39.6 l=-41-59 z=-3.0--0.5

+ su 11.7.-3079 128.60 Mag 1%-96%; mo 26.6.-3079 294.67 Dha 52%-66%;
dt=14.32 s=39.5 l=108-195 z=0.8-3.0

+ su 10.5.-3076 69.54 Ard 3%-33%; mo 25.4.-3076 235.32 Jye 2%-18%;
dt=14.97 s=39.4 l=74-108 z=-0.1-0.8

+ su 29.4.-3075 58.87 Mrg 1%-44%; mo 14.4.-3075 225.22 Anu 152%;
dt=14.23 s=39.4 l=62-129 z=-0.4-1.3

+ su 27.2.-3072 359.70 Rev 0%-77%; mo 12.2.-3072 165.13 Has 3%-50%;
dt=14.88 s=39.3 l=96-124 z=0.5-1.2

+* su 15.12.-3069 286.71 Sra 39%-47%; mo 1.12.-3069 92.50 Pun 4%-45%;
dt=13.89 s=39.2 l=-40--32 z=-3.0--2.8

+ su 4.10.-3065 212.69 Vis 1%-26%; mo 18.9.-3065 17.02 Bha 46%;
dt=15.37 s=39.1 l=129-193 z=1.3-3.0

+ su 22.7.-3061 139.04 PPh 1%-93%; mo 7.7.-3061 304.98 Dha 4%-53%;
dt=14.37 s=39.0 l=-2-80 z=-2.0-0.1

+ su 22.7.-3061 139.04 PPh 1%-70%; mo 7.7.-3061 304.98 Dha 16%-53%;
dt=14.37 s=39.0 l=110-184 z=0.9-2.8

+ su 21.5.-3058 79.66 Ard 1%-8%; mo 6.5.-3058 245.48 Mul 0%-4%;
dt=14.96 s=38.9 l=-22--13 z=-2.6--2.3

+ su 10.5.-3057 68.99 Ard 2%-58%; mo 25.4.-3057 235.40 Jye 138%;
dt=14.19 s=38.9 l=-38-36 z=-3.0--1.0
+ su 9.3.-3054 10.05 Asv 4%-62%; mo 22.2.-3054 175.54 Cit 2%-40%;
dt=14.93 s=38.8 l=-24-15 z=-2.6--1.6
+ su 27.2.-3053 359.78 Rev 0%; mo 11.2.-3053 164.67 Has 183%;
dt=15.40 s=38.8 l=139-145 z=1.6-1.8
+* su 26.12.-3051 297.54 Dha 4%-43%; mo 12.12.-3051 103.41 Pus 46%-73%;
dt=13.87 s=38.8 l=183-192 z=2.8-3.0
x+ su 14.10.-3047 223.63 Anu 0%-97%; mo 28.9.-3047 27.91 Krt 45%;
dt=15.37 s=38.6 l=5-161 z=-1.8-2.2
+ su 1.8.-3043 149.55 UPh 2%-90%; mo 17.7.-3043 315.35 Sat 42%;
dt=14.48 s=38.5 l=-38-64 z=-3.0--0.3
+ su 9.3.-3035 10.13 Asv 1%-11%; mo 21.2.-3035 175.11 Cit 174%;
dt=15.39 s=38.3 l=-1-43 z=-2.0--0.9
+ su 6.1.-3032 308.30 Sat 18%-37%; mo 23.12.-3033 114.27 Asl 2%-24%;
dt=13.97 s=38.2 l=187-191 z=2.9-3.0
+* su 6.1.-3032 308.30 Sat 5%-66%; mo 23.12.-3033 114.27 Asl 2%-61%;
dt=13.85 s=38.2 l=62-75 z=-0.4--0.0
+ su 30.4.-3029 59.67 Mrg 1%-6%; mo 16.4.-3029 226.55 Anu 1%-10%;
dt=13.92 s=38.2 l=-31--8 z=-2.8--2.2
x+ su 25.10.-3029 234.60 Jye 1%-97%; mo 10.10.-3029 38.85 Krt 45%;
dt=15.39 s=38.2 l=-37-31 z=-3.0--1.2
+ su 13.8.-3025 160.13 Has 18%-49%; mo 29.7.-3025 325.80 PBh 3%-31%;
dt=14.47 s=38.1 l=154-190 z=2.0-3.0
+ su 1.6.-3021 89.26 Pun 4%-83%; mo 17.5.-3021 255.73 PAs 110%;
dt=14.11 s=38.0 l=122-149 z=1.2-1.9
+ su 1.6.-3021 89.26 Pun 35%-73%; mo 17.5.-3021 255.73 PAs 110%;
dt=14.11 s=38.0 l=155-189 z=2.1-3.0
+* su 1.6.-3021 89.26 Pun 75%-76%; mo 18.5.-3021 255.73 PAs 110%;
dt=14.09 s=38.0 l=151-153 z=2.0
+ su 31.3.-3018 30.59 Krt 2%-65%; mo 16.3.-3018 196.18 Sva 0%-16%;
dt=15.02 s=37.9 l=100-158 z=0.6-2.1
+ su 16.1.-3014 318.99 Sat 5%-48%; mo 2.1.-3014 125.07 Mag 0%-58%;
dt=13.95 s=37.8 l=61-74 z=-0.4--0.1
+ su 5.11.-3011 245.57 Mul 2%-79%; mo 20.10.-3011 49.82 Roh 46%;
dt=15.34 s=37.7 l=114-189 z=1.0-3.0
+ su 23.8.-3007 170.79 Has 7%-102%; mo 8.8.-3007 336.31 UBh 3%-22%;
dt=14.54 s=37.6 l=48-173 z=-0.8-2.6
+ su 11.6.-3003 99.43 Pus 2%-82%; mo 28.5.-3003 265.91 PAs 65%-96%;
dt=14.06 s=37.5 l=54-113 z=-0.6-1.0
+* su 11.6.-3003 99.43 Pus 5%-93%; mo 27.5.-3003 265.91 PAs 96%;
dt=14.07 s=37.5 l=22-53 z=-1.5--0.6
+ su 10.4.-3000 40.80 Roh 2%-67%; mo 26.3.-3000 206.41 Vis 0%-3%;
dt=15.09 s=37.4 l=-15-47 z=-2.5--0.8
+ su 31.3.-2999 30.65 Krt 1%-35%; mo 15.3.-2999 195.79 Sva 152%;
dt=15.38 s=37.4 l=124-186 z=1.3-2.9
+* su 28.1.-2996 329.61 PBh 2%-21%; mo 14.1.-2996 135.80 PPh 8%-22%;
dt=13.81 s=37.3 l=184-187 z=2.9-3.0
+ su 16.1.-2995 318.86 Sat 0%-1%; mo 2.1.-2995 124.72 Mag 61%-132%;
dt=14.04 s=37.3 l=83-94 z=0.2-0.5
+ su 16.11.-2993 256.54 PAs 1%-97%; mo 31.10.-2993 60.81 Mrg 47%;
dt=15.31 s=37.2 l=-13-130 z=-2.4-1.4

+ su 3.9.-2989 181.54 Cit 7%-102%; mo 19.8.-2989 346.91 Rev 15%;
dt=14.65 s=37.1 l=-34-43 z=-3.0--0.9
+ su 22.6.-2985 109.66 Asl 15%-75%; mo 8.6.-2985 276.13 UAs 6%-82%;
dt=14.02 s=37.0 l=-34-8 z=-3.0--1.8
+ su 11.4.-2981 40.84 Roh 1%-48%; mo 26.3.-2981 206.04 Vis 128%-139%;
dt=15.38 s=36.9 l=10-79 z=-1.8-0.1
+ su 7.2.-2978 340.14 UBh 40%-49%; mo 24.1.-2978 146.45 PPh 0%-32%;
dt=13.92 s=36.8 l=180-187 z=2.8-3.0
+ su 27.1.-2977 329.49 PBh 0%-7%; mo 13.1.-2977 135.43 PPh 79%-137%;
dt=14.05 s=36.8 l=-33--24 z=-3.0--2.8
+ su 26.11.-2975 267.49 UAs 3%-97%; mo 11.11.-2975 71.81 Ard 44%-48%;
dt=15.36 s=36.8 l=-33-1 z=-3.0--2.0
+* su 3.7.-2967 119.94 Asl 2%-43%; mo 19.6.-2967 286.37 Sra 69%;
dt=14.02 s=36.5 l=179-186 z=2.8-3.0
+ su 21.4.-2963 51.00 Roh 2%-11%; mo 5.4.-2963 216.25 Anu 126%;
dt=15.41 s=36.4 l=-32--27 z=-3.0--2.9
+ su 18.2.-2960 350.61 Rev 1%-48%; mo 4.2.-2960 157.02 UPh 3%-52%;
dt=13.90 s=36.4 l=65-91 z=-0.3-0.4
+ su 7.2.-2959 340.05 UBh 5%-18%; mo 24.1.-2959 146.06 PPh 182%;
dt=14.04 s=36.3 l=162-185 z=2.4-3.0
+* su 7.2.-2959 340.05 UBh 1%-4%; mo 24.1.-2959 146.06 PPh 182%;
dt=14.05 s=36.3 l=157-161 z=2.2-2.3
+ su 8.12.-2957 278.41 UAs 4%-97%; mo 22.11.-2957 82.79 Pun 49%;
dt=15.26 s=36.3 l=97-184 z=0.6-3.0
+ su 25.9.-2953 203.22 Vis 3%-100%; mo 10.9.-2953 8.33 Asv 1%-5%;
dt=14.76 s=36.2 l=71-136 z=-0.2-1.6
+ su 14.7.-2949 130.28 Mag 58%-92%; mo 30.6.-2949 296.67 Dha 1%-57%;
dt=13.98 s=36.1 l=108-137 z=0.9-1.7
+* su 14.7.-2949 130.28 Mag 5%-97%; mo 30.6.-2949 296.67 Dha 57%;
dt=13.99 s=36.1 l=76-107 z=-0.0-0.9
+ su 3.5.-2945 61.15 Mrg 5%-74%; mo 17.4.-2945 226.43 Anu 60%-112%;
dt=15.38 s=36.0 l=148-183 z=2.0-3.0
+ su 28.2.-2942 1.00 Asv 3%-29%; mo 14.2.-2942 167.52 Has 43%;
dt=13.91 s=35.9 l=-30--19 z=-3.0--2.7
+ su 18.2.-2941 350.53 Rev 0%-28%; mo 4.2.-2941 156.62 UPh 172%-174%;
dt=14.05 s=35.9 l=46-96 z=-0.9-0.5
+* su 18.2.-2941 350.53 Rev 3%-23%; mo 4.2.-2941 156.62 UPh 174%;
dt=14.06 s=35.9 l=30-45 z=-1.3--0.9
+ su 18.12.-2939 289.28 Sra 1%-97%; mo 2.12.-2939 93.75 Pus 8%-49%;
dt=15.22 s=35.8 l=-26-109 z=-2.9-0.9
+ su 5.10.-2935 214.14 Anu 4%-60%; mo 20.9.-2935 19.14 Bha 1%;
dt=14.85 s=35.7 l=-30--1 z=-3.0--2.2
+ su 25.9.-2934 203.35 Vis 0%-19%; mo 10.9.-2934 7.77 Asv 22%-135%;
dt=15.42 s=35.7 l=87-127 z=0.3-1.4
+ su 24.7.-2931 140.69 PPh 72%-90%; mo 10.7.-2931 307.02 Sat 2%-45%;
dt=13.95 s=35.6 l=3-20 z=-2.0--1.6
+* su 24.7.-2931 140.69 PPh 5%-97%; mo 10.7.-2931 307.02 Sat 45%;
dt=13.97 s=35.6 l=-29-2 z=-3.0--2.1
+ su 13.5.-2927 71.29 Ard 2%-87%; mo 27.4.-2927 236.59 Jye 33%-99%;
dt=15.38 s=35.5 l=39-125 z=-1.1-1.4
+ su 28.2.-2923 0.95 Asv 0%-12%; mo 14.2.-2923 167.11 Has 165%;
dt=14.12 s=35.4 l=-29--22 z=-3.0--2.8

+ su 29.12.-2921 300.08 Dha 38%-69%; mo 14.12.-2921 104.66 Pus 3%-38%;
dt=15.30 s=35.4 l=-29--20 z=-3.0--2.7
+ su 5.10.-2916 214.27 Anu 3%-21%; mo 20.9.-2916 18.58 Bha 104%-132%;
dt=15.42 s=35.2 l=-28--7 z=-3.0--2.4
+ su 24.5.-2909 81.44 Pun 1%-80%; mo 8.5.-2909 246.75 Mul 85%;
dt=15.36 s=35.1 l=-28-22 z=-3.0--1.5
+ su 22.3.-2906 21.60 Bha 3%-49%; mo 8.3.-2906 188.30 Sva 1%-21%;
dt=13.90 s=35.0 l=97-127 z=0.6-1.5
+ su 16.9.-2906 193.71 Sva 0%-3%; mo 31.8.-2906 358.24 Rev 16%;
dt=15.37 s=35.0 l=106-133 z=0.9-1.6
+ su 12.3.-2905 11.30 Asv 5%-52%; mo 26.2.-2905 177.52 Cit 154%;
dt=14.10 s=35.0 l=146-180 z=2.0-3.0
+ su 9.1.-2902 310.83 Sat 3%-97%; mo 25.12.-2903 115.53 Asl 47%;
dt=15.15 s=34.9 l=94-181 z=0.5-3.0
x+ su 17.10.-2898 225.23 Anu 1%-14%; mo 2.10.-2898 29.46 Krt 131%;
dt=15.44 s=34.8 l=163-180 z=2.5-3.0
+* su 15.8.-2895 161.74 Has 5%-96%; mo 1.8.-2895 327.93 PBh 3%-26%;
dt=13.94 s=34.7 l=114-143 z=1.1-1.9
+ su 1.4.-2888 31.83 Krt 1%-50%; mo 18.3.-2888 198.59 Sva 1%-9%;
dt=13.91 s=34.5 l=-5-22 z=-2.4--1.6
+ su 26.9.-2888 204.56 Vis 0%-6%; mo 10.9.-2888 9.03 Asv 14%;
dt=15.34 s=34.5 l=-26-10 z=-3.0--1.9
+ su 22.3.-2887 21.58 Bha 1%-65%; mo 7.3.-2887 187.85 Sva 142%;
dt=14.13 s=34.5 l=26-107 z=-1.5-0.9
+ su 20.1.-2884 321.50 PBh 0%-97%; mo 5.1.-2884 126.33 Mag 3%-45%;
dt=15.12 s=34.4 l=-23-83 z=-2.9-0.2
x+ su 27.10.-2880 236.21 Jye 0%-20%; mo 12.10.-2880 40.39 Roh 130%;
dt=15.46 s=34.3 l=20-80 z=-1.6-0.1
+* su 26.8.-2877 172.38 Has 4%-90%; mo 12.8.-2877 338.50 UBh 0%-18%;
dt=13.93 s=34.3 l=1-23 z=-2.2--1.6
+ su 14.8.-2876 161.49 Has 3%-13%; mo 31.7.-2876 327.70 PBh 6%-83%;
dt=13.97 s=34.2 l=56-68 z=-0.6--0.3
+ su 15.6.-2873 101.83 Pus 1%-99%; mo 30.5.-2873 267.09 UAs 4%-57%;
dt=15.37 s=34.2 l=79-177 z=0.1-2.9
+ su 2.4.-2869 31.82 Krt 1%-39%; mo 19.3.-2869 198.13 Sva 128%;
dt=14.19 s=34.1 l=-25--6 z=-3.0--2.4
+ su 26.7.-2866 141.82 PPh 0%-1%; mo 11.7.-2866 307.60 Sat 2%-8%;
dt=14.62 s=34.0 l=110-121 z=1.0-1.3
+ su 25.6.-2855 112.07 Asl 1%-99%; mo 9.6.-2855 277.29 UAs 18%-45%;
dt=15.36 s=33.7 l=-24-78 z=-3.0-0.1
+ su 25.6.-2855 112.07 Asl 1%-42%; mo 9.6.-2855 277.29 UAs 9%-45%;
dt=15.36 s=33.7 l=103-160 z=0.8-2.5
x+ su 18.10.-2852 226.40 Anu 0%-9%; mo 2.10.-2852 30.78 Krt 11%;
dt=15.30 s=33.6 l=81-112 z=0.2-1.1
+ su 13.4.-2851 42.02 Roh 7%-94%; mo 29.3.-2851 208.35 Vis 114%;
dt=14.21 s=33.6 l=152-177 z=2.2-3.0
+ su 11.2.-2848 342.60 UBh 5%-69%; mo 27.1.-2848 147.72 UPh 36%;
dt=15.04 s=33.5 l=112-177 z=1.1-3.0
+ su 30.1.-2847 331.53 PBh 0%-15%; mo 15.1.-2847 137.15 PPh 163%;
dt=14.39 s=33.5 l=130-177 z=1.6-3.0
+ su 18.11.-2844 258.19 PAs 1%-20%; mo 2.11.-2844 62.32 Mrg 131%;
dt=15.46 s=33.4 l=97-165 z=0.6-2.7

+* su 17.9.-2841 193.89 Sva 1%-53%; mo 3.9.-2841 359.85 Rev 1%-7%;
dt=13.92 s=33.4 l=127-136 z=1.5-1.8
+ su 6.7.-2837 122.38 Mag 11%-67%; mo 21.6.-2837 287.54 Sra 2%-33%;
dt=15.44 s=33.3 l=-22-46 z=-3.0--0.9
x+ su 29.10.-2834 237.37 Jye 0%; mo 13.10.-2834 41.73 Roh 11%;
dt=15.29 s=33.2 l=-22 z=-3.0
+ su 24.4.-2833 52.20 Roh 1%-103%; mo 9.4.-2833 218.54 Anu 98%;
dt=14.25 s=33.2 l=36-131 z=-1.2-1.6
+ su 21.2.-2830 353.04 Rev 1%-62%; mo 6.2.-2830 158.30 UPh 2%-30%;
dt=15.01 s=33.1 l=2-65 z=-2.2--0.3
+ su 10.2.-2829 342.04 UBh 0%-25%; mo 26.1.-2829 147.80 UPh 157%;
dt=14.32 s=33.1 l=10-76 z=-2.0--0.0
+ su 29.11.-2826 269.15 UAs 2%-21%; mo 13.11.-2826 73.29 Ard 132%;
dt=15.46 s=33.0 l=-22-27 z=-3.0--1.5
+* su 27.9.-2823 204.74 Vis 5%-22%; mo 13.9.-2823 10.64 Asv 1%-3%;
dt=13.91 s=32.9 l=7-10 z=-2.1--2.0
+ su 17.7.-2819 132.74 Mag 6%-98%; mo 1.7.-2819 297.84 Dha 5%-22%;
dt=15.35 s=32.8 l=116-174 z=1.2-3.0
+ su 4.5.-2815 62.36 Mrg 2%-84%; mo 19.4.-2815 228.68 Jye 82%;
dt=14.30 s=32.7 l=-21-21 z=-3.0--1.7
+ su 28.7.-2801 143.18 PPh 4%-98%; mo 12.7.-2801 308.20 Sat 1%-12%;
dt=15.34 s=32.4 l=7-171 z=-2.1-2.9
+ su 16.5.-2797 72.52 Ard 5%-52%; mo 1.5.-2797 238.82 Jye 61%-66%;
dt=14.35 s=32.3 l=166-173 z=2.8-3.0
+ su 15.3.-2794 13.70 Bha 2%-20%; mo 28.2.-2794 179.25 Cit 8%-14%;
dt=14.94 s=32.2 l=152-173 z=2.3-3.0
+ su 4.3.-2793 2.85 Asv 4%-47%; mo 17.2.-2793 168.90 Has 143%;
dt=14.21 s=32.2 l=148-173 z=2.2-3.0
+ su 21.12.-2790 290.96 Sra 0%-26%; mo 5.12.-2790 95.19 Pus 132%;
dt=15.45 s=32.1 l=35-109 z=-1.3-1.0
+ su 7.8.-2783 153.68 UPh 49%-98%; mo 23.7.-2783 318.62 Sat 1%-3%;
dt=15.35 s=31.9 l=-18-49 z=-3.0--0.9
+ su 26.5.-2779 82.69 Pun 1%-103%; mo 11.5.-2779 248.94 Mul 2%-49%;
dt=14.41 s=31.8 l=58-166 z=-0.6-2.8
+ su 16.5.-2778 72.67 Ard 1%-6%; mo 1.5.-2778 238.22 Jye 175%;
dt=15.07 s=31.8 l=162-171 z=2.7-3.0
+ su 14.3.-2775 13.14 Asv 0%-60%; mo 27.2.-2775 179.33 Cit 133%;
dt=14.16 s=31.7 l=41-124 z=-1.1-1.5
+ su 6.6.-2761 92.89 Pun 1%-103%; mo 22.5.-2761 259.08 PAs 33%;
dt=14.45 s=31.4 l=-17-121 z=-3.0-1.4
+ su 26.5.-2760 82.84 Pun 1%-16%; mo 10.5.-2760 248.36 Mul 176%;
dt=15.10 s=31.4 l=45-75 z=-1.0--0.0
+ su 25.3.-2757 23.39 Bha 1%-65%; mo 11.3.-2757 189.69 Sva 123%;
dt=14.12 s=31.3 l=-17-24 z=-3.0--1.7
+ su 12.1.-2753 312.54 Sat 1%-34%; mo 27.12.-2754 116.94 Asl 130%;
dt=15.44 s=31.2 l=117-170 z=1.3-3.0
x+ su 30.10.-2750 237.42 Jye 0%-17%; mo 16.10.-2750 42.96 Roh 4%-73%;
dt=14.08 s=31.1 l=147-159 z=2.3-2.7
+ su 18.8.-2746 163.78 Has 1%-16%; mo 3.8.-2746 329.20 PBh 122%;
dt=14.80 s=31.0 l=152-169 z=2.4-3.0
+ su 16.6.-2743 103.12 Pus 1%-63%; mo 2.6.-2743 269.22 UAs 17%;
dt=14.63 s=31.0 l=-16-11 z=-3.0--2.1

+ su 22.1.-2735 323.22 PBh 0%-40%; mo 6.1.-2735 127.72 Mag 127%;
dt=15.43 s=30.8 l=-14-73 z=-3.0--0.1
+ su 9.11.-2732 248.41 Mul 1%-41%; mo 26.10.-2732 53.91 Mrg 3%-115%;
dt=14.09 s=30.7 l=5-37 z=-2.3--1.3
+ su 28.8.-2728 174.42 Cit 0%-35%; mo 13.8.-2728 339.77 UBh 115%;
dt=14.76 s=30.6 l=24-79 z=-1.7-0.1
+ su 28.6.-2725 113.40 Asl 46%-72%; mo 13.6.-2725 279.40 UAs 0%-1%;
dt=14.60 s=30.5 l=149-168 z=2.4-3.0
+ su 16.4.-2721 43.75 Roh 46%-97%; mo 2.4.-2721 210.26 Vis 92%-98%;
dt=14.03 s=30.4 l=122-167 z=1.5-3.0
+* su 16.4.-2721 43.75 Roh 6%-94%; mo 2.4.-2721 210.26 Vis 98%;
dt=14.04 s=30.4 l=90-121 z=0.4-1.5
+ su 28.6.-2706 113.54 Asl 1%-35%; mo 12.6.-2706 278.84 UAs 131%;
dt=15.20 s=30.1 l=61-104 z=-0.5-0.9
+ su 26.4.-2703 53.88 Mrg 53%-98%; mo 12.4.-2703 220.47 Anu 5%-84%;
dt=14.00 s=30.0 l=20-68 z=-1.9--0.3
+* su 26.4.-2703 53.88 Mrg 5%-81%; mo 12.4.-2703 220.47 Anu 84%;
dt=14.01 s=30.0 l=-11-19 z=-2.9--1.9
+ su 13.2.-2699 344.35 UBh 3%-56%; mo 28.1.-2699 149.06 UPh 118%;
dt=15.41 s=29.9 l=100-166 z=0.8-3.0
+ su 1.12.-2696 270.37 UAs 0%-58%; mo 17.11.-2696 75.84 Ard 3%-115%;
dt=14.13 s=29.8 l=78-153 z=0.0-2.6
+ su 19.9.-2692 195.92 Sva 1%-37%; mo 4.9.-2692 1.16 Asv 105%;
dt=14.66 s=29.8 l=130-165 z=1.8-3.0
+ su 8.7.-2688 123.87 Mag 0%-3%; mo 22.6.-2688 289.07 Sra 117%;
dt=15.23 s=29.7 l=-12--10 z=-3.0--2.9
+ su 24.2.-2681 354.80 Rev 0%-65%; mo 8.2.-2681 159.63 UPh 111%;
dt=15.40 s=29.5 l=-11-70 z=-3.0--0.2
+ su 12.12.-2678 281.29 Sra 42%-61%; mo 28.11.-2678 86.79 Pun 4%-114%;
dt=14.15 s=29.4 l=-11-32 z=-3.0--1.5
+ su 30.9.-2674 206.77 Vis 0%-55%; mo 15.9.-2674 11.97 Asv 101%;
dt=14.62 s=29.3 l=1-85 z=-2.6-0.3
+* su 18.5.-2667 74.14 Ard 3%-50%; mo 4.5.-2667 240.82 Mul 56%;
dt=13.95 s=29.2 l=148-163 z=2.5-3.0
+ su 29.6.-2660 114.72 Asl 0%-5%; mo 14.6.-2660 280.01 Sra 8%;
dt=15.38 s=29.0 l=133-162 z=2.0-3.0
+ su 23.12.-2660 292.18 Sra 1%-14%; mo 9.12.-2660 97.70 Pus 113%;
dt=14.16 s=29.0 l=155-163 z=2.7-3.0
+ su 30.7.-2652 144.72 PPh 1%-29%; mo 14.7.-2652 309.71 Sat 93%;
dt=15.29 s=28.8 l=77-113 z=0.0-1.3
+ su 29.5.-2649 84.28 Pun 45%-52%; mo 15.5.-2649 250.99 Mul 4%-34%;
dt=13.92 s=28.7 l=73-82 z=-0.1-0.2
+* su 29.5.-2649 84.28 Pun 2%-44%; mo 15.5.-2649 250.99 Mul 36%-41%;
dt=13.94 s=28.7 l=48-72 z=-1.0--0.1
+ su 18.3.-2645 15.49 Bha 1%-88%; mo 2.3.-2645 180.53 Cit 94%;
dt=15.39 s=28.7 l=109-161 z=1.2-3.0
+ su 3.1.-2641 303.00 Dha 2%-70%; mo 19.12.-2642 108.58 Asl 49%-111%;
dt=14.18 s=28.6 l=23-146 z=-1.9-2.4
x+ su 22.10.-2638 228.59 Jye 0%-56%; mo 7.10.-2638 33.74 Krt 98%;
dt=14.51 s=28.5 l=102-161 z=0.9-3.0
+ su 10.8.-2634 155.26 UPh 0%-50%; mo 26.7.-2634 320.12 PBh 5%-84%;
dt=15.46 s=28.4 l=85-134 z=0.3-2.0

+ su 28.3.-2627 25.75 Bha 1%-100%; mo 12.3.-2627 190.88 Sva 84%;
dt=15.38 s=28.2 l=-3-96 z=-2.9-0.7
+ su 13.1.-2623 313.75 Sat 2%-31%; mo 30.12.-2624 119.39 Asl 106%-108%;
dt=14.30 s=28.1 l=-7-15 z=-3.0--2.2
x+ su 1.11.-2620 239.55 Jye 0%-59%; mo 17.10.-2620 44.70 Roh 98%;
dt=14.45 s=28.1 l=-7-72 z=-3.0--0.2
+ su 20.8.-2616 165.88 Has 3%-64%; mo 5.8.-2616 330.61 PBh 3%-75%;
dt=15.46 s=28.0 l=-7-22 z=-3.0--1.9
+* su 8.6.-2612 94.21 Pus 0%-42%; mo 25.5.-2612 260.93 PAs 1%-52%;
dt=13.80 s=27.9 l=76-84 z=-0.0-0.3
+ su 25.1.-2605 324.44 PBh 3%-79%; mo 10.1.-2605 130.14 Mag 104%;
dt=14.23 s=27.7 l=125-159 z=1.8-3.0
+ su 1.9.-2598 176.56 Cit 0%-8%; mo 16.8.-2598 341.18 UBh 53%-68%;
dt=15.37 s=27.6 l=83-98 z=0.2-0.8
+ su 19.4.-2591 46.13 Roh 4%-73%; mo 3.4.-2591 211.42 Vis 61%;
dt=15.36 s=27.4 l=139-158 z=2.3-3.0
+ su 4.2.-2587 335.04 UBh 1%-92%; mo 20.1.-2587 140.81 PPh 98%;
dt=14.26 s=27.3 l=-1-114 z=-2.9-1.4
+ su 23.11.-2584 261.46 PAs 1%-62%; mo 8.11.-2584 66.68 Ard 98%;
dt=14.37 s=27.3 l=66-158 z=-0.4-3.0
+ su 11.9.-2580 187.32 Sva 1%-83%; mo 26.8.-2580 351.82 Rev 63%;
dt=15.47 s=27.2 l=35-130 z=-1.5-2.0
+ su 30.4.-2573 56.28 Mrg 0%-99%; mo 14.4.-2573 221.63 Anu 48%;
dt=15.35 s=27.0 l=32-150 z=-1.6-2.7
+ su 4.12.-2566 272.38 UAs 3%-65%; mo 20.11.-2566 77.67 Ard 98%;
dt=14.34 s=26.9 l=-3-55 z=-3.0--0.8
+ su 22.9.-2562 198.15 Sva 1%-21%; mo 7.9.-2562 2.54 Asv 59%;
dt=15.51 s=26.8 l=-3-0 z=-3.0--2.9
+ su 11.7.-2558 125.04 Mag 52%; mo 27.6.-2558 291.55 Sra 5%;
dt=13.86 s=26.7 l=129 z=2.0
+* su 11.7.-2558 125.04 Mag 3%-65%; mo 27.6.-2558 291.55 Sra 10%-102%;
dt=13.87 s=26.7 l=102-128 z=1.0-1.9
+ su 10.5.-2555 66.42 Mrg 2%-93%; mo 24.4.-2555 231.82 Jye 31%-35%;
dt=15.33 s=26.6 l=-2-97 z=-3.0-0.8
+ su 26.2.-2551 356.03 Rev 2%-98%; mo 11.2.-2551 161.93 Has 82%;
dt=14.33 s=26.5 l=111-156 z=1.3-3.0
+ su 3.10.-2544 209.03 Vis 0%-49%; mo 17.9.-2544 13.33 Asv 56%;
dt=15.47 s=26.4 l=115-155 z=1.5-3.0
+ su 21.7.-2540 135.43 PPh 40%-50%; mo 7.7.-2540 301.83 Dha 2%-49%;
dt=13.89 s=26.3 l=15-24 z=-2.4--2.0
+* su 21.7.-2540 135.43 PPh 51%-63%; mo 7.7.-2540 301.83 Dha 53%-89%;
dt=13.90 s=26.3 l=-1-14 z=-3.0--2.4
+ su 9.3.-2533 6.42 Asv 0%-103%; mo 22.2.-2533 172.39 Has 72%;
dt=14.37 s=26.1 l=-1-106 z=-3.0-1.1
+ su 26.12.-2530 294.12 Dha 2%-73%; mo 11.12.-2530 99.58 Pus 97%;
dt=14.24 s=26.1 l=44-154 z=-1.2-3.0
x+ su 14.10.-2526 219.96 Anu 5%-90%; mo 28.9.-2526 24.17 Bha 55%;
dt=15.46 s=26.0 l=-1-94 z=-3.0-0.7
+ su 1.6.-2519 86.71 Pun 1%-94%; mo 16.5.-2519 252.14 Mul 8%;
dt=15.32 s=25.8 l=82-153 z=0.2-3.0
+ su 5.1.-2511 304.90 Dha 0%-71%; mo 22.12.-2512 110.48 Asl 59%-96%;
dt=14.23 s=25.6 l=0-51 z=-3.0--1.0

+ su 12.5.-2509 67.10 Ard 1%-45%; mo 26.5.-2509 233.33 Jye 7%;
dt=804776.38 s=25.6 l=108-152 z=1.2-2.9
+ su 12.8.-2504 156.44 UPh 30%-41%; mo 29.7.-2504 322.61 PBh 64%-66%;
dt=13.97 s=25.5 l=141-152 z=2.5-3.0
+* su 12.8.-2504 156.44 UPh 6%-54%; mo 29.7.-2504 322.61 PBh 66%;
dt=13.97 s=25.5 l=116-140 z=1.6-2.5
+ su 31.3.-2497 27.02 Krt 26%-64%; mo 16.3.-2497 193.08 Sva 2%-47%;
dt=14.46 s=25.3 l=115-151 z=1.5-3.0
x+ su 5.11.-2490 241.90 Mul 0%-90%; mo 20.10.-2490 46.03 Roh 55%;
dt=15.47 s=25.2 l=50-152 z=-1.1-3.0
+ su 23.8.-2486 167.06 Has 7%-36%; mo 9.8.-2486 333.10 PBh 1%-57%;
dt=14.01 s=25.1 l=20-61 z=-2.2--0.6
+* su 23.8.-2486 167.06 Has 30%-47%; mo 9.8.-2486 333.10 PBh 57%;
dt=14.01 s=25.1 l=1-19 z=-3.0--2.3
+ su 10.4.-2479 37.24 Krt 0%-103%; mo 26.3.-2479 203.33 Vis 3%-33%;
dt=14.51 s=24.9 l=20-136 z=-2.3-2.4
+ su 31.3.-2478 27.17 Krt 3%-21%; mo 15.3.-2478 192.49 Sva 175%;
dt=15.14 s=24.9 l=105-151 z=1.1-3.0
+ su 27.1.-2475 326.25 PBh 3%-93%; mo 13.1.-2475 132.09 Mag 76%-90%;
dt=14.11 s=24.8 l=52-151 z=-1.0-3.0
+ su 15.11.-2472 252.88 Mul 6%-91%; mo 30.10.-2472 56.99 Mrg 55%;
dt=15.51 s=24.8 l=2-50 z=-3.0--1.1
+ su 21.4.-2461 47.44 Roh 2%-21%; mo 6.4.-2461 213.54 Anu 19%;
dt=14.66 s=24.5 l=3-41 z=-3.0--1.5
+ su 10.4.-2460 37.39 Krt 1%-33%; mo 26.3.-2460 202.75 Vis 162%;
dt=15.16 s=24.5 l=3-43 z=-3.0--1.4
+ su 7.2.-2457 336.81 UBh 33%-90%; mo 24.1.-2457 142.79 PPh 1%-85%;
dt=14.10 s=24.5 l=3-40 z=-3.0--1.5
+ su 27.11.-2454 263.86 PAs 1%-16%; mo 11.11.-2454 67.98 Ard 54%-56%;
dt=15.47 s=24.4 l=140-149 z=2.6-3.0
+ su 14.9.-2450 188.52 Sva 22%-29%; mo 31.8.-2450 354.32 Rev 42%;
dt=14.09 s=24.3 l=130-148 z=2.2-3.0
+* su 14.9.-2450 188.52 Sva 2%-35%; mo 31.8.-2450 354.32 Rev 42%;
dt=14.09 s=24.3 l=109-129 z=1.4-2.2
+ su 3.7.-2446 116.86 Asl 1%-21%; mo 18.6.-2446 282.82 Sra 3%-80%;
dt=14.51 s=24.2 l=63-77 z=-0.6--0.0
+ su 7.12.-2436 274.80 UAs 2%-93%; mo 21.11.-2436 78.95 Ard 57%;
dt=15.46 s=24.0 l=10-144 z=-2.8-2.8
+ su 24.9.-2432 199.36 Sva 25%-83%; mo 10.9.-2432 5.04 Asv 3%-37%;
dt=14.14 s=23.9 l=5-82 z=-3.0-0.2
+ su 13.7.-2428 127.17 Mag 0%-41%; mo 28.6.-2428 293.10 Sra 83%;
dt=14.64 s=23.8 l=39-92 z=-1.6-0.6
+ su 2.5.-2424 57.75 Mrg 5%-59%; mo 16.4.-2424 223.15 Anu 133%;
dt=15.22 s=23.8 l=114-147 z=1.6-3.0
+ su 1.3.-2421 357.71 Rev 70%-97%; mo 15.2.-2421 163.96 Has 31%-71%;
dt=14.00 s=23.7 l=109-147 z=1.4-3.0
+* su 1.3.-2421 357.71 Rev 0%-75%; mo 15.2.-2421 163.96 Has 71%;
dt=14.00 s=23.7 l=77-108 z=0.0-1.3
+ su 18.12.-2418 285.71 Sra 2%-49%; mo 3.12.-2418 89.92 Pun 58%;
dt=15.56 s=23.6 l=5-14 z=-3.0--2.6
+ su 25.9.-2413 199.50 Sva 2%-6%; mo 10.9.-2413 4.40 Asv 3%-71%;
dt=14.96 s=23.5 l=126-137 z=2.1-2.6

+ su 13.5.-2406 67.91 Ard 2%-71%; mo 27.4.-2406 233.32 Jye 118%;
dt=15.24 s=23.4 l=6-75 z=-3.0--0.0

+ su 11.3.-2403 8.06 Asv 60%-84%; mo 25.2.-2403 174.43 Cit 1%-62%;
dt=13.97 s=23.3 l=6-31 z=-3.0--1.9

+ su 29.12.-2400 296.55 Dha 5%-76%; mo 13.12.-2400 100.84 Pus 58%;
dt=15.44 s=23.2 l=115-146 z=1.6-3.0

x+ su 16.10.-2396 221.19 Anu 3%-65%; mo 1.10.-2396 26.66 Bha 30%;
dt=14.22 s=23.2 l=82-145 z=0.2-3.0

+ su 4.8.-2392 147.99 UPh 5%-62%; mo 20.7.-2392 313.83 Sat 4%-61%;
dt=14.39 s=23.1 l=79-145 z=0.1-3.0

+* su 11.3.-2384 7.78 Asv 2%-15%; mo 26.2.-2384 174.24 Cit 6%-32%;
dt=13.80 s=22.9 l=122-126 z=2.0-2.1

+ su 9.1.-2381 307.35 Sat 4%-99%; mo 24.12.-2382 111.72 Asl 57%;
dt=15.42 s=22.9 l=8-120 z=-3.0-1.9

x+ su 27.10.-2378 232.16 Jye 71%-101%; mo 13.10.-2378 37.55 Krt 3%-28%;
dt=14.26 s=22.8 l=8-88 z=-3.0-0.5

+ su 15.8.-2374 158.50 UPh 1%-96%; mo 31.7.-2374 324.29 PBh 22%-52%;
dt=14.36 s=22.7 l=8-141 z=-3.0-2.9

+ su 4.6.-2370 88.25 Pun 2%-58%; mo 19.5.-2370 253.60 PAs 89%;
dt=15.30 s=22.6 l=135-143 z=2.6-3.0

+ su 2.4.-2367 28.58 Krt 32%-33%; mo 19.3.-2367 195.17 Sva 28%-30%;
dt=13.92 s=22.6 l=143-144 z=2.9-3.0

+* su 2.4.-2367 28.58 Krt 2%-32%; mo 19.3.-2367 195.17 Sva 33%-40%;
dt=13.92 s=22.6 l=119-142 z=1.9-2.9

+* su 22.3.-2366 18.09 Bha 21%-34%; mo 8.3.-2366 184.63 Cit 5%-38%;
dt=13.80 s=22.5 l=9-14 z=-3.0--2.8

+ su 25.8.-2356 169.10 Has 30%-82%; mo 11.8.-2356 334.83 UBh 1%-44%;
dt=14.46 s=22.3 l=9-24 z=-3.0--2.3

+ su 14.6.-2352 98.45 Pus 0%-96%; mo 29.5.-2352 263.76 PAs 68%-74%;
dt=15.32 s=22.3 l=24-111 z=-2.4-1.5

+* su 13.4.-2349 38.76 Krt 2%-18%; mo 30.3.-2349 205.45 Vis 2%-27%;
dt=13.91 s=22.2 l=17-33 z=-2.7--2.0

+ su 31.1.-2345 328.70 PBh 6%-98%; mo 15.1.-2345 133.31 Mag 52%;
dt=15.40 s=22.1 l=106-142 z=1.3-3.0

+ su 18.11.-2342 254.14 PAs 6%-101%; mo 3.11.-2342 59.43 Mrg 26%;
dt=14.33 s=22.0 l=43-142 z=-1.5-3.0

+ su 6.9.-2338 179.77 Cit 2%-53%; mo 22.8.-2338 345.44 UBh 38%;
dt=14.31 s=22.0 l=95-141 z=0.9-3.0

+ su 25.6.-2334 108.69 Asl 0%-29%; mo 10.6.-2334 273.94 UAs 3%-60%;
dt=15.49 s=21.9 l=65-102 z=-0.5-1.2

+ su 23.4.-2331 48.93 Roh 3%-8%; mo 9.4.-2331 215.69 Anu 0%-3%;
dt=14.00 s=21.8 l=76-77 z=-0.0

+* su 13.4.-2330 38.55 Krt 4%-35%; mo 30.3.-2330 205.21 Vis 95%-123%;
dt=13.82 s=21.8 l=136-141 z=2.7-3.0

+ su 10.2.-2327 339.26 UBh 2%-98%; mo 25.1.-2327 143.98 PPh 48%;
dt=15.38 s=21.7 l=11-121 z=-3.0-2.1

+ su 28.11.-2324 265.13 PAs 5%-86%; mo 14.11.-2324 70.39 Ard 26%;
dt=14.44 s=21.7 l=11-50 z=-3.0--1.2

+ su 18.11.-2323 254.29 PAs 0%-2%; mo 3.11.-2323 58.78 Mrg 3%-16%;
dt=15.11 s=21.7 l=110-112 z=1.6-1.7

+ su 16.9.-2320 190.52 Sva 40%-96%; mo 1.9.-2320 356.13 Rev 4%-32%;
dt=14.27 s=21.6 l=12-135 z=-3.0-2.7

+ su 5.9.-2319 179.32 Cit 3%-12%; mo 22.8.-2319 345.40 UBh 2%-109%;
dt=13.95 s=21.6 l=98-114 z=1.0-1.7
+* su 23.4.-2312 48.73 Roh 3%-78%; mo 9.4.-2312 215.42 Anu 1%-133%;
dt=13.84 s=21.4 l=23-49 z=-2.5--1.3
+ su 10.12.-2306 276.08 UAs 3%-23%; mo 25.11.-2306 81.34 Pun 25%;
dt=14.39 s=21.3 l=136-139 z=2.8-3.0
+ su 17.7.-2298 129.33 Mag 13%-101%; mo 1.7.-2298 294.42 Dha 2%-35%;
dt=15.38 s=21.2 l=62-139 z=-0.7-3.0
+ su 4.3.-2291 0.16 Asv 3%-57%; mo 16.2.-2291 165.14 Has 36%;
dt=15.35 s=21.0 l=117-139 z=1.9-3.0
+ su 27.8.-2291 169.86 Has 0%-11%; mo 13.8.-2291 335.79 UBh 11%;
dt=14.19 s=21.0 l=71-119 z=-0.2-2.0
+ su 20.12.-2288 286.99 Sra 20%-101%; mo 5.12.-2288 92.27 Pun 24%;
dt=14.42 s=21.0 l=13-138 z=-3.0-3.0
+ su 8.10.-2284 212.19 Vis 1%-48%; mo 23.9.-2284 17.71 Bha 25%;
dt=14.23 s=20.9 l=108-139 z=1.5-3.0
+ su 27.7.-2280 139.75 PPh 6%-100%; mo 11.7.-2280 304.74 Dha 8%-24%;
dt=15.41 s=20.8 l=14-129 z=-3.0-2.5
+ su 15.3.-2273 10.51 Asv 16%-99%; mo 27.2.-2273 175.61 Cit 28%;
dt=15.33 s=20.7 l=14-137 z=-3.0-3.0
+ su 21.12.-2269 287.14 Sra 0%-17%; mo 6.12.-2269 91.63 Pun 76%-150%;
dt=15.16 s=20.6 l=38-96 z=-1.9-0.9
x+ su 19.10.-2266 223.11 Anu 52%-95%; mo 5.10.-2266 28.59 Krt 3%-23%;
dt=14.20 s=20.5 l=15-110 z=-3.0-1.6
+ su 8.10.-2265 211.78 Vis 3%-28%; mo 24.9.-2265 17.62 Bha 1%-115%;
dt=13.93 s=20.5 l=81-99 z=0.2-1.1
+ su 26.5.-2258 79.21 Ard 88%-102%; mo 12.5.-2258 245.89 Mul 0%-81%;
dt=13.91 s=20.4 l=76-95 z=-0.0-0.9
+* su 26.5.-2258 79.21 Ard 1%-96%; mo 12.5.-2258 245.89 Mul 83%-86%;
dt=13.92 s=20.4 l=48-75 z=-1.4--0.1
+ su 25.3.-2255 20.79 Bha 2%-34%; mo 10.3.-2255 186.00 Cit 18%;
dt=15.42 s=20.3 l=15-48 z=-3.0--1.4
+ su 11.1.-2251 308.65 Sat 7%-84%; mo 27.12.-2252 114.01 Asl 14%-20%;
dt=14.49 s=20.2 l=104-137 z=1.4-3.0
+ su 18.8.-2244 160.80 Has 43%-71%; mo 2.8.-2244 325.57 PBh 1%-5%;
dt=15.43 s=20.1 l=97-136 z=1.0-3.0
+ su 22.1.-2233 319.37 Sat 1%-102%; mo 7.1.-2233 124.79 Mag 17%;
dt=14.55 s=19.9 l=17-111 z=-3.0-1.7
+ su 12.1.-2232 308.79 Sat 1%-21%; mo 28.12.-2233 113.39 Asl 147%;
dt=15.19 s=19.8 l=113-136 z=1.8-3.0
+ su 10.11.-2230 245.01 Mul 2%-70%; mo 26.10.-2230 50.48 Roh 21%;
dt=14.15 s=19.8 l=105-135 z=1.4-3.0
+ su 5.4.-2218 30.54 Krt 1%-13%; mo 21.3.-2218 196.40 Sva 6%-55%;
dt=14.64 s=19.6 l=79-86 z=0.1-0.5
+ su 22.1.-2214 319.53 Sat 0%-31%; mo 7.1.-2214 124.19 Mag 144%;
dt=15.21 s=19.5 l=18-51 z=-3.0--1.3
+ su 20.11.-2212 255.96 PAs 48%-96%; mo 6.11.-2212 61.46 Mrg 0%-21%;
dt=14.11 s=19.5 l=18-77 z=-3.0--0.0
+ su 9.11.-2211 244.63 Mul 1%-27%; mo 26.10.-2211 50.35 Roh 5%-93%;
dt=13.94 s=19.4 l=50-64 z=-1.4--0.6
+ su 27.6.-2204 109.85 Asl 79%-102%; mo 13.6.-2204 276.36 UAs 34%-38%;
dt=14.02 s=19.3 l=100-133 z=1.2-3.0

+* su 27.6.-2204 109.85 Asl 4%-78%; mo 13.6.-2204 276.36 UAs 38%;
dt=14.04 s=19.3 l=74-99 z=-0.1-1.2
+ su 13.2.-2197 340.60 UBh 30%-35%; mo 29.1.-2197 146.15 PPh 1%-5%;
dt=14.64 s=19.2 l=126-134 z=2.6-3.0
+ su 8.7.-2186 120.15 Mag 54%-84%; mo 24.6.-2186 286.57 Sra 2%-23%;
dt=14.07 s=19.0 l=19-40 z=-3.0--1.9
+ su 19.8.-2179 161.16 Has 0%-27%; mo 4.8.-2179 327.09 PBh 13%;
dt=14.28 s=18.8 l=66-132 z=-0.6-3.0
+ su 13.2.-2178 340.75 UBh 0%-46%; mo 28.1.-2178 145.58 PPh 135%;
dt=15.23 s=18.8 l=77-132 z=0.0-3.0
+* su 12.12.-2176 277.82 UAs 5%-96%; mo 28.11.-2176 83.43 Pun 21%;
dt=14.06 s=18.8 l=100-132 z=1.3-3.0
+ su 7.5.-2164 60.99 Mrg 58%-90%; mo 22.4.-2164 227.14 Jye 3%-96%;
dt=14.46 s=18.5 l=101-132 z=1.3-3.0
+ su 30.8.-2161 171.78 Has 1%-21%; mo 16.8.-2161 337.65 UBh 6%;
dt=14.25 s=18.5 l=21-35 z=-3.0--2.2
+ su 24.2.-2160 351.25 Rev 0%-23%; mo 9.2.-2160 156.16 UPh 128%;
dt=15.29 s=18.5 l=21-34 z=-3.0--2.3
+ su 23.12.-2158 288.71 Sra 40%-57%; mo 9.12.-2158 94.39 Pus 2%-20%;
dt=14.04 s=18.4 l=21-44 z=-3.0--1.8
+ su 12.12.-2157 277.51 UAs 1%-6%; mo 28.11.-2157 83.26 Pun 25%-44%;
dt=13.97 s=18.4 l=21-24 z=-3.0--2.8
+ su 18.5.-2146 71.11 Ard 1%-84%; mo 3.5.-2146 237.32 Jye 82%;
dt=14.41 s=18.2 l=22-73 z=-3.0--0.2
+ su 30.7.-2131 141.09 PPh 0%-8%; mo 15.7.-2131 306.51 Dha 2%-76%;
dt=14.86 s=17.9 l=90-103 z=0.7-1.5
+ su 28.5.-2128 81.25 Pun 1%-11%; mo 14.5.-2128 247.50 Mul 68%;
dt=14.55 s=17.9 l=32-52 z=-2.5--1.4
+ su 17.3.-2124 12.02 Asv 6%-76%; mo 1.3.-2124 177.11 Cit 110%;
dt=15.28 s=17.8 l=71-129 z=-0.3-3.0
+* su 14.1.-2121 310.28 Sat 2%-55%; mo 31.12.-2122 116.18 Asl 17%;
dt=13.98 s=17.7 l=102-129 z=1.5-3.0
+* su 3.1.-2120 299.25 Dha 16%; mo 20.12.-2121 105.11 Pus 2%;
dt=13.86 s=17.7 l=23 z=-3.0
+* su 29.5.-2109 80.77 Pun 0%-6%; mo 15.5.-2109 247.49 Mul 7%-27%;
dt=13.82 s=17.5 l=107-110 z=1.7-1.9
+ su 28.3.-2106 22.33 Bha 0%-39%; mo 13.3.-2106 187.48 Sva 100%;
dt=15.33 s=17.5 l=24-43 z=-3.0--1.9
+ su 19.6.-2092 101.57 Pus 5%-97%; mo 4.6.-2092 267.86 UAs 41%;
dt=14.31 s=17.2 l=41-128 z=-2.1-3.0
+* su 25.1.-2084 320.73 PBh 0%-39%; mo 11.1.-2084 126.74 Mag 91%-132%;
dt=13.86 s=17.1 l=116-127 z=2.3-3.0
+ su 30.6.-2074 111.78 Asl 39%-66%; mo 16.6.-2074 278.07 UAs 3%-27%;
dt=14.27 s=16.9 l=26-93 z=-3.0-1.0
+ su 19.4.-2070 42.78 Roh 3%-101%; mo 3.4.-2070 208.05 Vis 76%;
dt=15.34 s=16.8 l=82-126 z=0.3-3.0
+* su 15.2.-2067 342.12 UBh 2%-12%; mo 1.2.-2067 148.38 UPh 1%-3%;
dt=13.93 s=16.7 l=120-126 z=2.6-3.0
+ su 29.4.-2052 52.96 Roh 1%-89%; mo 13.4.-2052 218.26 Anu 62%;
dt=15.35 s=16.5 l=27-74 z=-3.0--0.1
+ su 22.7.-2038 132.39 Mag 3%-54%; mo 7.7.-2038 298.62 Dha 2%;
dt=14.23 s=16.2 l=104-125 z=1.7-3.0

+* su 26.2.-2030 352.41 Rev 4%-83%; mo 12.2.-2030 158.67 UPh 113%;
dt=13.89 s=16.1 l=108-124 z=2.0-3.0
\+ su 15.12.-2027 279.93 UAs 1%-16%; mo 30.11.-2027 84.71 Pun 0%-77%;
dt=14.94 s=16.0 l=100-112 z=1.5-2.2
\+ su 3.10.-2023 205.22 Vis 0%; mo 18.9.-2023 9.85 Asv 71%;
dt=15.18 s=16.0 l=123 z=3.0
\+ su 21.7.-2019 131.99 Mag 0%-26%; mo 7.7.-2019 298.55 Dha 28%-120%;
dt=13.92 s=15.9 l=88-123 z=0.7-2.9
\+ su 21.5.-2016 73.27 Ard 13%-56%; mo 5.5.-2016 238.61 Jye 2%-33%;
dt=15.39 s=15.8 l=111-123 z=2.2-2.9
\+ su 8.3.-2012 2.83 Asv 88%-95%; mo 23.2.-2012 169.17 Has 2%-52%;
dt=13.91 s=15.8 l=29-38 z=-3.0--2.4
\+ su 14.10.-2005 216.13 Anu 63%-76%; mo 29.9.-2005 20.65 Bha 1%-65%;
dt=15.22 s=15.6 l=29-46 z=-3.0--1.9
\+ su 1.6.-1998 83.43 Pun 15%-101%; mo 16.5.-1998 248.76 Mul 21%;
dt=15.40 s=15.5 l=30-123 z=-3.0-3.0
\+ su 11.6.-1980 93.61 Pus 1%-70%; mo 27.5.-1980 258.92 PAs 6%-7%;
dt=15.52 s=15.2 l=31-81 z=-3.0-0.3
+* su 30.3.-1976 23.48 Bha 1%-55%; mo 16.3.-1976 189.95 Sva 82%;
dt=13.96 s=15.1 l=113-121 z=2.4-2.9
\+ su 17.1.-1972 312.33 Sat 1%-50%; mo 2.1.-1972 117.45 Asl 4%-112%;
dt=14.72 s=15.1 l=61-99 z=-1.0-1.5
x+ su 5.11.-1969 238.07 Jye 1%-79%; mo 20.10.-1969 42.43 Roh 66%;
dt=15.25 s=15.0 l=52-121 z=-1.6-3.0
\+ su 23.8.-1965 163.47 Has 63%-72%; mo 9.8.-1965 329.77 PBh 0%-62%;
dt=13.90 s=14.9 l=109-121 z=2.2-3.0
\+ su 12.6.-1961 93.37 Pus 1%-27%; mo 27.5.-1961 258.85 PAs 142%;
dt=15.12 s=14.9 l=34-75 z=-2.9--0.1
\+ su 10.4.-1958 33.71 Krt 73%-102%; mo 27.3.-1958 200.23 Vis 1%-68%;
dt=13.99 s=14.8 l=32-69 z=-3.0--0.5
\+ su 15.11.-1951 249.05 Mul 6%-39%; mo 31.10.-1951 53.37 Mrg 21%-42%;
dt=15.35 s=14.7 l=32-37 z=-3.0--2.7
\+ su 2.6.-1933 83.81 Pun 0%; mo 19.5.-1933 250.23 Mul 28%;
dt=14.36 s=14.4 l=87-89 z=0.8-0.9
\+ su 18.2.-1918 344.11 UBh 2%-82%; mo 3.2.-1918 149.66 UPh 2%-100%;
dt=14.54 s=14.1 l=42-115 z=-2.4-2.7
\+ su 7.12.-1915 271.00 UAs 40%-87%; mo 21.11.-1915 75.30 Ard 67%;
dt=15.29 s=14.1 l=34-118 z=-3.0-3.0
\+ su 24.9.-1911 195.64 Sva 85%-95%; mo 10.9.-1911 1.64 Asv 3%-27%;
dt=13.93 s=14.0 l=113-118 z=2.6-3.0
\+ su 14.7.-1907 124.08 Mag 3%-37%; mo 29.6.-1907 289.52 Sra 103%;
dt=15.01 s=14.0 l=91-117 z=1.1-2.9
\+ su 12.5.-1904 64.27 Mrg 30%-103%; mo 28.4.-1904 230.83 Jye 1%-23%;
dt=14.11 s=13.9 l=35-111 z=-3.0-2.5
\+ su 25.7.-1889 134.44 PPh 1%-3%; mo 10.7.-1889 299.83 Dha 57%-66%;
dt=14.99 s=13.7 l=35-37 z=-3.0--2.9
\+ su 29.12.-1879 292.82 Sra 5%-70%; mo 13.12.-1879 97.18 Pus 67%;
dt=15.33 s=13.5 l=88-116 z=0.9-2.9
x+* su 16.10.-1875 217.39 Anu 0%-10%; mo 2.10.-1875 23.22 Bha 1%-24%;
dt=13.87 s=13.4 l=75-80 z=-0.1-0.3
\+ su 22.3.-1864 15.23 Bha 5%-96%; mo 7.3.-1864 181.22 Cit 49%-76%;
dt=14.41 s=13.3 l=53-116 z=-1.8-3.0

+ su 9.1.-1860 303.65 Dha 1%-81%; mo 25.12.-1861 108.07 Asl 66%;
dt=15.40 s=13.2 l=37-87 z=-3.0-0.8
+ su 2.4.-1846 25.48 Bha 0%-53%; mo 18.3.-1846 191.59 Sva 65%;
dt=14.40 s=13.0 l=37-69 z=-3.0--0.5
+ su 26.8.-1835 165.90 Has 15%-26%; mo 11.8.-1835 331.11 PBh 2%-54%;
dt=14.88 s=12.8 l=38-50 z=-3.0--2.1
+ su 14.6.-1831 94.96 Pus 40%-77%; mo 30.5.-1831 260.63 PAs 3%-98%;
dt=14.92 s=12.7 l=38-76 z=-3.0--0.0
+ su 31.1.-1824 325.11 PBh 0%-100%; mo 15.1.-1824 129.69 Mag 62%;
dt=15.36 s=12.6 l=62-114 z=-1.2-2.9
+ su 18.11.-1821 250.28 Mul 42%-47%; mo 4.11.-1821 55.97 Mrg 2%-24%;
dt=13.91 s=12.6 l=66-71 z=-0.9--0.5
+* su 18.11.-1821 250.28 Mul 4%-41%; mo 4.11.-1821 55.97 Mrg 27%-55%;
dt=13.92 s=12.6 l=45-65 z=-2.5--0.9
+ su 6.9.-1817 176.54 Cit 2%-30%; mo 22.8.-1817 341.69 UBh 1%-25%;
dt=14.98 s=12.5 l=93-98 z=1.3-1.7
+ su 24.4.-1810 45.85 Roh 1%-13%; mo 9.4.-1810 212.18 Vis 41%;
dt=14.29 s=12.4 l=110-113 z=2.7-3.0
+* su 13.4.-1809 35.24 Krt 4%-23%; mo 30.3.-1809 201.88 Vis 4%-39%;
dt=13.80 s=12.4 l=66-71 z=-0.8--0.4
+ su 10.2.-1806 335.71 UBh 1%-35%; mo 26.1.-1806 140.39 PPh 58%;
dt=15.47 s=12.3 l=39-63 z=-3.0--1.1
+ su 4.5.-1792 55.99 Mrg 29%-97%; mo 19.4.-1792 222.40 Anu 28%;
dt=14.24 s=12.1 l=40-112 z=-3.0-2.9
+ su 17.7.-1777 125.79 Mag 4%-82%; mo 2.7.-1777 291.20 Sra 53%-54%;
dt=15.06 s=11.9 l=46-112 z=-2.6-3.0
+ su 4.3.-1770 356.72 Rev 4%-86%; mo 16.2.-1770 161.59 Has 46%;
dt=15.40 s=11.8 l=55-111 z=-1.8-3.0
+ su 20.12.-1767 283.15 Sra 88%-100%; mo 6.12.-1767 88.85 Pun 1%-53%;
dt=13.96 s=11.7 l=41-62 z=-3.0--1.2
+ su 8.10.-1763 208.87 Vis 3%-83%; mo 23.9.-1763 13.86 Bha 3%-44%;
dt=14.87 s=11.7 l=64-99 z=-1.0-2.0
+ su 14.3.-1752 7.11 Asv 0%-30%; mo 28.2.-1752 172.09 Has 38%;
dt=15.49 s=11.5 l=42-66 z=-3.0--0.9
+ su 20.12.-1748 283.24 Sra 0%-4%; mo 5.12.-1748 88.23 Pun 175%;
dt=14.65 s=11.4 l=79-105 z=0.2-2.5
+ su 15.3.-1733 6.90 Asv 0%-6%; mo 27.2.-1733 171.98 Has 172%;
dt=15.23 s=11.2 l=68-101 z=-0.8-2.2
+ su 18.8.-1723 157.18 UPh 6%-68%; mo 2.8.-1723 322.23 PBh 19%;
dt=15.19 s=11.0 l=56-109 z=-1.8-3.0
+ su 5.4.-1716 27.71 Krt 3%-48%; mo 20.3.-1716 192.86 Sva 11%-18%;
dt=15.43 s=10.9 l=68-109 z=-0.8-2.9
+ su 22.1.-1712 315.60 Sat 67%-83%; mo 8.1.-1712 121.45 Mag 1%-46%;
dt=14.05 s=10.9 l=44-61 z=-3.0--1.4
x+ su 10.11.-1709 241.63 Mul 2%-83%; mo 26.10.-1709 46.57 Roh 40%;
dt=14.75 s=10.8 l=44-86 z=-3.0-0.9
+ su 29.8.-1705 167.79 Has 78%-96%; mo 14.8.-1705 332.70 PBh 1%-10%;
dt=15.31 s=10.8 l=44-58 z=-3.0--1.7
+ su 16.4.-1698 37.94 Krt 22%-81%; mo 31.3.-1698 203.15 Vis 7%;
dt=15.47 s=10.7 l=44-108 z=-3.0-3.0
+ su 22.1.-1693 315.72 Sat 1%-12%; mo 7.1.-1693 120.83 Mag 3%-73%;
dt=14.73 s=10.6 l=52-63 z=-2.3--1.3

+ su 16.4.-1679 37.67 Krt 4%-36%; mo 1.4.-1679 203.10 Vis 142%;
dt=15.10 s=10.4 l=99-107 z=2.2-3.0
+* su 13.2.-1676 336.89 UBh 6%-53%; mo 30.1.-1676 142.89 PPh 36%;
dt=14.07 s=10.3 l=98-107 z=2.1-3.0
+ su 2.12.-1673 263.53 PAs 89%-95%; mo 17.11.-1673 68.54 Ard 2%-22%;
dt=14.59 s=10.3 l=101-106 z=2.4-2.9
+ su 8.7.-1665 116.70 Asl 48%-70%; mo 24.6.-1665 283.40 Sra 2%-57%;
dt=13.89 s=10.2 l=87-107 z=1.0-3.0
+ su 27.4.-1661 47.84 Roh 1%-31%; mo 12.4.-1661 213.36 Anu 130%;
dt=15.05 s=10.1 l=46-67 z=-3.0--0.9
+ su 23.2.-1658 347.43 Rev 74%-102%; mo 9.2.-1658 153.51 UPh 1%-29%;
dt=14.15 s=10.1 l=46-71 z=-3.0--0.5
+ su 12.12.-1655 274.45 UAs 4%-95%; mo 27.11.-1655 79.52 Ard 40%;
dt=14.66 s=10.0 l=46-74 z=-3.0--0.2
+ su 17.4.-1633 38.26 Krt 0%-4%; mo 3.4.-1633 204.66 Vis 1%-12%;
dt=14.34 s=9.7 l=61-69 z=-1.6--0.7
+ su 30.9.-1632 199.97 Sva 1%; mo 15.9.-1632 4.36 Asv 131%;
dt=15.51 s=9.7 l=105 z=3.0
+ su 17.3.-1622 8.29 Asv 0%-20%; mo 3.3.-1622 174.49 Cit 11%;
dt=14.19 s=9.6 l=95-105 z=1.9-3.0
+ su 3.1.-1618 296.18 Dha 2%-91%; mo 19.12.-1619 101.44 Pus 20%-39%;
dt=14.48 s=9.5 l=60-105 z=-1.7-3.0
+ su 23.12.-1618 284.81 Sra 1%-6%; mo 9.12.-1618 90.50 Pun 3%-38%;
dt=13.96 s=9.5 l=87-92 z=1.1-1.6
+ su 29.5.-1607 78.25 Ard 3%-89%; mo 14.5.-1607 243.96 Mul 16%-90%;
dt=14.94 s=9.4 l=53-104 z=-2.5-3.0
+ su 17.3.-1603 8.42 Asv 4%-61%; mo 2.3.-1603 173.86 Cit 71%-133%;
dt=14.86 s=9.3 l=83-103 z=0.8-2.9
+ su 14.1.-1600 306.96 Sat 1%-79%; mo 31.12.-1601 112.34 Asl 38%;
dt=14.55 s=9.3 l=49-78 z=-3.0-0.1
x+ su 2.11.-1578 232.69 Jye 1%-22%; mo 17.10.-1578 36.90 Krt 126%;
dt=15.44 s=9.0 l=59-102 z=-1.9-2.9
+ su 20.8.-1574 158.45 UPh 2%-7%; mo 6.8.-1574 324.19 PBh 127%;
dt=14.50 s=8.9 l=50-51 z=-3.0--2.9
+ su 5.2.-1564 328.31 PBh 3%-51%; mo 21.1.-1564 133.95 PPh 31%;
dt=14.35 s=8.8 l=75-102 z=-0.1-2.9
+ su 24.1.-1563 317.19 Sat 25%-26%; mo 10.1.-1563 123.16 Mag 6%-12%;
dt=13.86 s=8.8 l=70-71 z=-0.7--0.6
+* su 24.1.-1563 317.19 Sat 3%-24%; mo 10.1.-1563 123.16 Mag 19%-125%;
dt=13.87 s=8.8 l=53-69 z=-2.7--0.8
+ su 19.4.-1549 39.28 Krt 1%-97%; mo 4.4.-1549 204.86 Vis 97%;
dt=14.97 s=8.6 l=84-102 z=0.9-3.0
+ su 15.2.-1546 338.87 UBh 11%-95%; mo 1.2.-1546 144.66 PPh 26%;
dt=14.40 s=8.5 l=51-102 z=-3.0-3.0
+ su 11.9.-1538 179.76 Cit 1%-24%; mo 27.8.-1538 345.22 UBh 109%;
dt=14.59 s=8.4 l=83-101 z=0.8-2.9
+ su 4.12.-1524 265.57 PAs 0%-25%; mo 19.11.-1524 69.80 Ard 126%;
dt=15.37 s=8.2 l=52-90 z=-3.0-1.6
+ su 22.7.-1517 129.32 Mag 78%-96%; mo 7.7.-1517 295.04 Dha 0%-25%;
dt=14.87 s=8.1 l=70-100 z=-0.8-2.9
+* su 26.2.-1509 348.93 Rev 1%-49%; mo 12.2.-1509 155.24 UPh 1%-66%;
dt=13.80 s=8.0 l=53-63 z=-2.9--1.6

+ su 21.5.-1495 69.83 Ard 0%; mo 6.5.-1495 235.42 Jye 53%;
dt=15.09 s=7.9 l=100 z=3.0
+ su 19.3.-1492 10.13 Asv 25%-97%; mo 5.3.-1492 176.33 Cit 4%;
dt=14.25 s=7.8 l=53-99 z=-3.0-2.9
+ su 13.10.-1484 212.25 Vis 47%-69%; mo 28.9.-1484 17.33 Bha 92%;
dt=14.69 s=7.7 l=53-99 z=-3.0-3.0
+ su 1.6.-1477 80.00 Pun 8%-80%; mo 17.5.-1477 245.57 Mul 1%-38%;
dt=15.12 s=7.6 l=53-95 z=-3.0-2.5
+ su 28.1.-1433 319.72 Sat 3%-32%; mo 12.1.-1433 124.41 Mag 123%;
dt=15.17 s=7.1 l=83-97 z=1.0-2.9
+ su 15.11.-1430 245.13 Mul 2%-53%; mo 31.10.-1430 49.95 Roh 86%;
dt=14.85 s=7.0 l=55-64 z=-3.0--1.7
+ su 3.7.-1404 110.61 Asl 3%-14%; mo 17.6.-1404 275.79 UAs 50%-126%;
dt=15.35 s=6.7 l=82-96 z=0.9-3.0
+ su 1.3.-1379 351.40 Rev 4%; mo 14.2.-1379 156.50 UPh 109%;
dt=15.05 s=6.4 l=95 z=2.9
+ su 23.5.-1365 71.02 Ard 3%-40%; mo 9.5.-1365 237.85 Jye 41%;
dt=13.92 s=6.2 l=58-69 z=-3.0--1.2
+ su 12.5.-1364 60.89 Mrg 1%-19%; mo 27.4.-1364 227.21 Jye 179%;
dt=14.22 s=6.2 l=58-77 z=-3.0-0.0
+ su 12.3.-1361 1.81 Asv 14%-33%; mo 25.2.-1361 167.06 Has 3%-63%;
dt=15.05 s=6.2 l=58-68 z=-3.0--1.4
+ su 26.8.-1314 162.62 Has 54%-71%; mo 11.8.-1314 327.47 PBh 3%-46%;
dt=15.42 s=5.7 l=59-67 z=-3.0--1.6
+ su 14.6.-1310 91.43 Pun 25%-53%; mo 30.5.-1310 257.64 PAs 69%-130%;
dt=14.35 s=5.6 l=60-93 z=-3.0-2.9
+ su 13.4.-1307 32.67 Krt 85%; mo 29.3.-1307 198.30 Sva 5%;
dt=14.88 s=5.6 l=60 z=-3.0
+ su 30.1.-1303 321.36 PBh 6%-87%; mo 15.1.-1303 126.26 Mag 78%;
dt=14.98 s=5.5 l=76-93 z=-0.1-3.0
+ su 17.9.-1278 183.93 Cit 0%-3%; mo 2.9.-1278 348.61 Rev 64%;
dt=15.33 s=5.3 l=88-92 z=2.1-2.9
+ su 27.9.-1260 194.69 Sva 85%-90%; mo 12.9.-1260 359.30 Rev 5%-10%;
dt=15.37 s=5.1 l=61-62 z=-3.0--2.8
+* su 4.5.-1252 52.47 Roh 2%-22%; mo 20.4.-1252 218.92 Anu 170%;
dt=14.06 s=5.0 l=83-90 z=1.4-2.8
+ su 4.3.-1249 353.10 Rev 43%-85%; mo 17.2.-1249 158.23 UPh 61%;
dt=15.07 s=4.9 l=62-91 z=-3.0-2.9
+ su 20.12.-1246 279.46 UAs 50%; mo 6.12.-1246 85.25 Pun 3%;
dt=13.95 s=4.9 l=91 z=2.9
+ su 27.7.-1238 132.57 Mag 0%-25%; mo 12.7.-1238 298.41 Dha 68%;
dt=14.67 s=4.8 l=70-90 z=-1.3-2.8
+ su 19.10.-1224 216.39 Anu 14%-41%; mo 3.10.-1224 20.87 Bha 54%;
dt=15.24 s=4.7 l=62-90 z=-3.0-3.0
+ su 6.6.-1217 83.41 Pun 1%-86%; mo 22.5.-1217 249.44 Mul 10%;
dt=14.80 s=4.6 l=63-84 z=-3.0-1.6
+* su 11.1.-1209 301.18 Dha 0%-49%; mo 28.12.-1210 107.10 Asl 1%-42%;
dt=13.82 s=4.5 l=79-87 z=0.5-2.3
+ su 5.4.-1195 24.23 Bha 44%-58%; mo 20.3.-1195 189.56 Sva 32%;
dt=15.18 s=4.4 l=63-89 z=-3.0-2.9
+ su 21.1.-1191 311.95 Sat 4%-29%; mo 7.1.-1191 117.96 Asl 4%-66%;
dt=13.94 s=4.3 l=72-87 z=-0.9-2.5

+ su 28.8.-1184 164.08 Has 83%-91%; mo 13.8.-1184 329.52 PBh 2%-23%;
dt=14.80 s=4.3 l=82-89 z=1.2-2.9
+ su 16.6.-1180 93.04 Pun 37%-53%; mo 2.6.-1180 259.67 PAs 3%-96%;
dt=13.91 s=4.2 l=72-88 z=-1.1-2.7
+* su 16.6.-1180 93.04 Pun 54%-60%; mo 2.6.-1180 259.67 PAs 100%-114%;
dt=13.91 s=4.2 l=64-71 z=-3.0--1.3
+ su 16.4.-1177 34.49 Krt 9%-12%; mo 1.4.-1177 199.86 Sva 1%-11%;
dt=15.31 s=4.2 l=64-68 z=-3.0--2.0
+ su 21.11.-1170 249.19 Mul 58%-87%; mo 6.11.-1170 53.62 Mrg 52%;
dt=15.15 s=4.1 l=64-88 z=-3.0-2.8
+* su 12.2.-1155 333.29 PBh 2%-39%; mo 29.1.-1155 139.48 PPh 0%-29%;
dt=13.81 s=4.0 l=71-77 z=-1.2-0.3
+ su 23.2.-1137 343.85 UBh 1%-11%; mo 9.2.-1137 150.14 UPh 2%-46%;
dt=13.94 s=3.8 l=76-87 z=-0.1-2.8
+ su 23.12.-1116 282.00 Sra 86%-90%; mo 8.12.-1116 86.57 Pun 52%-53%;
dt=15.07 s=3.6 l=66-87 z=-3.0-2.8
+ su 30.9.-1111 196.34 Sva 0%-9%; mo 15.9.-1111 0.78 Asv 143%;
dt=15.49 s=3.6 l=71-87 z=-1.6-2.9
+ su 18.5.-1104 65.00 Mrg 18%-42%; mo 2.5.-1104 230.30 Jye 119%;
dt=15.32 s=3.5 l=66-87 z=-3.0-3.0
+* su 17.3.-1101 4.76 Asv 1%-11%; mo 3.3.-1101 171.23 Has 3%-11%;
dt=13.83 s=3.5 l=77-79 z=0.2-0.7
+ su 9.8.-1090 144.48 PPh 0%-64%; mo 26.7.-1090 310.94 Sat 17%-46%;
dt=13.95 s=3.4 l=66-77 z=-3.0-0.3
+ su 8.5.-1076 55.59 Mrg 0%-6%; mo 23.4.-1076 221.60 Anu 10%;
dt=14.80 s=3.2 l=67-78 z=-3.0-0.4
+ su 25.1.-1061 314.41 Sat 73%-74%; mo 10.1.-1061 119.30 Asl 0%-14%;
dt=14.97 s=3.1 l=67-70 z=-3.0--2.0
+ su 14.1.-1060 303.09 Dha 0%-2%; mo 31.12.-1061 108.52 Asl 172%;
dt=14.31 s=3.1 l=69-85 z=-2.4-2.8
x+ su 2.11.-1057 229.02 Jye 0%-10%; mo 18.10.-1057 33.20 Krt 135%;
dt=15.53 s=3.1 l=67-73 z=-3.0--1.0
+ su 20.6.-1050 95.48 Pus 3%-40%; mo 4.6.-1050 260.83 PAs 78%;
dt=15.28 s=3.0 l=79-85 z=1.0-3.0
+ su 10.9.-1036 176.16 Cit 5%-42%; mo 27.8.-1036 342.38 UBh 0%-19%;
dt=13.96 s=2.9 l=75.2-85.4 z=-0.6-2.9
+ su 29.4.-1010 45.94 Roh 0%-23%; mo 14.4.-1010 212.03 Vis 112%;
dt=14.45 s=2.7 l=68.8-80.0 z=-3.0-1.2
+ su 15.2.-1006 335.12 UBh 20%-22%; mo 1.2.-1006 140.94 PPh 163%;
dt=14.15 s=2.6 l=68.9-84.7 z=-3.0-3.0
+ su 9.3.-989 356.67 Rev 0%-12%; mo 22.2.-989 162.12 Has 32%;
dt=14.94 s=2.5 l=69.3-74.7 z=-3.0--0.8
+ su 2.8.-978 136.58 PPh 45%-58%; mo 18.7.-978 301.80 Dha 29%;
dt=15.19 s=2.4 l=69.6-84.0 z=-3.0-3.0
+ su 26.12.-967 283.80 Sra 17%-23%; mo 10.12.-967 87.95 Pun 135%;
dt=15.48 s=2.3 l=69.9-83.7 z=-3.0-2.9
+ su 13.10.-963 208.41 Vis 21%-36%; mo 29.9.-963 14.05 Bha 20%-95%;
dt=14.15 s=2.3 l=70.0-83.6 z=-3.0-2.9
+* su 19.3.-952 6.50 Asv 13%-52%; mo 5.3.-952 172.72 Has 143%;
dt=14.02 s=2.2 l=70.2-83.4 z=-3.0-3.0
+ su 11.6.-938 86.68 Pun 34%-44%; mo 27.5.-938 252.69 Mul 49%;
dt=14.75 s=2.1 l=70.5-83.1 z=-3.0-3.0

+ su 10.4.-935 27.63 Krt 61%-79%; mo 26.3.-935 193.50 Sva 5%;
dt=14.72 s=2.1 l=70.6-83.0 z=-3.0-3.0
+ su 3.9.-924 168.05 Has 29%-76%; mo 19.8.-924 333.08 PBh 2%;
dt=15.15 s=2.0 l=70.9-82.7 z=-3.0-2.9
x+ su 15.11.-909 241.22 Mul 43%-50%; mo 1.11.-909 46.61 Roh 61%-108%;
dt=14.29 s=1.9 l=71.2-82.4 z=-3.0-2.9
+ su 3.9.-905 167.50 Has 10%-20%; mo 20.8.-905 333.17 PBh 124%;
dt=14.53 s=1.9 l=71.3-82.3 z=-3.0-2.9
+ su 7.12.-873 263.18 PAs 17%-29%; mo 22.11.-873 68.49 Ard 111%;
dt=14.27 s=1.6 l=71.9-81.7 z=-3.0-3.0
+ su 5.10.-851 199.60 Sva 36%-44%; mo 21.9.-851 5.09 Asv 106%;
dt=14.38 s=1.5 l=72.4-81.2 z=-3.0-2.9
+ su 8.1.-818 295.96 Dha 65%-70%; mo 24.12.-819 101.28 Pus 108%;
dt=14.38 s=1.3 l=73.0-80.6 z=-3.0-3.0
+ su 15.8.-811 148.67 UPh 4%-13%; mo 31.7.-811 313.58 Sat 98%;
dt=15.49 s=1.2 l=73.2-80.4 z=-3.0-2.9
+ su 2.4.-804 19.27 Bha 18%-31%; mo 17.3.-804 184.35 Cit 97%;
dt=15.35 s=1.2 l=73.3-80.3 z=-3.0-2.9
x+ su 7.11.-797 232.22 Jye 63%-64%; mo 24.10.-797 37.61 Krt 98%;
dt=14.28 s=1.1 l=73.4-80.2 z=-3.0-2.9
+* su 14.6.-789 87.97 Pun 20%-24%; mo 31.5.-789 254.62 PAs 107%-145%;
dt=13.88 s=1.1 l=73.6-80.0 z=-3.0-2.8
+ su 10.2.-764 328.25 PBh 10%-20%; mo 26.1.-764 133.72 PPh 98%;
dt=14.54 s=1.0 l=74.0-79.6 z=-3.0-2.9
+ su 17.9.-757 180.45 Cit 56%-61%; mo 2.9.-757 345.03 UBh 73%;
dt=15.50 s=0.9 l=74.1-79.5 z=-3.0-2.9
+ su 5.5.-750 49.95 Roh 92%-96%; mo 19.4.-750 215.31 Anu 64%;
dt=15.25 s=0.9 l=74.2-79.4 z=-3.0-2.9
+ su 9.12.-743 265.05 PAs 55%-60%; mo 25.11.-743 70.49 Ard 94%-96%;
dt=14.22 s=0.8 l=74.3-79.3 z=-3.0-3.0
+ su 19.10.-703 212.85 Vis 87%; mo 4.10.-703 17.15 Bha 60%;
dt=15.53 s=0.6 l=74.9-78.7 z=-3.0-3.0
+ su 17.6.-678 90.56 Pun 69%-73%; mo 2.6.-678 256.11 PAs 13%;
dt=15.15 s=0.5 l=75.3-78.3 z=-3.0-2.8
x+ su 10.11.-667 234.69 Jye 15%-17%; mo 25.10.-667 38.88 Krt 57%;
dt=15.45 s=0.5 l=75.4-78.2 z=-3.0-2.9
+ su 28.8.-663 160.39 Has 20%-23%; mo 14.8.-663 326.42 PBh 63%;
dt=14.19 s=0.5 l=75.5-78.2 z=-3.0-2.9
+ su 15.4.-656 30.93 Krt 6%-10%; mo 31.3.-656 196.75 Sva 39%-42%;
dt=14.77 s=0.4 l=75.6-78.1 z=-3.0-2.9
+ su 8.7.-623 110.41 Asl 24%-26%; mo 23.6.-623 276.59 UAs 108%;
dt=14.32 s=0.3 l=76.0-77.7 z=-3.0-2.7
+ su 13.12.-613 267.58 UAs 76%-78%; mo 27.11.-613 71.74 Ard 58%;
dt=15.42 s=0.3 l=76.1-77.6 z=-3.0-2.8
+ su 30.9.-609 192.44 Sva 94%-96%; mo 16.9.-609 358.07 Rev 38%;
dt=14.33 s=0.2 l=76.1-77.5 z=-3.0-2.7
+ su 19.7.-605 120.66 Mag 4%-5%; mo 5.7.-605 286.82 Sra 95%;
dt=14.44 s=0.2 l=76.2-77.5 z=-3.0-2.6
+ su 14.1.-558 300.25 Dha 96%; mo 29.12.-559 104.60 Pus 59%;
dt=15.41 s=0.0 l=76.85 z=0
x+ su 1.11.-555 225.05 Anu 71%; mo 18.10.-555 30.35 Krt 24%;
dt=14.51 s=0.0 l=76.85 z=0

+ su 20.8.-551 151.78 UPh 17%; mo 6.8.-551 317.83 Sat 61%;
dt=14.22 s=0.0 l=76.85 z=0
+ su 20.6.-529 92.21 Pun 12%; mo 4.6.-529 257.48 PAs 91%;
dt=15.36 s=0.0 l=76.85 z=0
+ su 23.11.-519 246.99 Mul 86%; mo 8.11.-519 52.14 Roh 20%;
dt=14.49 s=0.0 l=76.85 z=0
+ su 30.6.-511 102.41 Pus 26%; mo 15.6.-511 267.66 UAs 77%;
dt=15.50 s=0.0 l=76.85 z=0
+ su 28.4.-508 42.56 Roh 39%; mo 14.4.-508 209.31 Vis 2%;
dt=13.93 s=0.0 l=76.85 z=0
+ su 16.2.-504 332.40 PBh 96%; mo 1.2.-504 137.08 PPh 52%;
dt=15.35 s=0.0 l=76.85 z=0
+ su 22.9.-497 183.53 Cit 44%; mo 8.9.-497 349.40 Rev 36%;
dt=14.11 s=0.0 l=76.85 z=0
+ su 22.7.-475 122.95 Mag 58%; mo 6.7.-475 288.08 Sra 34%;
dt=15.38 s=0.0 l=76.85 z=0
+ su 1.9.-468 163.20 Has 8%; mo 17.8.-468 329.10 PBh 16%;
dt=14.31 s=0.0 l=76.85 z=0
+ su 26.12.-465 279.89 UAs 58%; mo 11.12.-465 84.95 Pun 18%;
dt=14.65 s=0.0 l=76.85 z=0
+ su 2.8.-457 133.29 Mag 62%; mo 18.7.-457 298.35 Dha 38%;
dt=15.50 s=0.0 l=76.85 z=0
+ su 20.3.-450 3.90 Asv 67%; mo 5.3.-450 168.97 Has 36%;
dt=15.25 s=0.0 l=76.85 z=0
+ su 26.12.-446 280.03 Sra 15%; mo 11.12.-446 84.36 Pun 146%;
dt=15.31 s=0.0 l=76.85 z=0
+* su 24.10.-443 215.90 Anu 68%; mo 10.10.-443 21.61 Bha 22%;
dt=14.06 s=0.0 l=76.85 z=0
+ su 31.5.-435 73.01 Ard 67%; mo 17.5.-435 239.57 Jye 97%;
dt=14.01 s=0.0 l=76.85 z=0
+ su 27.1.-410 312.47 Sat 77%; mo 12.1.-410 117.61 Asl 12%;
dt=14.81 s=0.0 l=76.85 z=0
+ su 3.9.-403 164.71 Has 99%; mo 19.8.-403 329.50 PBh 9%;
dt=15.49 s=0.0 l=76.85 z=0
+ su 21.4.-396 34.80 Krt 17%; mo 6.4.-396 200.22 Vis 8%;
dt=15.18 s=0.0 l=76.85 z=0
+ su 10.4.-395 24.04 Bha 43%; mo 26.3.-395 189.95 Sva 58%;
dt=14.46 s=0.0 l=76.85 z=0
+ su 26.11.-389 248.68 Mul 81%; mo 12.11.-389 54.32 Mrg 16%;
dt=14.00 s=0.0 l=76.85 z=0
+ su 3.7.-381 103.59 Pus 86%; mo 18.6.-381 270.02 UAs 48%;
dt=14.14 s=0.0 l=76.85 z=0
+ su 13.7.-363 113.86 Asl 45%; mo 29.6.-363 280.20 Sra 11%;
dt=14.28 s=0.0 l=76.85 z=0
+ su 18.2.-355 333.99 UBh 2%; mo 2.2.-355 138.60 PPh 136%;
dt=15.34 s=0.0 l=76.85 z=0
+ su 6.12.-352 259.36 PAs 2%; mo 22.11.-352 65.05 Mrg 50%;
dt=13.90 s=0.0 l=76.85 z=0
+ su 23.5.-323 64.78 Mrg 40%; mo 8.5.-323 231.10 Jye 93%;
dt=14.26 s=0.0 l=76.85 z=0
+ su 23.3.-301 5.52 Asv 59%; mo 7.3.-301 170.41 Has 116%;
dt=15.36 s=0.0 l=76.85 z=0

x+ su 27.10.-294 218.01 Anu 17%; mo 12.10.-294 22.88 Bha 63%;
dt=14.95 s=0.0 l=76.85 z=0
\+ su 16.7.-252 116.19 Asl 22%; mo 30.7.-252 282.01 Sra 6%;
dt=1629211.68 s=0.0 l=76.85 z=0
\+ su 5.7.-251 105.41 Pus 38%; mo 21.6.-251 271.87 UAs 29%;
dt=14.13 s=0.0 l=76.85 z=0
\+ su 16.9.-236 176.80 Cit 52%; mo 1.9.-236 341.68 UBh 33%;
dt=15.24 s=0.0 l=76.85 z=0
\+ su 14.3.-189 356.25 Rev 16%; mo 28.2.-189 162.37 Has 27%;
dt=14.08 s=0.0 l=76.85 z=0
\+ su 19.10.-182 209.13 Vis 82%; mo 4.10.-182 13.65 Bha 68%;
dt=15.35 s=0.0 l=76.85 z=0
\+ su 6.6.-175 77.22 Ard 62%; mo 21.5.-175 242.52 Mul 35%;
dt=15.39 s=0.0 l=76.85 z=0
\+ su 17.6.-157 87.39 Pun 79%; mo 2.6.-157 252.69 Mul 21%;
dt=15.52 s=0.0 l=76.85 z=0
\+ su 22.1.-149 305.21 Dha 56%; mo 7.1.-149 110.40 Asl 5%;
dt=14.54 s=0.0 l=76.85 z=0
x+ su 10.11.-146 230.95 Jye 27%; mo 25.10.-146 35.29 Krt 63%;
dt=15.32 s=0.0 l=76.85 z=0
\+ su 15.4.-135 27.37 Krt 44%; mo 1.4.-135 193.68 Sva 72%;
dt=14.13 s=0.0 l=76.85 z=0
\+ su 23.2.-95 337.25 UBh 45%; mo 8.2.-95 142.83 PPh 98%;
dt=14.41 s=0.0 l=76.85 z=0
\+ su 12.12.-92 263.86 PAs 93%; mo 26.11.-92 68.07 Ard 62%;
dt=15.39 s=0.0 l=76.85 z=0
\+ su 18.5.-81 58.07 Mrg 98%; mo 4.5.-81 224.45 Anu 30%;
dt=14.22 s=0.0 l=76.85 z=0
\+ su 14.1.-37 296.61 Dha 46%; mo 30.12.-38 100.90 Pus 62%;
dt=15.50 s=0.0 l=76.85 z=0
\+ su 7.4.-23 18.96 Bha 57%; mo 24.3.-23 185.10 Cit 69%;
dt=14.25 s=0.0 l=76.85 z=0
\+ su 19.6.-8 88.78 Pun 5%; mo 4.6.-8 254.34 PAs 108%;
dt=15.05 s=0.0 l=76.85 z=0

# N: Two Eclipses in a Month in the Full Moon Calendar

The Mahābhārata mentions that the war was announced by two eclipses within one month. If it is assumed that a full moon calendar was used, then this means that there was a solar eclipse in the middle of the month and a lunar eclipse at the end of the month. Though, in the author's opinion, this is not in agreement with the text. The following list contains all double eclipses of this type that occurred between 3500 BCE and 1 BCE and were potentially observable from Kurukṣetra. The events are marked with a – in order to distinguish them from the events in Appendix M.

Attention: *Here, the solar eclipse precedes the lunar eclipse.* In appendix M, it is the other way round.

The abbreviations *su* is followed by information on the solar eclipse: date (Julian with astronomical counting of years), ecliptic longitude and lunar mansion in the Lahiri zodiac as well as the magnitude of the eclipse in %. The abbreviation *mo* is followed by the same information for the lunar eclipse. The value *dt* is the number of days between the end of the solar eclipse and the beginning of the partial phase of the lunar eclipse. Eclipses are considered valid if the entire disc of the Moon or the Sun is above the horizon. However, it must be kept in mind that the full moon is usually not visible when she touches the horizon. This problem in particular concerns double eclipses that are marked with an * or a # (explained below).

An *x* at the beginning of a line indicates that the eclipses occurred approximately in the sky area which is demanded by epic. The solar eclipse should be near Jyeṣṭhā, the lunar eclipse in Kṛttikā or Rohiṇī, so that they can be assigned to the month of Kārttika. The calculations are based on the Lahiri *ayanāṃśa*. Unfortunately, it is unknown what definition of the lunar mansions underlies the information given in the Mahābhārata.

An * after the – indicates that the solar eclipse may have been dated to the 13th of the half-month, as requested by the epic. Since here the lunar eclipse follows the solar eclipse, the day number of the solar eclipse must have been counted from the previous full moon. Again, it must be taken into account that there are at least 13.8 days between a lunar and a solar eclipse. Day number 1 could have been the day on which the Moon set *after* sunrise for the first time. In this case, the previous day would have been considered the full moon day. If, e. g. the full moon day was 1st January, then the day number 1 was 2nd January. The solar eclipse would have occurred 14 days later on 15th January at sunrise. Since it had started before sunrise, it may have been dated to the previous day and thus would have fallen on the 13th day. Note, however, that this explanation is speculative.

A # after the – indicates that the lunar eclipse may have been dated to the 13th after the new moon, thus after the solar eclipse. This case could have occurred when both eclipses took place at sunrise at an interval of 14 days.

- su 13.6.-3497 103.83 Pus 1%-57%; mo 28.6.-3497 298.72 Dha 81%;
  dt=15.49 s=51.5 l=121-170 z=0.9-1.8

-* su 13.6.-3497 103.83 Pus 4%-67%; mo 28.6.-3497 298.72 Dha 64%-81%;
  dt=15.48 s=51.5 l=93-120 z=0.3-0.8

-# su 12.4.-3494 45.56 Roh 21%-30%; mo 26.4.-3494 238.78 Jye 1%-162%;
  dt=13.85 s=51.4 l=-77--49 z=-3.0--2.5

- su 1.4.-3493 35.14 Krt 2%-70%; mo 15.4.-3493 228.44 Jye 2%-26%;
  dt=13.90 s=51.4 l=-70--51 z=-2.9--2.5

- su 29.1.-3490 334.48 UBh 2%-90%; mo 13.2.-3490 169.56 Has 81%;
  dt=15.40 s=51.3 l=153-230 z=1.5-3.0

- su 17.11.-3487 261.22 PAs 1%-81%; mo 2.12.-3487 96.11 Pus 1%-93%;
  dt=14.63 s=51.2 l=148-222 z=1.4-2.8

- su 5.9.-3483 186.77 Sva 1%-49%; mo 19.9.-3483 21.18 Bha 106%;
  dt=14.18 s=51.1 l=198-229 z=2.4-3.0

- su 23.6.-3479 114.10 Asl 1%-37%; mo 8.7.-3479 309.09 Sat 90%;
  dt=15.51 s=50.9 l=10-42 z=-1.3--0.7

- su 23.6.-3479 114.10 Asl 2%-16%; mo 8.7.-3479 309.09 Sat 4%-89%;
  dt=15.51 s=50.9 l=142-162 z=1.3-1.7

-* su 23.6.-3479 114.10 Asl 3%-48%; mo 8.7.-3479 309.09 Sat 82%-90%;
  dt=15.50 s=50.9 l=-16-9 z=-1.8--1.3

-# su 23.4.-3476 55.70 Mrg 0%-15%; mo 7.5.-3476 248.91 Mul 21%-177%;
  dt=13.85 s=50.8 l=158-202 z=1.6-2.5

- su 12.4.-3475 45.28 Roh 3%-55%; mo 26.4.-3475 238.59 Jye 4%-41%;
  dt=13.92 s=50.8 l=179-209 z=2.0-2.6

- su 9.2.-3472 345.00 UBh 1%-81%; mo 24.2.-3472 179.95 Cit 91%;
  dt=15.37 s=50.7 l=31-160 z=-0.9-1.7

- su 28.11.-3469 272.14 UAs 0%-79%; mo 13.12.-3469 107.01 Asl 5%-95%;
  dt=14.67 s=50.6 l=21-91 z=-1.1-0.3

- su 16.9.-3465 197.62 Sva 1%-77%; mo 30.9.-3465 32.07 Krt 107%;
  dt=14.16 s=50.5 l=64-144 z=-0.2-1.3

- su 11.3.-3464 14.89 Bha 1%-13%; mo 27.3.-3464 209.60 Vis 5%;
  dt=15.36 s=50.5 l=170-192 z=1.9-2.3
- su 4.7.-3461 124.43 Mag 0%-18%; mo 20.7.-3461 319.52 Sat 6%-94%;
  dt=15.41 s=50.4 l=30-48 z=-0.9--0.6
- su 23.4.-3457 55.42 Mrg 1%-40%; mo 7.5.-3457 248.76 Mul 4%-55%;
  dt=13.95 s=50.3 l=68-110 z=-0.2-0.7
- su 19.2.-3454 355.43 Rev 0%-70%; mo 6.3.-3454 190.26 Sva 103%;
  dt=15.32 s=50.2 l=-73-33 z=-3.0--0.9
- su 8.12.-3451 283.03 Sra 53%-77%; mo 23.12.-3451 117.86 Asl 3%-97%;
  dt=14.61 s=50.1 l=-73--38 z=-3.0--2.3
- su 26.9.-3447 208.52 Vis 1%-78%; mo 10.10.-3447 43.00 Roh 109%;
  dt=14.14 s=50.0 l=-71-11 z=-3.0--1.3
- su 22.3.-3446 25.13 Bha 0%-8%; mo 7.4.-3446 219.81 Anu 17%;
  dt=15.35 s=49.9 l=68-87 z=-0.2-0.2
- su 14.7.-3443 134.84 PPh 14%-18%; mo 30.7.-3443 330.04 PBh 10%-34%;
  dt=15.40 s=49.9 l=-72--68 z=-3.0--2.9
- su 14.7.-3443 134.84 PPh 1%-2%; mo 30.7.-3443 330.04 PBh 107%;
  dt=15.40 s=49.9 l=139-140 z=1.3

-* su 15.7.-3443 134.84 PPh 2%-8%; mo 30.7.-3443 330.04 PBh 107%;
  dt=15.54 s=49.9 l=127-137 z=1.0-1.2

- su 3.5.-3439 65.54 Mrg 2%-26%; mo 17.5.-3439 258.92 PAs 4%-69%;
  dt=14.00 s=49.7 l=-43-11 z=-2.4--1.3
- su 2.3.-3436 5.80 Asv 34%-58%; mo 17.3.-3436 200.53 Vis 5%-116%;
  dt=15.29 s=49.6 l=158-224 z=1.7-3.0
- su 20.12.-3433 293.85 Dha 1%-73%; mo 4.1.-3432 128.64 Mag 2%-101%;
  dt=14.74 s=49.6 l=131-195 z=1.1-2.4

x- su 8.10.-3429 219.47 Anu 0%-79%; mo 22.10.-3429 53.96 Mrg 109%;
  dt=14.14 s=49.4 l=151-224 z=1.5-3.0

- su 1.4.-3428 35.32 Krt 0%; mo 17.4.-3428 229.98 Jye 30%;
  dt=15.36 s=49.4 l=-23--22 z=-2.0
- su 26.7.-3425 145.31 PPh 1%-22%; mo 11.8.-3425 340.62 UBh 1%-107%;
  dt=15.41 s=49.3 l=157-177 z=1.6-2.0
- su 15.5.-3421 75.66 Ard 3%-15%; mo 29.5.-3421 269.11 UAs 0%-82%;
  dt=14.07 s=49.2 l=205-224 z=2.6-3.0
- su 13.3.-3418 16.10 Bha 1%-45%; mo 28.3.-3418 210.74 Vis 4%-130%;
  dt=15.24 s=49.1 l=56-123 z=-0.4-1.0
- su 30.12.-3415 304.62 Dha 1%-68%; mo 14.1.-3414 139.35 PPh 2%-105%;
  dt=14.78 s=49.0 l=8-69 z=-1.4--0.1

x- su 18.10.-3411 230.44 Jye 1%-79%; mo 1.11.-3411 64.93 Mrg 86%-109%;
  dt=14.12 s=48.9 l=13-99 z=-1.3-0.5

- su 5.8.-3407 155.86 UPh 0%-25%; mo 21.8.-3407 351.29 Rev 5%-118%;
  dt=15.43 s=48.8 l=34-58 z=-0.9--0.4
- su 25.5.-3403 85.79 Pun 1%-8%; mo 8.6.-3403 279.33 UAs 2%-32%;
  dt=14.15 s=48.7 l=93-98 z=0.3-0.5
- su 25.5.-3403 85.79 Pun 1%-4%; mo 8.6.-3403 279.33 UAs 96%;
  dt=14.15 s=48.7 l=162-173 z=1.8-2.0
- su 23.3.-3400 26.36 Bha 1%-30%; mo 7.4.-3400 220.91 Anu 5%-144%;
  dt=15.19 s=48.6 l=-44--9 z=-2.5--1.8
- su 13.3.-3399 16.25 Bha 3%-103%; mo 27.3.-3399 210.17 Vis 0%-1%;
  dt=14.63 s=48.5 l=23-150 z=-1.1-1.5
- su 10.1.-3396 315.31 Sat 55%-61%; mo 25.1.-3396 149.97 UPh 7%-81%;
  dt=14.70 s=48.5 l=-68--56 z=-3.0--2.8

x- su 29.10.-3393 241.44 Mul 1%-79%; mo 12.11.-3393 75.90 Ard 109%;
dt=14.02 s=48.4 l=-68--38 z=-3.0--2.4
- su 16.8.-3389 166.49 Has 26%-30%; mo 1.9.-3389 2.02 Asv 6%-38%;
dt=15.41 s=48.2 l=-67--62 z=-3.0--2.9
- su 5.6.-3385 95.96 Pus 1%-2%; mo 19.6.-3385 289.60 Sra 4%-11%;
dt=14.24 s=48.1 l=-20--19 z=-2.0
- su 4.4.-3382 36.57 Krt 0%-1%; mo 19.4.-3382 231.05 Jye 4%-10%;
dt=15.16 s=48.0 l=217-218 z=2.9-3.0
- su 24.3.-3381 26.50 Bha 1%-103%; mo 7.4.-3381 220.33 Anu 12%-16%;
dt=14.54 s=48.0 l=-67-54 z=-3.0--0.5
- su 21.1.-3378 325.94 PBh 1%-52%; mo 5.2.-3378 160.54 Has 4%-119%;
dt=14.84 s=47.9 l=131-181 z=1.1-2.2
- su 9.11.-3375 252.43 Mul 2%-78%; mo 23.11.-3375 86.84 Pun 1%-110%;
dt=14.06 s=47.8 l=102-185 z=0.5-2.3
- su 27.8.-3371 177.20 Cit 0%-35%; mo 12.9.-3371 12.83 Asv 6%-123%;
dt=15.44 s=47.7 l=140-176 z=1.3-2.1
- su 21.2.-3370 356.73 Rev 1%-6%; mo 7.3.-3370 190.24 Sva 1%-13%;
dt=13.94 s=47.7 l=65-73 z=-0.2--0.1
- su 3.4.-3363 36.72 Krt 9%-25%; mo 18.4.-3363 230.47 Jye 32%;
dt=14.37 s=47.5 l=-65--62 z=-3.0--2.9
- su 3.4.-3363 36.72 Krt 7%-93%; mo 18.4.-3363 230.47 Jye 32%;
dt=14.37 s=47.5 l=145-218 z=1.4-3.0
- su 1.2.-3360 336.47 UBh 0%-40%; mo 16.2.-3360 171.01 Has 7%-127%;
dt=14.88 s=47.4 l=18-59 z=-1.2--0.4
- su 20.11.-3357 263.41 PAs 5%-78%; mo 4.12.-3357 97.76 Pus 1%-112%;
dt=14.01 s=47.3 l=-24-48 z=-2.1--0.6
- su 7.9.-3353 187.98 Sva 1%-39%; mo 23.9.-3353 23.69 Bha 4%-125%;
dt=15.44 s=47.2 l=9-53 z=-1.4--0.5
- su 3.3.-3352 7.06 Asv 0%-6%; mo 17.3.-3352 200.52 Vis 19%-26%;
dt=13.97 s=47.2 l=-44--31 z=-2.6--2.3
- su 15.4.-3345 46.90 Roh 3%-104%; mo 29.4.-3345 240.59 Mul 41%-49%;
dt=14.43 s=47.0 l=27-185 z=-1.0-2.3
- su 11.2.-3342 346.94 Rev 26%-27%; mo 26.2.-3342 181.43 Cit 7%-14%;
dt=14.85 s=46.9 l=-63--62 z=-3.0
- su 1.12.-3339 274.36 UAs 59%-63%; mo 15.12.-3339 108.63 Asl 6%-24%;
dt=13.97 s=46.8 l=213-216 z=2.9-3.0
- su 26.6.-3330 115.87 Asl 5%-97%; mo 11.7.-3330 310.40 Sat 2%-10%;
dt=14.96 s=46.5 l=113-145 z=0.8-1.5
- su 25.4.-3327 57.07 Mrg 2%-103%; mo 9.5.-3327 250.72 Mul 65%;
dt=14.37 s=46.4 l=-62-71 z=-3.0--0.1
- su 23.2.-3324 357.32 Rev 1%-12%; mo 9.3.-3324 191.76 Sva 4%-108%;
dt=14.94 s=46.3 l=164-179 z=1.9-2.2
- su 11.2.-3323 346.50 UBh 36%-86%; mo 26.2.-3323 181.46 Cit 9%;
dt=15.46 s=46.3 l=132-214 z=1.2-3.0
-* su 11.2.-3323 346.50 UBh 1%-67%; mo 26.2.-3323 181.46 Cit 9%;
dt=15.48 s=46.3 l=102-131 z=0.6-1.2
- su 12.12.-3321 285.26 Sra 1%-73%; mo 26.12.-3321 119.44 Asl 4%-117%;
dt=13.93 s=46.3 l=91-140 z=0.3-1.4
- su 29.9.-3317 209.73 Vis 1%-44%; mo 15.10.-3317 45.55 Roh 15%-125%;
dt=15.43 s=46.1 l=99-161 z=0.5-1.8
- su 6.7.-3312 126.19 Mag 5%-97%; mo 21.7.-3312 320.86 PBh 3%-18%;
dt=15.00 s=46.0 l=-9-44 z=-1.9--0.7

- su 6.5.-3309 67.22 Ard 0%-1%; mo 21.5.-3309 260.84 PAs 82%;
  dt=14.24 s=45.9 l=-47--45 z=-2.7
- su 6.5.-3309 67.22 Ard 69%-96%; mo 21.5.-3309 260.84 PAs 6%-82%;
  dt=14.24 s=45.9 l=182-214 z=2.3-3.0
- su 22.2.-3305 356.91 Rev 1%-98%; mo 9.3.-3305 191.80 Sva 19%;
  dt=15.46 s=45.8 l=18-129 z=-1.3-1.1
-* su 22.2.-3305 356.91 Rev 5%-69%; mo 9.3.-3305 191.80 Sva 19%;
  dt=15.47 s=45.8 l=-11-17 z=-1.9--1.3
- su 22.12.-3303 296.11 Dha 5%-68%; mo 5.1.-3302 130.18 Mag 4%-122%;
  dt=13.89 s=45.7 l=-28-8 z=-2.3--1.5
x- su 9.10.-3299 220.68 Anu 0%-45%; mo 25.10.-3299 56.53 Mrg 68%-125%;
  dt=15.43 s=45.6 l=-39-26 z=-2.5--1.1
- su 17.7.-3294 136.58 PPh 2%; mo 1.8.-3294 331.39 PBh 25%;
  dt=15.07 s=45.5 l=-59 z=-3.0
- su 17.5.-3291 77.39 Ard 0%-63%; mo 31.5.-3291 271.00 UAs 3%-97%;
  dt=14.27 s=45.4 l=84-133 z=0.2-1.3
- su 4.3.-3287 7.26 Asv 4%-99%; mo 19.3.-3287 202.08 Vis 30%;
  dt=15.38 s=45.3 l=-58-19 z=-3.0--1.3
- su 22.12.-3284 295.89 Dha 1%-28%; mo 5.1.-3283 129.92 Mag 1%-4%;
  dt=13.97 s=45.2 l=105-128 z=0.6-1.1
x- su 21.10.-3281 231.65 Jye 1%-37%; mo 6.11.-3281 67.50 Ard 124%;
  dt=15.43 s=45.1 l=182-211 z=2.3-3.0
- su 28.7.-3276 147.04 UPh 3%-97%; mo 12.8.-3276 342.00 UBh 2%-31%;
  dt=15.12 s=45.0 l=101-194 z=0.6-2.6
- su 28.5.-3273 87.56 Pun 1%-22%; mo 11.6.-3273 281.19 Sra 2%-83%;
  dt=14.24 s=44.9 l=-14-1 z=-2.0--1.7
- su 16.3.-3269 17.54 Bha 73%-99%; mo 31.3.-3269 212.31 Vis 42%;
  dt=15.45 s=44.8 l=154-210 z=1.7-3.0
-* su 16.3.-3269 17.54 Bha 2%-81%; mo 31.3.-3269 212.31 Vis 42%;
  dt=15.47 s=44.8 l=124-153 z=1.1-1.7
- su 13.1.-3266 317.60 Sat 3%-26%; mo 27.1.-3266 151.45 UPh 1%-70%;
  dt=13.84 s=44.7 l=101-112 z=0.6-0.8
- su 2.1.-3265 306.65 Dha 4%-40%; mo 16.1.-3265 140.61 PPh 0%-9%;
  dt=13.97 s=44.6 l=-21-8 z=-2.2--1.5
x- su 31.10.-3263 242.65 Mul 1%-47%; mo 16.11.-3263 78.48 Ard 124%;
  dt=15.42 s=44.6 l=42-112 z=-0.8-0.8
- su 8.8.-3258 157.57 UPh 4%-97%; mo 23.8.-3258 352.68 Rev 3%-35%;
  dt=15.23 s=44.4 l=-27-84 z=-2.3-0.2
- su 26.3.-3251 27.77 Krt 3%-100%; mo 10.4.-3251 222.50 Anu 55%;
  dt=15.45 s=44.3 l=43-161 z=-0.8-1.9
-* su 26.3.-3251 27.77 Krt 1%-90%; mo 10.4.-3251 222.50 Anu 55%;
  dt=15.47 s=44.3 l=13-42 z=-1.4--0.8
- su 11.11.-3245 253.64 PAs 2%-47%; mo 27.11.-3245 89.42 Pun 124%;
  dt=15.34 s=44.1 l=-55--25 z=-3.0--2.3
- su 18.8.-3240 168.20 Has 5%-80%; mo 3.9.-3240 3.44 Asv 38%;
  dt=15.18 s=43.9 l=-54--30 z=-3.0--2.5
- su 6.4.-3233 37.96 Krt 0%-95%; mo 21.4.-3233 232.67 Jye 68%;
  dt=15.44 s=43.7 l=-54-46 z=-3.0--0.7
-# su 4.2.-3230 338.78 UBh 1%-22%; mo 18.2.-3230 172.41 Has 2%-135%;
  dt=13.92 s=43.7 l=115-136 z=0.9-1.4
- su 24.1.-3229 327.96 PBh 4%-74%; mo 7.2.-3229 161.77 Has 1%-24%;
  dt=13.97 s=43.6 l=96-138 z=0.5-1.4

- su 22.11.-3227 264.62 PAs 0%-47%; mo 7.12.-3227 100.34 Pus 125%;
  dt=15.39 s=43.6 l=123-198 z=1.1-2.8
- su 30.8.-3222 178.89 Cit 1%-97%; mo 14.9.-3222 14.26 Bha 41%;
  dt=15.31 s=43.4 l=104-206 z=0.6-3.0
-# su 19.6.-3218 107.99 Asl 3%-73%; mo 3.7.-3218 301.31 Dha 3%-19%;
  dt=13.90 s=43.3 l=118-152 z=1.0-1.8
- su 17.4.-3215 48.12 Roh 71%-83%; mo 2.5.-3215 242.82 Mul 82%;
  dt=15.46 s=43.2 l=183-206 z=2.5-3.0
-* su 17.4.-3215 48.12 Roh 6%-85%; mo 2.5.-3215 242.82 Mul 82%;
  dt=15.47 s=43.2 l=154-182 z=1.8-2.4
-# su 15.2.-3212 349.26 Rev 1%-22%; mo 29.2.-3212 182.79 Cit 5%-165%;
  dt=13.90 s=43.2 l=-3-24 z=-1.9--1.2
- su 3.2.-3211 338.50 UBh 5%-94%; mo 17.2.-3211 172.24 Has 3%-33%;
  dt=13.98 s=43.1 l=-22-27 z=-2.3--1.1
- su 3.12.-3209 275.56 UAs 1%-46%; mo 18.12.-3209 111.19 Asl 127%;
  dt=15.38 s=43.1 l=-16-61 z=-2.2--0.4
- su 9.9.-3204 189.66 Sva 0%-97%; mo 24.9.-3204 25.15 Bha 42%;
  dt=15.35 s=42.9 l=-17-92 z=-2.2-0.4
-# su 29.6.-3200 118.27 Asl 1%-95%; mo 13.7.-3200 311.69 Sat 3%-30%;
  dt=13.90 s=42.8 l=8-43 z=-1.6--0.8
- su 28.4.-3197 58.27 Mrg 1%-67%; mo 13.5.-3197 252.97 Mul 96%;
  dt=15.46 s=42.7 l=73-136 z=-0.1-1.4
-* su 28.4.-3197 58.27 Mrg 6%-71%; mo 13.5.-3197 252.97 Mul 96%;
  dt=15.47 s=42.7 l=45-72 z=-0.7--0.1
- su 29.5.-3189 87.81 Pun 0%-20%; mo 13.6.-3189 282.15 Sra 0%-16%;
  dt=14.97 s=42.5 l=139-163 z=1.5-2.0
- su 20.9.-3186 200.49 Vis 2%-72%; mo 6.10.-3186 36.08 Krt 42%;
  dt=15.29 s=42.4 l=-50--31 z=-3.0--2.6
- su 8.5.-3179 68.41 Ard 1%-50%; mo 23.5.-3179 263.13 PAs 110%;
  dt=15.47 s=42.2 l=-38-12 z=-2.7--1.5
-* su 8.5.-3179 68.41 Ard 51%-55%; mo 23.5.-3179 263.13 PAs 110%;
  dt=15.47 s=42.2 l=-49--39 z=-3.0--2.8
-# su 8.3.-3176 10.00 Asv 0%-2%; mo 22.3.-3176 203.37 Vis 6%-121%;
  dt=13.87 s=42.1 l=146-163 z=1.7-2.1
- su 25.2.-3175 359.35 Rev 4%-97%; mo 11.3.-3175 192.97 Sva 0%-55%;
  dt=14.03 s=42.1 l=106-172 z=0.7-2.3
- su 25.12.-3173 297.32 Dha 1%-41%; mo 9.1.-3172 132.72 Mag 134%;
  dt=15.33 s=42.1 l=70-152 z=-0.1-1.8
- su 14.12.-3172 286.61 Sra 3%-101%; mo 29.12.-3172 121.40 Mag 1%;
  dt=14.78 s=42.0 l=144-202 z=1.6-3.0
- su 8.6.-3171 97.99 Pus 0%-7%; mo 23.6.-3171 292.44 Sra 3%-28%;
  dt=15.03 s=42.0 l=23-38 z=-1.3--0.9
- su 1.10.-3168 211.38 Vis 0%-97%; mo 16.10.-3168 47.05 Roh 41%;
  dt=15.43 s=41.9 l=91-202 z=0.3-3.0
-# su 21.7.-3164 139.04 PPh 4%-78%; mo 4.8.-3164 332.66 PBh 2%-48%;
  dt=13.92 s=41.8 l=150-177 z=1.8-2.4
-* su 20.5.-3161 78.56 Ard 1%-39%; mo 4.6.-3161 273.32 UAs 121%-123%;
  dt=15.47 s=41.7 l=187-201 z=2.7-3.0
- su 8.3.-3157 9.65 Asv 0%-97%; mo 22.3.-3157 203.24 Vis 3%-68%;
  dt=14.06 s=41.6 l=-7-68 z=-2.0--0.2
- su 4.1.-3154 308.11 Sat 2%-36%; mo 19.1.-3154 143.38 PPh 140%;
  dt=15.24 s=41.5 l=-47-19 z=-3.0--1.4

- su 25.12.-3154 297.47 Dha 3%-102%; mo 9.1.-3153 132.13 Mag 1%-5%;
dt=14.71 s=41.5 l=13-117 z=-1.5-1.0

x- su 12.10.-3150 222.31 Anu 0%-97%; mo 27.10.-3150 58.04 Mrg 41%;
dt=15.46 s=41.4 l=-39-74 z=-2.8--0.1

-# su 1.8.-3146 149.52 UPh 1%-55%; mo 15.8.-3146 343.26 UBh 3%-55%;
dt=13.95 s=41.3 l=40-60 z=-0.9--0.4

- su 30.5.-3143 88.73 Pun 1%-16%; mo 14.6.-3143 283.54 Sra 136%;
dt=15.48 s=41.2 l=97-116 z=0.5-1.0

-* su 30.5.-3143 88.73 Pun 4%-22%; mo 14.6.-3143 283.54 Sra 130%-136%;
dt=15.47 s=41.2 l=80-96 z=0.1-0.5

- su 18.3.-3139 19.92 Bha 1%-15%; mo 1.4.-3139 213.48 Anu 81%;
dt=14.07 s=41.1 l=-46--37 z=-3.0--2.8

- su 16.1.-3136 318.81 Sat 0%-30%; mo 31.1.-3136 153.95 UPh 147%;
dt=15.26 s=41.0 l=164-199 z=2.1-3.0

- su 4.1.-3135 308.25 Sat 40%-69%; mo 19.1.-3135 142.78 PPh 2%-12%;
dt=14.58 s=41.0 l=-46-9 z=-3.0--1.6

x- su 23.10.-3132 233.27 Jye 1%-16%; mo 7.11.-3132 69.04 Ard 40%;
dt=15.49 s=40.9 l=189-199 z=2.7-3.0

- su 11.8.-3128 160.09 Has 1%-76%; mo 25.8.-3128 353.94 Rev 4%-54%;
dt=13.84 s=40.8 l=106-119 z=0.7-1.0

- su 10.6.-3125 98.94 Pus 0%-1%; mo 25.6.-3125 293.82 Dha 148%;
dt=15.50 s=40.7 l=-19--18 z=-2.4--2.3

-* su 10.6.-3125 98.94 Pus 1%-3%; mo 25.6.-3125 293.82 Dha 143%-148%;
dt=15.49 s=40.7 l=-26--20 z=-2.5--2.4

- su 30.3.-3121 30.12 Krt 5%-81%; mo 13.4.-3121 223.67 Anu 1%-95%;
dt=14.17 s=40.6 l=128-197 z=1.3-3.0

- su 26.1.-3118 329.45 PBh 1%-22%; mo 10.2.-3118 164.45 Has 76%-156%;
dt=15.22 s=40.6 l=36-100 z=-1.0-0.6

- su 16.1.-3117 318.97 Sat 3%-102%; mo 30.1.-3117 153.35 UPh 20%;
dt=14.59 s=40.5 l=116-198 z=1.0-3.0

- su 3.11.-3114 244.25 Mul 0%-97%; mo 18.11.-3114 80.02 Pun 39%;
dt=15.52 s=40.4 l=54-173 z=-0.6-2.4

- su 2.9.-3111 181.61 Cit 0%-1%; mo 16.9.-3111 15.82 Bha 174%;
dt=13.97 s=40.4 l=120-124 z=1.1-1.2

- su 22.8.-3110 170.73 Has 2%-87%; mo 5.9.-3110 4.70 Asv 1%-65%;
dt=13.86 s=40.3 l=-22-2 z=-2.5--1.8

- su 10.6.-3106 99.01 Pus 2%-84%; mo 25.6.-3106 293.39 Dha 2%-13%;
dt=14.94 s=40.2 l=145-168 z=1.7-2.3

- su 9.4.-3103 40.29 Roh 1%-67%; mo 23.4.-3103 233.85 Jye 5%-108%;
dt=14.22 s=40.2 l=17-78 z=-1.5--0.0

- su 6.2.-3100 340.01 UBh 0%-4%; mo 21.2.-3100 174.88 Cit 166%;
dt=15.11 s=40.1 l=-43--39 z=-3.0--2.9

- su 26.1.-3099 329.60 PBh 4%-102%; mo 9.2.-3099 163.84 Has 29%;
dt=14.53 s=40.0 l=-10-125 z=-2.2-1.2

- su 13.11.-3096 255.23 PAs 3%-97%; mo 29.11.-3096 90.99 Pun 39%;
dt=15.44 s=40.0 l=-43-42 z=-3.0--0.8

- su 13.9.-3093 192.41 Sva 0%-2%; mo 27.9.-3093 26.68 Krt 172%;
dt=13.96 s=39.9 l=-11--4 z=-2.2--2.0

- su 20.6.-3088 109.28 Asl 2%-85%; mo 5.7.-3088 303.70 Dha 3%-25%;
dt=14.90 s=39.7 l=40-55 z=-0.9--0.5

- su 20.4.-3085 50.41 Roh 1%-5%; mo 4.5.-3085 244.01 Mul 123%;
dt=14.26 s=39.7 l=-42--39 z=-3.0--2.9

- su 17.2.-3082 350.50 Rev 0%-2%; mo 4.3.-3082 185.23 Cit 5%-24%;
  dt=15.09 s=39.6 l=175-178 z=2.5-2.6
- su 6.2.-3081 340.16 UBh 2%-102%; mo 21.2.-3081 174.27 Cit 40%;
  dt=14.36 s=39.6 l=-41-2 z=-3.0--1.9
- su 25.11.-3078 266.18 PAs 0%-80%; mo 10.12.-3078 101.91 Pus 39%;
  dt=15.55 s=39.5 l=141-194 z=1.6-3.0
- su 13.9.-3074 192.23 Sva 5%-97%; mo 27.9.-3074 26.40 Bha 2%-69%;
  dt=13.91 s=39.4 l=76-120 z=-0.0-1.1
- su 2.7.-3070 119.59 Asl 0%-68%; mo 17.7.-3070 314.07 Sat 0%-28%;
  dt=14.97 s=39.3 l=108-117 z=0.8-1.0
- su 1.5.-3067 60.54 Mrg 14%-39%; mo 15.5.-3067 254.19 PAs 6%-137%;
  dt=14.34 s=39.2 l=155-194 z=2.0-3.0
- su 17.2.-3063 350.65 Rev 6%-103%; mo 3.3.-3063 184.62 Cit 52%;
  dt=14.41 s=39.1 l=102-193 z=0.7-3.0
- su 5.12.-3060 277.11 UAs 4%-98%; mo 20.12.-3060 112.78 Asl 40%;
  dt=15.54 s=39.0 l=19-142 z=-1.5-1.7

-* su 5.12.-3060 277.11 UAs 2%-14%; mo 20.12.-3060 112.78 Asl 40%;
  dt=15.55 s=39.0 l=8-18 z=-1.7--1.5

- su 5.10.-3057 214.19 Anu 0%-3%; mo 19.10.-3057 48.54 Roh 170%;
  dt=13.95 s=38.9 l=80-93 z=0.1-0.4
- su 23.9.-3056 203.07 Vis 3%-89%; mo 7.10.-3056 37.32 Krt 70%-71%;
  dt=13.93 s=38.9 l=-39--4 z=-3.0--2.1
- su 12.7.-3052 129.97 Mag 1%-73%; mo 27.7.-3052 324.51 PBh 2%-46%;
  dt=14.94 s=38.8 l=-9-13 z=-2.2--1.6
- su 12.5.-3049 70.65 Ard 1%-23%; mo 26.5.-3049 264.36 PAs 1%-150%;
  dt=14.39 s=38.7 l=43-87 z=-0.9-0.3
- su 30.4.-3048 59.99 Mrg 19%-67%; mo 15.5.-3048 254.27 PAs 2%-16%;
  dt=14.97 s=38.7 l=157-192 z=2.1-3.0
- su 28.2.-3045 1.06 Asv 4%-103%; mo 14.3.-3045 194.91 Sva 42%-66%;
  dt=14.35 s=38.6 l=-20-120 z=-2.5-1.1
- su 16.12.-3042 287.98 Sra 0%-87%; mo 1.1.-3041 123.59 Mag 43%;
  dt=15.43 s=38.5 l=-38-15 z=-3.0--1.6
- su 5.10.-3038 213.97 Anu 78%-97%; mo 19.10.-3038 48.29 Roh 4%-71%;
  dt=13.96 s=38.4 l=167-191 z=2.4-3.0
- su 11.5.-3030 70.12 Ard 2%-57%; mo 26.5.-3030 264.45 PAs 0%-28%;
  dt=15.01 s=38.2 l=42-98 z=-0.9-0.6
- su 10.3.-3027 11.40 Asv 0%-45%; mo 24.3.-3027 205.14 Vis 80%;
  dt=14.20 s=38.1 l=-37-1 z=-3.0--2.0
- su 27.12.-3024 298.82 Dha 48%-98%; mo 11.1.-3023 134.34 PPh 46%;
  dt=15.52 s=38.0 l=138-190 z=1.6-3.0

-* su 27.12.-3024 298.82 Dha 4%-46%; mo 11.1.-3023 134.34 PPh 46%;
  dt=15.54 s=38.0 l=116-137 z=1.0-1.6

x- su 27.10.-3021 236.12 Jye 0%-2%; mo 10.11.-3021 70.49 Ard 98%-171%;
  dt=13.93 s=38.0 l=165-183 z=2.3-2.8

x- su 15.10.-3020 224.89 Anu 4%-96%; mo 29.10.-3020 59.27 Mrg 2%-71%;
  dt=14.00 s=37.9 l=31-102 z=-1.2-0.7

- su 3.8.-3016 150.93 UPh 0%-27%; mo 18.8.-3016 345.61 UBh 44%-61%;
  dt=14.88 s=37.8 l=116-149 z=1.0-1.9
- su 21.5.-3012 80.25 Pun 0%-49%; mo 5.6.-3012 274.66 UAs 41%;
  dt=15.04 s=37.7 l=-36-1 z=-3.0--2.0
- su 22.3.-3009 21.69 Bha 46%-90%; mo 5.4.-3009 215.33 Anu 5%-95%;
  dt=14.23 s=37.6 l=133-188 z=1.5-3.0

- su 7.1.-3005 309.57 Sat 3%-99%; mo 22.1.-3005 144.99 PPh 51%;
  dt=15.51 s=37.5 l=18-125 z=-1.6-1.3
-* su 7.1.-3005 309.57 Sat 3%-59%; mo 22.1.-3005 144.99 PPh 51%;
  dt=15.54 s=37.5 l=-7-17 z=-2.3--1.6
- su 6.11.-3003 247.12 Mul 0%-1%; mo 20.11.-3003 81.46 Pun 51%-160%;
  dt=13.92 s=37.5 l=28-45 z=-1.3--0.8
x- su 26.10.-3002 235.86 Jye 1%-52%; mo 9.11.-3002 70.27 Ard 71%;
  dt=14.00 s=37.5 l=-35--26 z=-3.0--2.8
- su 14.8.-2998 161.53 Has 0%-5%; mo 29.8.-2998 356.28 Rev 67%;
  dt=14.86 s=37.4 l=-1-8 z=-2.1--1.8
- su 2.6.-2994 90.40 Pun 15%-25%; mo 17.6.-2994 284.90 Sra 4%-50%;
  dt=15.14 s=37.3 l=175-188 z=2.6-3.0
- su 1.4.-2991 31.92 Krt 1%-67%; mo 15.4.-2991 225.49 Anu 2%-111%;
  dt=14.16 s=37.2 l=35-89 z=-1.1-0.3
- su 17.1.-2987 320.27 PBh 4%-95%; mo 2.2.-2987 155.59 UPh 57%;
  dt=15.40 s=37.1 l=-34-3 z=-3.0--2.0
- su 6.11.-2984 246.83 Mul 45%-96%; mo 20.11.-2984 81.25 Pun 5%-71%;
  dt=14.08 s=37.0 l=120-186 z=1.2-3.0
- su 12.6.-2976 100.59 Pus 1%-17%; mo 27.6.-2976 295.20 Dha 4%-63%;
  dt=15.22 s=36.8 l=60-76 z=-0.4--0.0
- su 12.6.-2976 100.59 Pus 1%-42%; mo 27.6.-2976 295.20 Dha 64%;
  dt=15.22 s=36.8 l=101-164 z=0.7-2.4
- su 29.1.-2969 330.87 PBh 75%-99%; mo 13.2.-2969 166.10 Has 64%;
  dt=15.49 s=36.6 l=139-186 z=1.7-3.0
-* su 29.1.-2969 330.87 PBh 0%-74%; mo 13.2.-2969 166.10 Has 64%;
  dt=15.52 s=36.6 l=111-138 z=0.9-1.7
- su 17.11.-2966 257.79 PAs 4%-96%; mo 1.12.-2966 92.21 Pun 2%-72%;
  dt=14.12 s=36.5 l=-15-77 z=-2.5--0.0
- su 23.6.-2958 110.82 Asl 0%-41%; mo 8.7.-2958 305.55 Dha 74%;
  dt=15.16 s=36.3 l=9-64 z=-1.8--0.3
- su 8.2.-2951 341.42 UBh 3%-93%; mo 23.2.-2951 176.54 Cit 73%;
  dt=15.49 s=36.1 l=20-125 z=-1.6-1.3
-* su 8.2.-2951 341.42 UBh 5%-75%; mo 23.2.-2951 176.54 Cit 73%;
  dt=15.51 s=36.1 l=-7-19 z=-2.3--1.6
- su 15.9.-2944 193.77 Sva 0%-8%; mo 30.9.-2944 28.69 Krt 1%-21%;
  dt=14.70 s=36.0 l=61-65 z=-0.4--0.3
-# su 23.4.-2936 52.25 Roh 3%-8%; mo 7.5.-2936 245.36 Mul 23%;
  dt=13.88 s=35.7 l=182-183 z=3.0
- su 19.2.-2933 351.87 Rev 2%-47%; mo 7.3.-2933 186.90 Sva 83%;
  dt=15.39 s=35.7 l=-30-7 z=-3.0--1.9
- su 9.12.-2930 279.64 UAs 15%-96%; mo 23.12.-2930 114.00 Asl 1%-76%;
  dt=14.19 s=35.6 l=81-183 z=0.1-3.0
- su 15.7.-2922 131.46 Mag 1%-23%; mo 30.7.-2922 326.45 PBh 91%;
  dt=15.24 s=35.4 l=163-182 z=2.5-3.0
-# su 4.5.-2918 62.38 Mrg 2%-65%; mo 18.5.-2918 255.51 PAs 1%-38%;
  dt=13.87 s=35.3 l=73-116 z=-0.1-1.1
- su 2.3.-2915 2.27 Asv 66%-72%; mo 17.3.-2915 197.21 Sva 95%;
  dt=15.47 s=35.2 l=146-182 z=2.0-3.0
-* su 2.3.-2915 2.27 Asv 1%-66%; mo 17.3.-2915 197.21 Sva 95%;
  dt=15.49 s=35.2 l=119-145 z=1.2-1.9
- su 19.12.-2912 290.50 Sra 3%-96%; mo 2.1.-2911 124.80 Mag 78%-79%;
  dt=14.18 s=35.1 l=-28-62 z=-3.0--0.4

- su 7.10.-2908 215.57 Anu 1%-66%; mo 22.10.-2908 50.53 Roh 30%-78%;
  dt=14.65 s=35.0 l=147-181 z=2.0-3.0
- su 2.4.-2907 32.14 Krt 11%-17%; mo 17.4.-2907 226.48 Anu 2%-13%;
  dt=15.01 s=35.0 l=175-181 z=2.8-3.0
- su 25.7.-2904 141.89 PPh 0%-46%; mo 10.8.-2904 337.01 UBh 98%;
  dt=15.29 s=34.9 l=53-109 z=-0.7-0.9
-# su 14.5.-2900 72.52 Ard 45%-86%; mo 28.5.-2900 265.68 PAs 2%-53%;
  dt=13.87 s=34.8 l=-27-9 z=-3.0--1.9
- su 13.3.-2897 12.59 Asv 1%-60%; mo 28.3.-2897 207.46 Vis 107%;
  dt=15.46 s=34.8 l=30-106 z=-1.3-0.9
-* su 13.3.-2897 12.59 Asv 5%-57%; mo 28.3.-2897 207.46 Vis 107%;
  dt=15.48 s=34.8 l=5-29 z=-2.1--1.4
x- su 18.10.-2890 226.54 Anu 2%-94%; mo 2.11.-2890 61.49 Mrg 5%-79%;
  dt=14.62 s=34.6 l=8-66 z=-2.0--0.3
- su 13.4.-2889 42.31 Roh 1%-16%; mo 28.4.-2889 236.67 Jye 27%;
  dt=15.06 s=34.6 l=73-114 z=-0.1-1.1
- su 5.8.-2886 152.40 UPh 4%-48%; mo 21.8.-2886 347.65 Rev 102%-103%;
  dt=15.29 s=34.5 l=-26--2 z=-3.0--2.3
- su 23.3.-2879 22.86 Bha 0%-6%; mo 8.4.-2879 217.67 Anu 120%;
  dt=15.41 s=34.3 l=-26--22 z=-3.0--2.9
- su 10.1.-2875 312.03 Sat 25%-91%; mo 24.1.-2875 146.21 PPh 3%-89%;
  dt=14.27 s=34.2 l=63-179 z=-0.4-3.0
- su 23.4.-2871 52.44 Roh 0%-1%; mo 8.5.-2871 246.82 Mul 40%;
  dt=15.09 s=34.1 l=-6-7 z=-2.4--2.0
-# su 5.6.-2864 92.83 Pun 4%-92%; mo 19.6.-2864 286.12 Sra 3%-80%;
  dt=13.89 s=33.9 l=115-151 z=1.1-2.2
- su 4.4.-2861 33.08 Krt 30%-34%; mo 19.4.-2861 227.84 Jye 134%;
  dt=15.45 s=33.9 l=160-178 z=2.5-3.0
-* su 4.4.-2861 33.08 Krt 4%-34%; mo 19.4.-2861 227.84 Jye 134%;
  dt=15.45 s=33.9 l=139-159 z=1.8-2.4
- su 21.1.-2857 322.69 PBh 0%-83%; mo 4.2.-2857 156.80 UPh 96%;
  dt=14.24 s=33.8 l=-24-68 z=-3.0--0.2
- su 9.11.-2854 248.52 Mul 1%-101%; mo 24.11.-2854 83.39 Pun 48%-80%;
  dt=14.57 s=33.7 l=85-177 z=0.3-3.0
- su 27.8.-2850 173.63 Cit 1%-50%; mo 12.9.-2850 9.14 Asv 38%-110%;
  dt=15.38 s=33.6 l=61-125 z=-0.5-1.4
-# su 16.6.-2846 103.03 Pus 2%-71%; mo 30.6.-2846 296.40 Dha 2%-93%;
  dt=13.91 s=33.5 l=11-40 z=-2.0--1.1
- su 14.4.-2843 43.28 Roh 1%-21%; mo 29.4.-2843 238.00 Jye 148%;
  dt=15.44 s=33.4 l=45-81 z=-0.9-0.1
-* su 14.4.-2843 43.28 Roh 4%-21%; mo 29.4.-2843 238.00 Jye 148%;
  dt=15.45 s=33.4 l=28-44 z=-1.4--1.0
- su 19.11.-2836 259.52 PAs 5%-100%; mo 4.12.-2836 94.32 Pus 80%-81%;
  dt=14.45 s=33.2 l=-22-47 z=-3.0--0.9
- su 6.9.-2832 184.36 Cit 1%-51%; mo 22.9.-2832 19.98 Bha 2%-112%;
  dt=15.38 s=33.1 l=-22-4 z=-3.0--2.2
- su 26.6.-2828 113.28 Asl 1%-14%; mo 10.7.-2828 306.75 Sat 1%-19%;
  dt=13.82 s=33.0 l=91-94 z=0.5
- su 12.2.-2821 343.76 UBh 4%-64%; mo 26.2.-2821 177.75 Cit 84%-114%;
  dt=14.34 s=32.9 l=77-175 z=0.0-3.0
- su 1.12.-2818 270.49 UAs 1%-23%; mo 15.12.-2818 105.20 Pus 83%;
  dt=14.50 s=32.8 l=161-174 z=2.6-3.0

- su 18.9.-2814 195.16 Sva 1%-8%; mo 4.10.-2814 30.88 Krt 113%;
  dt=15.43 s=32.7 l=170-174 z=2.9-3.0
- su 7.7.-2810 123.59 Mag 1%-35%; mo 21.7.-2810 317.16 Sat 29%-91%;
  dt=13.84 s=32.6 l=-20--9 z=-3.0--2.7
-# su 8.7.-2810 123.59 Mag 1%-23%; mo 22.7.-2810 317.16 Sat 0%-45%;
  dt=13.98 s=32.6 l=166-173 z=2.7-3.0
- su 22.2.-2803 354.18 Rev 1%-52%; mo 8.3.-2803 188.13 Sva 125%;
  dt=14.36 s=32.4 l=-20-73 z=-3.0--0.1
- su 11.12.-2800 281.42 Sra 1%-96%; mo 25.12.-2800 116.03 Asl 87%;
  dt=14.46 s=32.3 l=19-133 z=-1.8-1.8
- su 28.9.-2796 206.02 Vis 1%-53%; mo 14.10.-2796 41.82 Roh 5%-113%;
  dt=15.46 s=32.2 l=40-106 z=-1.1-0.9
- su 6.5.-2788 63.69 Mrg 1%-57%; mo 21.5.-2788 257.82 PAs 45%;
  dt=14.89 s=32.0 l=164-172 z=2.7-3.0
- su 22.2.-2784 353.63 Rev 5%-96%; mo 8.3.-2784 188.22 Sva 4%;
  dt=15.01 s=32.0 l=-19--2 z=-3.0--2.5
- su 22.12.-2782 292.30 Sra 6%-77%; mo 6.1.-2781 126.79 Mag 91%;
  dt=14.28 s=31.9 l=-18--1 z=-3.0--2.5
- su 29.7.-2774 144.39 PPh 2%-36%; mo 12.8.-2774 338.21 UBh 3%-130%;
  dt=13.91 s=31.7 l=96-139 z=0.6-2.0
- su 18.7.-2773 133.44 PPh 56%-83%; mo 2.8.-2773 327.67 PBh 1%-6%;
  dt=14.65 s=31.7 l=-18-50 z=-3.0--0.8
- su 17.5.-2770 73.86 Ard 0%-103%; mo 1.6.-2770 267.97 UAs 2%-61%;
  dt=14.84 s=31.6 l=48-101 z=-0.9-0.8
- su 16.3.-2767 14.82 Bha 3%-26%; mo 30.3.-2767 208.70 Vis 149%;
  dt=14.44 s=31.5 l=120-171 z=1.4-3.0
- su 2.1.-2763 303.13 Dha 2%-87%; mo 16.1.-2763 137.49 PPh 97%;
  dt=14.37 s=31.4 l=102-170 z=0.8-3.0

x- su 20.10.-2760 227.88 Jye 0%-47%; mo 5.11.-2760 63.78 Mrg 111%;
  dt=15.50 s=31.4 l=134-170 z=1.8-3.0

- su 8.8.-2756 154.90 UPh 3%-37%; mo 22.8.-2756 348.85 Rev 85%-136%;
  dt=13.95 s=31.3 l=-16-29 z=-3.0--1.5
- su 27.5.-2752 84.03 Pun 32%-57%; mo 11.6.-2752 278.14 UAs 5%-74%;
  dt=14.79 s=31.2 l=-16-3 z=-3.0--2.4
- su 27.3.-2749 25.07 Bha 1%-12%; mo 10.4.-2749 218.94 Anu 161%;
  dt=14.49 s=31.1 l=19-71 z=-1.8--0.2
- su 15.3.-2748 14.29 Bha 1%-98%; mo 30.3.-2748 208.80 Vis 1%-26%;
  dt=15.07 s=31.1 l=79-151 z=0.1-2.4
- su 13.1.-2745 313.88 Sat 5%-82%; mo 27.1.-2745 148.11 UPh 104%;
  dt=14.30 s=31.0 l=-16-97 z=-3.0-0.7

x- su 31.10.-2742 238.86 Jye 0%-54%; mo 16.11.-2742 74.77 Ard 4%-111%;
  dt=15.52 s=30.9 l=-1-76 z=-2.5--0.0

- su 9.8.-2737 154.36 UPh 4%-72%; mo 24.8.-2737 348.89 Rev 5%-18%;
  dt=14.76 s=30.8 l=83-168 z=0.2-3.0
- su 26.3.-2730 24.53 Bha 3%-83%; mo 10.4.-2730 219.01 Anu 39%;
  dt=15.09 s=30.7 l=-15-48 z=-3.0--0.9
- su 30.8.-2720 176.15 Cit 1%-36%; mo 13.9.-2720 10.36 Asv 144%;
  dt=14.06 s=30.4 l=106-161 z=1.0-2.8
- su 19.8.-2719 164.93 Has 22%-52%; mo 3.9.-2719 359.62 Rev 2%-22%;
  dt=14.82 s=30.4 l=-14-44 z=-3.0--1.1
- su 18.6.-2716 104.47 Pus 0%-49%; mo 2.7.-2716 298.63 Dha 104%;
  dt=14.71 s=30.3 l=65-120 z=-0.4-1.5

- su 4.2.-2709 335.16 UBh 44%-65%; mo 18.2.-2709 169.12 Has 4%-122%;
  dt=14.18 s=30.2 l=104-166 z=0.9-3.0
- su 22.11.-2706 260.82 PAs 1%-54%; mo 8.12.-2706 96.68 Pus 81%-110%;
  dt=15.54 s=30.1 l=88-166 z=0.4-3.0
- su 10.9.-2702 186.88 Sva 2%-35%; mo 24.9.-2702 21.20 Bha 146%;
  dt=14.08 s=30.0 l=-13-42 z=-3.0--1.1
- su 17.4.-2694 44.89 Roh 14%-88%; mo 2.5.-2694 239.38 Jye 5%-65%;
  dt=15.22 s=29.8 l=100-165 z=0.8-3.0
- su 14.2.-2691 345.69 UBh 0%-55%; mo 28.2.-2691 179.52 Cit 6%-134%;
  dt=14.11 s=29.7 l=0-63 z=-2.6--0.4

-# su 4.2.-2690 335.12 UBh 2%-49%; mo 18.2.-2690 168.70 Has 0%-3%;
  dt=13.95 s=29.7 l=137-154 z=2.0-2.6

- su 2.12.-2688 271.77 UAs 5%-54%; mo 18.12.-2688 107.57 Asl 99%-111%;
  dt=15.46 s=29.7 l=-12-36 z=-3.0--1.3
- su 10.9.-2683 186.31 Cit 1%-20%; mo 25.9.-2683 21.27 Bha 0%-27%;
  dt=14.92 s=29.5 l=118-148 z=1.4-2.4
- su 27.4.-2676 55.03 Mrg 1%-75%; mo 12.5.-2676 249.54 Mul 6%-78%;
  dt=15.26 s=29.4 l=-11-53 z=-3.0--0.8

-# su 15.2.-2672 345.62 UBh 4%-49%; mo 29.2.-2672 179.12 Cit 2%-14%;
  dt=13.92 s=29.3 l=20-44 z=-1.9--1.1

- su 2.10.-2666 208.54 Vis 1%-33%; mo 16.10.-2666 43.06 Roh 148%;
  dt=14.17 s=29.1 l=99-158 z=0.8-2.8
- su 21.9.-2665 197.10 Sva 0%-9%; mo 6.10.-2665 32.17 Krt 1%-28%;
  dt=14.97 s=29.1 l=6-17 z=-2.4--2.0
- su 10.7.-2661 125.20 Mag 3%-62%; mo 24.7.-2661 318.77 Sat 2%-6%;
  dt=13.94 s=29.0 l=16-32 z=-2.1--1.5
- su 24.12.-2652 293.54 Dha 1%-49%; mo 9.1.-2651 129.19 Mag 117%;
  dt=15.55 s=28.8 l=43-134 z=-1.2-2.0
- su 9.6.-2650 94.96 Pus 1%-18%; mo 24.6.-2650 288.85 Sra 6%;
  dt=14.58 s=28.8 l=151-162 z=2.6-3.0

x- su 12.10.-2648 219.45 Anu 2%-32%; mo 26.10.-2648 54.04 Mrg 148%;
  dt=14.17 s=28.7 l=-9-33 z=-3.0--1.5

- su 1.10.-2647 207.96 Vis 2%-48%; mo 16.10.-2647 43.13 Roh 4%-29%;
  dt=14.87 s=28.7 l=38-52 z=-1.3--0.8
- su 31.7.-2644 145.98 PPh 0%; mo 15.8.-2644 340.36 UBh 5%;
  dt=14.48 s=28.6 l=110 z=1.2
- su 19.5.-2640 75.30 Ard 12%-46%; mo 3.6.-2640 269.90 UAs 1%-105%;
  dt=15.34 s=28.5 l=127-162 z=1.8-3.0

-# su 8.3.-2636 6.42 Asv 1%-54%; mo 22.3.-2636 199.76 Sva 38%;
  dt=13.89 s=28.4 l=150-161 z=2.6-3.0

- su 4.1.-2633 304.36 Dha 1%-22%; mo 20.1.-2633 139.90 PPh 121%;
  dt=15.42 s=28.4 l=-8-5 z=-3.0--2.5
- su 19.6.-2632 105.15 Pus 0%-23%; mo 4.7.-2632 299.16 Dha 2%-17%;
  dt=14.62 s=28.4 l=58-92 z=-0.6-0.6
- su 11.8.-2626 156.53 UPh 10%-17%; mo 26.8.-2626 350.99 Rev 3%-53%;
  dt=14.44 s=28.2 l=-7-1 z=-3.0--2.7
- su 1.8.-2625 146.06 PPh 16%-61%; mo 15.8.-2625 339.80 UBh 2%-24%;
  dt=13.90 s=28.2 l=145-161 z=2.4-3.0
- su 30.5.-2622 85.45 Pun 0%-29%; mo 14.6.-2622 280.13 Sra 20%-117%;
  dt=15.38 s=28.1 l=19-49 z=-2.0--1.0

-* su 30.5.-2622 85.45 Pun 30%-31%; mo 14.6.-2622 280.13 Sra 0%-14%;
  dt=15.38 s=28.1 l=16-18 z=-2.1

-# su 19.3.-2618 16.73 Bha 1%-67%; mo 2.4.-2618 210.01 Vis 4%-52%;
dt=13.89 s=28.0 l=38-73 z=-1.4--0.1
- su 15.1.-2615 315.09 Sat 1%-24%; mo 30.1.-2615 150.52 UPh 127%;
dt=15.53 s=28.0 l=140-159 z=2.3-3.0
x- su 3.11.-2612 241.34 Mul 0%-30%; mo 17.11.-2612 76.02 Ard 148%;
dt=14.30 s=27.9 l=77-140 z=0.0-2.3
x- su 23.10.-2611 229.79 Jye 14%-57%; mo 7.11.-2611 65.11 Mrg 3%-29%;
dt=14.95 s=27.9 l=121-160 z=1.6-3.0
- su 11.8.-2607 156.60 UPh 4%-60%; mo 25.8.-2607 350.42 Rev 3%-31%;
dt=13.89 s=27.8 l=26-45 z=-1.8--1.1
- su 26.1.-2597 325.76 PBh 0%-33%; mo 10.2.-2597 161.07 Has 134%;
dt=15.52 s=27.6 l=12-97 z=-2.3-0.7
- su 14.11.-2594 252.30 Mul 2%-28%; mo 29.11.-2594 87.00 Pun 148%;
dt=14.26 s=27.5 l=-5-13 z=-3.0--2.3
x- su 3.11.-2593 240.74 Mul 4%-55%; mo 18.11.-2593 76.10 Ard 28%;
dt=14.98 s=27.5 l=-5-36 z=-3.0--1.5
- su 2.9.-2590 177.86 Cit 0%-27%; mo 17.9.-2590 12.44 Asv 50%-161%;
dt=14.40 s=27.4 l=86-128 z=0.4-1.9
- su 12.9.-2572 188.64 Sva 0%-10%; mo 27.9.-2572 23.27 Bha 135%-147%;
dt=14.35 s=27.0 l=-4--2 z=-3.0--2.9
- su 2.9.-2571 177.91 Cit 29%-60%; mo 16.9.-2571 11.90 Asv 0%-40%;
dt=13.88 s=27.0 l=139-156 z=2.3-3.0
- su 20.6.-2567 105.74 Pus 6%-101%; mo 6.7.-2567 300.51 Dha 2%;
dt=15.33 s=26.9 l=-3-56 z=-3.0--0.8
-# su 20.4.-2564 47.32 Roh 2%-91%; mo 4.5.-2564 240.55 Mul 2%-95%;
dt=13.90 s=26.8 l=75-104 z=-0.1-1.0
- su 17.2.-2561 346.86 Rev 0%-16%; mo 4.3.-2561 181.95 Cit 153%;
dt=15.48 s=26.7 l=126-156 z=1.9-3.0
- su 6.2.-2560 336.43 UBh 7%-98%; mo 21.2.-2560 171.10 Has 0%-8%;
dt=14.93 s=26.7 l=4-20 z=-2.7--2.1
- su 6.12.-2558 274.17 UAs 0%-25%; mo 20.12.-2558 108.85 Asl 151%;
dt=14.41 s=26.7 l=55-121 z=-0.8-1.7
- su 25.11.-2557 262.66 PAs 0%-90%; mo 10.12.-2557 98.03 Pus 1%-29%;
dt=15.08 s=26.7 l=70-144 z=-0.2-2.6
- su 13.9.-2553 188.67 Sva 5%-60%; mo 27.9.-2553 22.74 Bha 0%-43%;
dt=13.88 s=26.6 l=12-34 z=-2.4--1.6
- su 2.7.-2549 116.02 Asl 80%-82%; mo 17.7.-2549 310.85 Sat 1%-5%;
dt=15.41 s=26.5 l=153-155 z=2.9-3.0
- su 27.2.-2543 357.29 Rev 0%-6%; mo 14.3.-2543 192.28 Sva 164%;
dt=15.45 s=26.3 l=13-50 z=-2.4--1.0
- su 17.2.-2542 346.95 Rev 3%; mo 4.3.-2542 181.49 Cit 1%;
dt=14.99 s=26.3 l=118 z=1.6
- su 5.12.-2539 273.59 UAs 0%-63%; mo 20.12.-2539 108.93 Asl 30%;
dt=15.06 s=26.3 l=-1-19 z=-3.0--2.2
- su 4.10.-2536 210.38 Vis 0%-26%; mo 19.10.-2536 45.08 Roh 167%;
dt=14.33 s=26.2 l=40-89 z=-1.4-0.5
- su 12.7.-2531 126.36 Mag 15%-87%; mo 27.7.-2531 321.28 PBh 3%-22%;
dt=15.39 s=26.1 l=41-154 z=-1.4-3.0
- su 28.2.-2524 357.40 Rev 42%-80%; mo 14.3.-2524 191.81 Sva 1%-31%;
dt=14.93 s=25.9 l=0-16 z=-3.0--2.3
- su 5.10.-2517 210.38 Vis 1%-59%; mo 19.10.-2517 44.57 Roh 1%-46%;
dt=13.87 s=25.8 l=113-136 z=1.4-2.3

- su 23.7.-2513 136.76 PPh 7%-101%; mo 7.8.-2513 331.76 PBh 30%;
  dt=15.26 s=25.7 l=0-76 z=-3.0--0.0
-# su 23.5.-2510 77.74 Ard 0%-14%; mo 6.6.-2510 271.08 UAs 1%-22%;
  dt=13.98 s=25.6 l=128-131 z=2.0-2.1
- su 12.5.-2509 67.10 Ard 1%-46%; mo 26.5.-2509 260.91 PAs 7%;
  dt=14.63 s=25.6 l=108-153 z=1.2-3.0
- su 7.1.-2503 306.65 Dha 0%-12%; mo 22.1.-2503 141.18 PPh 161%;
  dt=14.50 s=25.5 l=49-94 z=-1.1-0.7
- su 27.12.-2503 295.32 Dha 6%-96%; mo 11.1.-2502 130.56 Mag 0%-35%;
  dt=15.20 s=25.5 l=36-133 z=-1.6-2.2
x- su 26.10.-2500 232.29 Jye 1%-24%; mo 9.11.-2500 66.98 Ard 168%;
  dt=14.27 s=25.4 l=122-152 z=1.8-3.0
x- su 15.10.-2499 221.30 Anu 4%-26%; mo 29.10.-2499 55.52 Mrg 47%;
  dt=13.87 s=25.4 l=0-4 z=-3.0--2.8
- su 22.5.-2491 77.22 Ard 1%-97%; mo 5.6.-2491 271.11 UAs 1%-20%;
  dt=14.66 s=25.2 l=7-125 z=-2.8-1.9
- su 21.3.-2488 18.10 Bha 5%-94%; mo 5.4.-2488 212.28 Vis 59%;
  dt=14.81 s=25.1 l=112-151 z=1.4-3.0
- su 7.1.-2484 306.09 Dha 5%-81%; mo 22.1.-2484 141.27 PPh 39%;
  dt=15.11 s=25.0 l=1-14 z=-3.0--2.5
x- su 6.11.-2482 243.28 Mul 3%-24%; mo 20.11.-2482 77.94 Ard 169%;
  dt=14.21 s=25.0 l=1-37 z=-3.0--1.6
- su 14.8.-2477 157.80 UPh 0%-88%; mo 29.8.-2477 352.97 Rev 42%;
  dt=15.30 s=24.9 l=96-151 z=0.8-3.0
- su 2.6.-2473 87.36 Pun 45%-51%; mo 17.6.-2473 281.34 Sra 2%-30%;
  dt=14.61 s=24.8 l=2-12 z=-3.0--2.6
- su 1.4.-2470 28.36 Krt 55%-102%; mo 16.4.-2470 222.45 Anu 1%-75%;
  dt=14.75 s=24.7 l=2-76 z=-3.0--0.0
-* su 18.1.-2466 316.80 Sat 81%-85%; mo 2.2.-2466 151.91 UPh 1%-14%;
  dt=15.25 s=24.7 l=146-149 z=2.8-3.0
x- su 6.11.-2463 243.24 Mul 2%-61%; mo 20.11.-2463 77.48 Ard 4%-48%;
  dt=13.86 s=24.6 l=80-99 z=0.1-0.9
- su 24.8.-2459 168.44 Has 2%-101%; mo 8.9.-2459 3.69 Asv 47%;
  dt=15.20 s=24.5 l=3-71 z=-3.0--0.2
- su 29.1.-2448 327.43 PBh 5%-97%; mo 13.2.-2448 162.46 Has 50%-52%;
  dt=15.26 s=24.3 l=39-142 z=-1.6-2.7
-* su 29.1.-2448 327.43 PBh 80%-93%; mo 13.2.-2448 162.46 Has 3%-49%;
  dt=15.27 s=24.3 l=25-38 z=-2.1--1.6
- su 28.11.-2446 265.25 PAs 1%-21%; mo 12.12.-2446 99.79 Pus 171%;
  dt=14.19 s=24.2 l=63-121 z=-0.6-1.8
- su 24.6.-2437 107.73 Asl 1%-88%; mo 9.7.-2437 301.93 Dha 4%-55%;
  dt=14.79 s=24.0 l=70-142 z=-0.3-2.7
- su 23.4.-2434 48.78 Roh 2%-74%; mo 7.5.-2434 242.73 Mul 107%;
  dt=14.65 s=24.0 l=118-147 z=1.8-3.0
- su 8.2.-2430 338.00 UBh 1%-56%; mo 23.2.-2430 172.96 Has 59%;
  dt=15.17 s=23.9 l=5-29 z=-3.0--2.0
-# su 28.11.-2427 265.18 PAs 2%-10%; mo 12.12.-2427 99.36 Pus 3%-16%;
  dt=13.99 s=23.8 l=58-61 z=-0.8--0.6
- su 23.5.-2426 77.83 Ard 0%-14%; mo 7.6.-2426 272.42 UAs 7%;
  dt=15.33 s=23.8 l=5-57 z=-3.0--0.8
- su 15.9.-2423 189.92 Sva 0%-101%; mo 30.9.-2423 25.31 Bha 52%;
  dt=15.24 s=23.7 l=71-147 z=-0.2-3.0

- su 4.7.-2419 117.98 Asl 26%-49%; mo 19.7.-2419 312.32 Sat 1%-65%;
  dt=14.86 s=23.7 l=5-26 z=-3.0--2.1
- su 3.5.-2416 58.95 Mrg 0%-57%; mo 17.5.-2416 252.86 Mul 123%;
  dt=14.60 s=23.6 l=6-78 z=-3.0-0.1
- su 9.12.-2409 276.12 UAs 0%-71%; mo 23.12.-2409 110.24 Asl 2%-47%;
  dt=13.84 s=23.4 l=53-66 z=-1.0--0.4
- su 26.9.-2405 200.77 Vis 0%-93%; mo 11.10.-2405 36.20 Krt 53%;
  dt=15.13 s=23.4 l=6-39 z=-3.0--1.6
- su 2.3.-2394 358.90 Rev 17%-86%; mo 17.3.-2394 193.72 Sva 79%;
  dt=15.31 s=23.1 l=59-145 z=-0.8-3.0
-* su 2.3.-2394 358.90 Rev 26%-83%; mo 17.3.-2394 193.72 Sva 1%-79%;
  dt=15.33 s=23.1 l=32-58 z=-1.9--0.8
- su 30.12.-2392 297.96 Dha 0%-11%; mo 13.1.-2391 132.20 Mag 72%-182%;
  dt=14.11 s=23.1 l=15-59 z=-2.7--0.7
- su 26.7.-2383 138.68 PPh 1%-19%; mo 10.8.-2383 333.31 PBh 18%-67%;
  dt=14.97 s=22.9 l=135-145 z=2.5-3.0
- su 25.5.-2380 79.28 Ard 2%-21%; mo 8.6.-2380 273.15 UAs 155%;
  dt=14.52 s=22.8 l=137-144 z=2.7-3.0
- su 12.3.-2376 9.23 Asv 1%-32%; mo 27.3.-2376 204.00 Vis 91%;
  dt=15.25 s=22.7 l=8-34 z=-3.0--1.9
-# su 31.12.-2373 297.85 Dha 0%-50%; mo 14.1.-2372 131.83 Mag 2%-52%;
  dt=13.97 s=22.7 l=39-52 z=-1.6--1.1
x- su 18.10.-2369 222.61 Anu 4%-102%; mo 2.11.-2369 58.08 Mrg 4%-53%;
  dt=15.15 s=22.6 l=27-126 z=-2.2-2.2
- su 5.6.-2362 89.47 Pun 0%-1%; mo 19.6.-2362 283.35 Sra 170%;
  dt=14.50 s=22.5 l=29-31 z=-2.1--2.0
- su 10.1.-2354 308.62 Sat 0%-43%; mo 24.1.-2354 142.52 PPh 2%-35%;
  dt=13.83 s=22.3 l=44-51 z=-1.4--1.1
- su 24.4.-2350 49.41 Roh 0%-9%; mo 9.5.-2350 243.29 Mul 19%;
  dt=14.59 s=22.2 l=137-143 z=2.7-3.0
- su 16.8.-2347 159.66 UPh 1%-71%; mo 31.8.-2347 354.59 Rev 5%-93%;
  dt=14.91 s=22.1 l=59-107 z=-0.8-1.4
-# su 5.6.-2343 89.54 Pun 4%-89%; mo 19.6.-2343 282.81 Sra 0%-48%;
  dt=13.93 s=22.1 l=38-62 z=-1.7--0.6
- su 3.4.-2340 29.75 Krt 6%-49%; mo 18.4.-2340 224.45 Anu 116%;
  dt=15.37 s=22.0 l=89-142 z=0.6-3.0
-* su 3.4.-2340 29.75 Krt 4%-49%; mo 18.4.-2340 224.45 Anu 44%-116%;
  dt=15.38 s=22.0 l=62-88 z=-0.6-0.5
- su 9.11.-2333 244.58 Mul 68%-83%; mo 24.11.-2333 80.00 Pun 0%-32%;
  dt=15.05 s=21.9 l=134-142 z=2.6-3.0
- su 14.4.-2322 39.95 Krt 1%-15%; mo 29.4.-2322 234.63 Jye 129%;
  dt=15.38 s=21.6 l=11-24 z=-3.0--2.4
-# su 1.2.-2318 329.95 PBh 3%-70%; mo 15.2.-2318 163.68 Has 1%-67%;
  dt=13.95 s=21.6 l=39-53 z=-1.7--1.1
- su 19.11.-2315 255.57 PAs 2%-102%; mo 4.12.-2315 90.93 Pun 10%-54%;
  dt=15.00 s=21.5 l=12-71 z=-3.0--0.3
- su 12.2.-2300 340.50 UBh 1%-19%; mo 26.2.-2300 174.15 Cit 1%-30%;
  dt=13.84 s=21.2 l=53-58 z=-1.1--0.9
- su 18.9.-2293 191.71 Sva 2%-68%; mo 3.10.-2293 27.04 Krt 96%-100%;
  dt=15.10 s=21.1 l=37-118 z=-1.9-2.0
-# su 8.7.-2289 120.27 Mag 0%-52%; mo 22.7.-2289 313.73 Sat 2%-86%;
  dt=13.90 s=21.0 l=71-106 z=-0.2-1.4

- su 6.5.-2286 60.26 Mrg 0%-4%; mo 21.5.-2286 254.96 PAs 157%;
  dt=15.45 s=20.9 l=119-127 z=2.0-2.4
-* su 6.5.-2286 60.26 Mrg 0%-6%; mo 21.5.-2286 254.96 PAs 129%-157%;
  dt=15.45 s=20.9 l=108-118 z=1.5-2.0
- su 25.4.-2285 50.03 Roh 6%-89%; mo 10.5.-2285 244.59 Mul 5%;
  dt=15.31 s=20.9 l=14-93 z=-3.0-0.8
- su 11.12.-2279 277.51 UAs 94%-100%; mo 26.12.-2279 112.69 Asl 3%-41%;
  dt=14.89 s=20.8 l=128-138 z=2.5-3.0
-# su 5.3.-2264 1.37 Asv 5%-32%; mo 19.3.-2264 194.89 Sva 1%-33%;
  dt=13.97 s=20.5 l=58-63 z=-0.9--0.7
- su 22.12.-2261 288.41 Sra 3%-53%; mo 6.1.-2260 123.48 Mag 21%-46%;
  dt=14.84 s=20.4 l=15-22 z=-3.0--2.7
- su 17.5.-2249 70.35 Ard 59%-98%; mo 1.6.-2249 264.88 PAs 0%-34%;
  dt=15.31 s=20.2 l=107-137 z=1.5-3.0
- su 2.1.-2242 299.27 Dha 2%-43%; mo 17.1.-2242 134.21 PPh 51%-66%;
  dt=14.92 s=20.0 l=118-136 z=2.1-3.0
x- su 20.10.-2239 224.32 Anu 1%-65%; mo 4.11.-2239 59.91 Mrg 101%;
  dt=15.23 s=20.0 l=21-104 z=-2.7-1.4
- su 27.5.-2231 80.52 Pun 4%-45%; mo 11.6.-2231 275.06 UAs 42%-48%;
  dt=15.26 s=19.8 l=17-125 z=-3.0-2.4
- su 13.1.-2224 310.05 Sat 68%-90%; mo 28.1.-2224 144.86 PPh 2%-70%;
  dt=14.83 s=19.7 l=17-36 z=-3.0--2.0
- su 27.3.-2209 21.44 Bha 0%-42%; mo 11.4.-2209 215.45 Anu 19%;
  dt=14.71 s=19.4 l=85-134 z=0.5-3.0
- su 11.11.-2203 246.24 Mul 1%-24%; mo 26.11.-2203 81.89 Pun 100%;
  dt=15.31 s=19.3 l=121-134 z=2.3-3.0
- su 30.8.-2199 172.74 Has 2%-66%; mo 13.9.-2199 6.68 Asv 5%-87%;
  dt=13.81 s=19.2 l=36-50 z=-2.1--1.4
- su 6.4.-2191 31.66 Krt 53%-97%; mo 21.4.-2191 225.67 Anu 4%-32%;
  dt=14.71 s=19.1 l=19-70 z=-3.0--0.3
- su 4.2.-2188 331.42 PBh 6%-82%; mo 19.2.-2188 165.94 Has 89%;
  dt=14.75 s=19.0 l=91-132 z=0.8-2.9
- su 22.11.-2185 257.20 PAs 3%-64%; mo 7.12.-2185 92.85 Pun 100%;
  dt=15.25 s=18.9 l=20-79 z=-3.0-0.1
- su 30.8.-2180 172.35 Has 44%-68%; mo 13.9.-2180 6.58 Asv 0%-5%;
  dt=14.29 s=18.8 l=111-133 z=1.8-3.0
- su 29.6.-2177 111.18 Asl 0%-32%; mo 14.7.-2177 305.84 Dha 86%;
  dt=15.11 s=18.8 l=105-132 z=1.5-3.0
- su 14.2.-2170 341.99 UBh 25%-78%; mo 1.3.-2170 176.37 Cit 2%-100%;
  dt=14.63 s=18.7 l=20-71 z=-3.0--0.3
- su 10.9.-2162 183.05 Cit 3%-96%; mo 24.9.-2162 17.41 Bha 8%;
  dt=14.28 s=18.5 l=21-111 z=-3.0-1.9
- su 9.7.-2159 121.49 Mag 5%-45%; mo 24.7.-2159 316.21 Sat 97%;
  dt=15.06 s=18.4 l=21-40 z=-3.0--2.0
- su 14.12.-2149 279.07 UAs 1%-58%; mo 29.12.-2149 114.65 Asl 102%;
  dt=15.40 s=18.3 l=87-131 z=0.6-3.0
- su 2.10.-2145 205.07 Vis 1%-61%; mo 16.10.-2145 39.27 Krt 97%-129%;
  dt=13.85 s=18.2 l=22-36 z=-3.0--2.2
- su 27.3.-2144 22.09 Bha 1%-17%; mo 12.4.-2144 216.75 Anu 4%;
  dt=15.30 s=18.2 l=77-111 z=0.0-1.9
- su 9.5.-2137 62.09 Mrg 4%-97%; mo 24.5.-2137 256.19 PAs 2%-72%;
  dt=14.85 s=18.0 l=40-89 z=-2.0-0.7

- su 8.3.-2134 2.90 Asv 5%-56%; mo 22.3.-2134 197.02 Sva 125%;
  dt=14.58 s=18.0 l=78-129 z=0.1-3.0
- su 24.12.-2131 289.94 Sra 2%-55%; mo 9.1.-2130 125.47 Mag 105%;
  dt=15.29 s=17.9 l=23-58 z=-3.0--1.0
- su 2.10.-2126 204.63 Vis 0%-53%; mo 16.10.-2126 39.21 Krt 9%-11%;
  dt=14.47 s=17.8 l=70-129 z=-0.4-2.9
- su 31.7.-2123 142.30 PPh 1%-22%; mo 15.8.-2123 337.16 UBh 115%;
  dt=15.03 s=17.8 l=113-129 z=2.1-3.0
- su 18.3.-2116 13.26 Asv 1%-23%; mo 2.4.-2116 207.26 Vis 140%;
  dt=14.48 s=17.6 l=23-40 z=-3.0--2.0

x- su 24.10.-2109 226.90 Jye 45%-58%; mo 7.11.-2109 61.20 Mrg 6%-129%;
  dt=13.87 s=17.5 l=101-129 z=1.4-3.0

- su 12.10.-2108 215.51 Anu 0%-96%; mo 26.10.-2108 50.17 Roh 12%;
  dt=14.41 s=17.5 l=24-110 z=-3.0-1.9
- su 11.8.-2105 152.82 UPh 3%-48%; mo 26.8.-2105 347.75 Rev 122%;
  dt=14.98 s=17.4 l=24-45 z=-3.0--1.8
- su 15.1.-2094 311.52 Sat 0%-49%; mo 30.1.-2094 146.89 UPh 113%;
  dt=15.46 s=17.2 l=59-128 z=-1.0-3.0
- su 9.4.-2080 33.81 Krt 1%-18%; mo 23.4.-2080 227.63 Jye 171%;
  dt=14.43 s=17.0 l=82-126 z=0.4-2.9
- su 26.1.-2076 322.20 PBh 1%-15%; mo 11.2.-2076 157.49 UPh 120%;
  dt=15.33 s=16.9 l=26-38 z=-3.0--2.3
- su 11.7.-2075 122.61 Mag 1%-21%; mo 25.7.-2075 316.32 Sat 0%-13%;
  dt=14.13 s=16.9 l=62-89 z=-0.9-0.7

x- su 3.11.-2072 237.36 Jye 1%-74%; mo 17.11.-2072 72.15 Ard 12%;
  dt=14.58 s=16.8 l=73-126 z=-0.2-2.9

- su 2.9.-2069 174.08 Cit 9%-38%; mo 17.9.-2069 9.15 Asv 5%-132%;
  dt=14.94 s=16.8 l=99-126 z=1.4-3.0

-# su 10.4.-2061 33.86 Krt 6%-65%; mo 24.4.-2061 227.10 Jye 21%-49%;
  dt=13.91 s=16.6 l=102-125 z=1.6-3.0

- su 25.11.-2055 259.79 PAs 4%-54%; mo 9.12.-2055 94.10 Pus 3%-130%;
  dt=13.91 s=16.5 l=63-107 z=-0.8-1.8
- su 14.11.-2054 248.32 Mul 5%-66%; mo 29.11.-2054 83.13 Pun 1%-12%;
  dt=14.52 s=16.5 l=27-95 z=-3.0-1.1
- su 2.9.-2050 174.22 Cit 25%-101%; mo 16.9.-2050 8.51 Asv 9%;
  dt=14.32 s=16.4 l=27-125 z=-3.0-3.0
- su 1.7.-2047 112.92 Asl 0%-1%; mo 16.7.-2047 307.49 Sat 133%;
  dt=14.99 s=16.4 l=82-84 z=0.4-0.5

-# su 20.4.-2043 44.06 Roh 88%; mo 4.5.-2043 237.25 Jye 0%;
  dt=13.86 s=16.3 l=27 z=-3.0

- su 17.2.-2040 343.36 UBh 14%-27%; mo 3.3.-2040 178.47 Cit 136%;
  dt=15.45 s=16.3 l=71-125 z=-0.4-3.0

-* su 17.2.-2040 343.36 UBh 0%-14%; mo 3.3.-2040 178.47 Cit 136%;
  dt=15.47 s=16.3 l=58-70 z=-1.2--0.4

- su 1.7.-2028 112.59 Asl 86%-100%; mo 16.7.-2028 307.48 Sat 1%;
  dt=15.55 s=16.0 l=105-124 z=1.8-3.0

-* su 1.7.-2028 112.59 Asl 58%-91%; mo 16.7.-2028 307.48 Sat 0%-1%;
  dt=15.55 s=16.0 l=85-104 z=0.6-1.7

- su 6.12.-2018 270.21 UAs 4%-95%; mo 20.12.-2018 105.02 Pus 14%;
  dt=14.66 s=15.9 l=71-124 z=-0.4-3.0
- su 4.10.-2015 206.49 Vis 1%-44%; mo 19.10.-2015 41.71 Roh 1%-135%;
  dt=14.84 s=15.8 l=90-115 z=0.9-2.4

- su 24.9.-2014 195.76 Sva 18%; mo 8.10.-2014 30.15 Krt 2%;
  dt=14.29 s=15.8 l=123 z=3.0
- su 12.7.-2010 122.89 Mag 32%-100%; mo 27.7.-2010 317.89 Sat 9%;
  dt=15.53 s=15.7 l=29-123 z=-3.0-3.0
- su 27.2.-2003 353.75 Rev 48%-101%; mo 14.3.-2003 188.62 Sva 9%;
  dt=15.39 s=15.6 l=30-123 z=-3.0-3.0
- su 28.12.-2001 292.51 Sra 2%-45%; mo 11.1.-2000 126.69 Mag 6%-137%;
  dt=13.95 s=15.6 l=40-85 z=-2.4-0.5
- su 16.12.-2000 281.11 Sra 33%-44%; mo 31.12.-2000 115.89 Asl 1%-16%;
  dt=14.60 s=15.5 l=30-64 z=-3.0--0.8
- su 4.10.-1996 206.63 Vis 3%-101%; mo 18.10.-1996 41.06 Roh 17%;
  dt=14.20 s=15.5 l=30-110 z=-3.0-2.2

-# su 23.5.-1989 74.54 Ard 36%-68%; mo 6.6.-1989 267.73 UAs 1%-110%;
  dt=13.85 s=15.4 l=30-74 z=-3.0--0.1

- su 10.3.-1985 4.15 Asv 1%-29%; mo 26.3.-1985 198.92 Sva 20%;
  dt=15.24 s=15.3 l=30-35 z=-3.0--2.7

-* su 3.8.-1974 143.69 PPh 0%-51%; mo 18.8.-1974 338.90 UBh 24%;
  dt=15.56 s=15.1 l=106-121 z=2.0-3.0

- su 7.1.-1963 302.76 Dha 2%-95%; mo 22.1.-1963 137.46 PPh 24%;
  dt=14.74 s=14.9 l=76-121 z=-0.0-3.0
- su 3.7.-1963 114.07 Asl 1%-8%; mo 17.7.-1963 307.87 Sat 7%;
  dt=14.35 s=14.9 l=90-121 z=0.9-3.0

x- su 26.10.-1960 228.49 Jye 62%-95%; mo 9.11.-1960 62.95 Mrg 1%-19%;
  dt=14.18 s=14.9 l=104-121 z=1.8-3.0

- su 13.8.-1956 154.19 UPh 1%-5%; mo 28.8.-1956 349.52 Rev 29%;
  dt=15.58 s=14.8 l=32-38 z=-3.0--2.6
- su 13.8.-1956 154.19 UPh 1%-84%; mo 28.8.-1956 349.52 Rev 29%;
  dt=15.58 s=14.8 l=66-120 z=-0.7-3.0
- su 1.4.-1949 24.79 Bha 34%-103%; mo 16.4.-1949 219.37 Anu 3%-47%;
  dt=15.23 s=14.7 l=54-120 z=-1.5-3.0
- su 29.1.-1946 324.71 PBh 0%-21%; mo 12.2.-1946 158.68 UPh 1%-147%;
  dt=14.01 s=14.6 l=35-57 z=-2.8--1.3
- su 18.1.-1945 313.50 Sat 49%-54%; mo 2.2.-1945 148.13 UPh 3%-28%;
  dt=14.66 s=14.6 l=33-43 z=-3.0--2.3

x- su 6.11.-1942 239.47 Jye 2%-43%; mo 20.11.-1942 73.91 Ard 20%;
  dt=14.10 s=14.6 l=33-64 z=-3.0--0.9

-# su 24.6.-1935 105.08 Pus 0%-2%; mo 8.7.-1935 298.43 Dha 151%;
  dt=13.89 s=14.4 l=74-80 z=-0.2-0.3

- su 13.6.-1934 94.51 Pus 59%-75%; mo 27.6.-1934 288.04 Sra 2%-20%;
  dt=14.10 s=14.4 l=94-119 z=1.2-3.0
- su 11.4.-1931 35.04 Krt 0%-4%; mo 26.4.-1931 229.54 Jye 61%;
  dt=15.13 s=14.4 l=33-47 z=-3.0--2.0
- su 28.11.-1925 261.33 PAs 2%-31%; mo 13.12.-1925 96.41 Pus 4%-127%;
  dt=14.73 s=14.3 l=70-91 z=-0.5-1.0
- su 23.6.-1916 104.71 Pus 3%-97%; mo 7.7.-1916 298.34 Dha 32%;
  dt=14.12 s=14.1 l=34-80 z=-3.0-0.3
- su 9.2.-1909 334.75 UBh 2%-87%; mo 24.2.-1909 169.26 Has 43%;
  dt=14.82 s=14.0 l=94-117 z=1.3-2.9
- su 28.11.-1906 261.44 PAs 42%-67%; mo 12.12.-1906 95.78 Pus 1%-23%;
  dt=14.07 s=13.9 l=87-118 z=0.7-3.0
- su 15.9.-1902 186.18 Cit 1%-100%; mo 1.10.-1902 21.80 Bha 38%;
  dt=15.54 s=13.9 l=60-118 z=-1.2-3.0

- su 15.7.-1880 125.23 Mag 17%-33%; mo 29.7.-1880 319.11 Sat 4%-52%;
  dt=14.35 s=13.5 l=100-117 z=1.7-3.0
- su 30.12.-1871 294.12 Dha 1%-32%; mo 14.1.-1870 128.88 Mag 83%-153%;
  dt=14.56 s=13.4 l=36-90 z=-3.0-1.0
- su 14.6.-1869 94.80 Pus 0%; mo 30.6.-1869 289.58 Sra 18%;
  dt=15.46 s=13.3 l=114-116 z=2.8-3.0
- su 26.7.-1862 135.59 PPh 0%-96%; mo 9.8.-1862 329.61 PBh 61%;
  dt=14.37 s=13.2 l=37-116 z=-3.0-3.0
- su 30.12.-1852 294.20 Dha 21%-80%; mo 13.1.-1851 128.29 Mag 1%-32%;
  dt=13.93 s=13.1 l=84-115 z=0.6-3.0

x- su 17.10.-1848 218.75 Anu 29%-100%; mo 2.11.-1848 54.55 Mrg 39%;
  dt=15.49 s=13.0 l=37-114 z=-3.0-2.9

- su 24.3.-1837 16.36 Bha 82%; mo 8.4.-1837 210.70 Vis 1%;
  dt=14.93 s=12.8 l=38 z=-3.0
- su 21.1.-1834 315.70 Sat 0%-12%; mo 4.2.-1834 150.20 UPh 165%;
  dt=14.54 s=12.8 l=101-114 z=1.9-3.0
- su 5.6.-1822 86.09 Pun 62%-91%; mo 19.6.-1822 279.70 UAs 2%-13%;
  dt=14.31 s=12.6 l=90-114 z=1.1-3.0

-# su 21.1.-1815 315.76 Sat 3%-17%; mo 4.2.-1815 149.64 UPh 1%-9%;
  dt=13.99 s=12.5 l=90-92 z=1.1-1.3

x- su 8.11.-1812 240.69 Mul 0%-17%; mo 23.11.-1812 76.49 Ard 38%;
  dt=15.54 s=12.4 l=101-113 z=2.0-3.0

- su 27.8.-1808 167.07 Has 1%-52%; mo 11.9.-1808 1.52 Asv 79%;
  dt=14.47 s=12.4 l=83-113 z=0.6-3.0
- su 15.6.-1804 96.28 Pus 3%-100%; mo 29.6.-1804 289.91 Sra 28%;
  dt=14.18 s=12.3 l=39-104 z=-3.0-2.3
- su 1.2.-1797 326.44 PBh 4%-29%; mo 15.2.-1797 160.21 Has 1%-18%;
  dt=13.84 s=12.2 l=99-103 z=1.8-2.2
- su 19.11.-1794 251.67 Mul 4%-81%; mo 5.12.-1794 87.44 Pun 38%;
  dt=15.39 s=12.1 l=40-86 z=-3.0-0.8
- su 26.5.-1775 76.80 Ard 1%-13%; mo 9.6.-1775 270.31 UAs 36%;
  dt=14.15 s=11.8 l=41-77 z=-3.0--0.0

-# su 23.2.-1761 347.56 Rev 5%-100%; mo 9.3.-1761 181.12 Cit 17%-72%;
  dt=13.90 s=11.6 l=83-110 z=0.6-2.9

- su 11.12.-1758 273.61 UAs 1%-100%; mo 26.12.-1758 109.25 Asl 40%;
  dt=15.47 s=11.6 l=42-111 z=-3.0-3.0
- su 29.9.-1754 199.21 Sva 2%-32%; mo 14.10.-1754 34.05 Krt 86%;
  dt=14.63 s=11.5 l=95-111 z=1.6-3.0
- su 18.7.-1750 127.14 Mag 7%-97%; mo 1.8.-1750 320.91 PBh 46%-65%;
  dt=14.11 s=11.5 l=42-110 z=-3.0-2.9
- su 21.12.-1740 284.53 Sra 1%-8%; mo 6.1.-1739 120.08 Mag 42%;
  dt=15.30 s=11.3 l=42-43 z=-3.0--2.9
- su 16.5.-1728 66.95 Ard 69%-100%; mo 31.5.-1728 261.63 PAs 19%;
  dt=15.50 s=11.1 l=56-109 z=-1.8-2.9

-* su 16.5.-1728 66.95 Ard 61%-68%; mo 31.5.-1728 261.63 PAs 19%;
  dt=15.51 s=11.1 l=43-55 z=-3.0--1.9

- su 27.5.-1710 77.11 Ard 29%-64%; mo 12.6.-1710 271.82 UAs 1%-32%;
  dt=15.39 s=10.8 l=44-98 z=-3.0-2.0

-# su 27.3.-1707 18.71 Bha 2%-75%; mo 10.4.-1707 212.02 Vis 111%;
  dt=13.85 s=10.8 l=94-108 z=1.6-2.9

- su 12.1.-1703 306.22 Dha 89%-101%; mo 27.1.-1703 141.54 PPh 50%;
  dt=15.32 s=10.7 l=44-108 z=-3.0-3.0

x- su 31.10.-1700 231.88 Jye 2%-28%; mo 15.11.-1700 66.97 Ard 1%-75%;
dt=14.78 s=10.7 l=83-97 z=0.6-2.0
- su 19.8.-1696 158.54 UPh 13%-88%; mo 2.9.-1696 352.53 Rev 4%-90%;
dt=14.03 s=10.6 l=52-107 z=-2.2-2.9
- su 18.6.-1674 97.47 Pus 49%-65%; mo 3.7.-1674 292.28 Sra 56%;
dt=15.50 s=10.3 l=92-106 z=1.6-2.9
-* su 18.6.-1674 97.47 Pus 4%-78%; mo 3.7.-1674 292.28 Sra 28%-56%;
dt=15.49 s=10.3 l=64-91 z=-1.2-1.5
- su 18.5.-1663 68.45 Ard 0%-3%; mo 1.6.-1663 261.97 PAs 31%;
dt=14.20 s=10.2 l=61-84 z=-1.5-0.7
- su 28.6.-1656 107.70 Asl 1%-33%; mo 14.7.-1656 302.58 Dha 68%;
dt=15.40 s=10.1 l=80-106 z=0.4-3.0
- su 14.2.-1649 338.26 UBh 26%-92%; mo 1.3.-1649 173.19 Has 73%;
dt=15.16 s=10.0 l=46-105 z=-3.0-2.9
- su 3.12.-1646 264.72 PAs 1%-5%; mo 18.12.-1646 99.88 Pus 4%-23%;
dt=14.92 s=9.9 l=57-60 z=-2.0--1.7
- su 21.9.-1642 190.61 Sva 39%-88%; mo 5.10.-1642 24.81 Bha 6%-103%;
dt=13.97 s=9.9 l=47-106 z=-3.0-3.0
-# su 9.5.-1635 59.52 Mrg 1%-6%; mo 23.5.-1635 252.73 Mul 111%-162%;
dt=13.87 s=9.8 l=47-55 z=-3.0--2.2
- su 28.4.-1634 48.98 Roh 54%-76%; mo 12.5.-1634 242.50 Mul 35%;
dt=14.16 s=9.7 l=47-105 z=-3.0-3.0
-* su 20.7.-1620 128.32 Mag 1%-4%; mo 4.8.-1620 323.36 PBh 85%-87%;
dt=15.50 s=9.5 l=103-105 z=2.8-3.0
- su 18.3.-1595 9.63 Asv 1%-7%; mo 2.4.-1595 204.19 Vis 5%-28%;
dt=15.02 s=9.2 l=71-75 z=-0.6--0.2
x- su 23.10.-1588 223.24 Anu 4%-82%; mo 6.11.-1588 57.56 Mrg 107%;
dt=13.92 s=9.1 l=49-79 z=-3.0-0.3
- su 10.8.-1584 149.18 UPh 6%-31%; mo 26.8.-1584 344.42 UBh 37%-58%;
dt=15.35 s=9.0 l=49-53 z=-3.0--2.6
- su 30.5.-1580 79.37 Ard 20%-78%; mo 13.6.-1580 273.05 UAs 9%-76%;
dt=14.38 s=9.0 l=49-102 z=-3.0-2.9
- su 10.6.-1562 89.52 Pun 1%-38%; mo 25.6.-1562 283.28 Sra 89%;
dt=14.31 s=8.7 l=56-102 z=-2.3-2.9
- su 1.9.-1548 170.35 Has 0%-7%; mo 17.9.-1548 5.77 Asv 112%;
dt=15.38 s=8.6 l=98-102 z=2.5-3.0
- su 2.7.-1526 109.89 Asl 0%-13%; mo 16.7.-1526 303.88 Dha 113%;
dt=14.55 s=8.3 l=96-101 z=2.3-2.9
- su 20.4.-1522 40.61 Roh 47%-92%; mo 4.5.-1522 234.15 Jye 27%-30%;
dt=14.18 s=8.2 l=52-101 z=-3.0-3.0
- su 4.10.-1494 202.65 Vis 2%-46%; mo 19.10.-1494 38.28 Krt 119%;
dt=15.34 s=7.8 l=66-100 z=-1.3-3.0
- su 3.8.-1453 140.34 PPh 24%-35%; mo 18.8.-1453 335.31 UBh 0%-16%;
dt=15.38 s=7.3 l=67-97 z=-1.2-2.9
- su 2.6.-1450 81.32 Pun 2%-29%; mo 16.6.-1450 274.75 UAs 94%;
dt=13.97 s=7.3 l=55-63 z=-3.0--1.9
x- su 5.11.-1440 235.44 Jye 3%-53%; mo 20.11.-1440 71.12 Ard 119%;
dt=15.23 s=7.2 l=55-90 z=-3.0-1.9
- su 13.8.-1435 150.80 UPh 19%-77%; mo 29.8.-1435 345.91 UBh 21%;
dt=15.28 s=7.1 l=55-97 z=-3.0-2.9
- su 31.3.-1428 21.31 Bha 53%-101%; mo 15.4.-1428 216.12 Anu 31%;
dt=15.44 s=7.0 l=55-97 z=-3.0-3.0

- su 29.1.-1406 320.92 PBh 29%-37%; mo 12.2.-1406 155.00 UPh 1%-15%;
  dt=14.24 s=6.7 l=76-96 z=-0.0-2.9
- su 27.11.-1404 257.41 PAs 1%-8%; mo 12.12.-1404 93.01 Pun 120%;
  dt=15.27 s=6.7 l=92-96 z=2.4-3.0
- su 4.9.-1399 171.94 Has 0%-3%; mo 19.9.-1399 7.31 Asv 30%;
  dt=15.50 s=6.7 l=70-75 z=-0.9--0.1

-* su 4.9.-1399 171.94 Has 1%-6%; mo 19.9.-1399 7.31 Asv 30%;
  dt=15.49 s=6.7 l=59-69 z=-2.5--1.0

- su 4.7.-1396 111.97 Asl 1%-27%; mo 18.7.-1396 305.49 Dha 5%-136%;
  dt=13.92 s=6.6 l=62-96 z=-2.2-2.9
- su 9.2.-1388 331.54 PBh 5%-27%; mo 23.2.-1388 165.55 Has 22%;
  dt=14.15 s=6.5 l=57-61 z=-3.0--2.4
- su 15.9.-1381 182.62 Cit 58%-84%; mo 1.10.-1381 18.11 Bha 32%;
  dt=15.37 s=6.4 l=57-95 z=-3.0-2.9
- su 3.5.-1374 51.97 Roh 26%-72%; mo 18.5.-1374 246.66 Mul 72%;
  dt=15.45 s=6.4 l=57-95 z=-3.0-3.0
- su 2.3.-1352 352.56 Rev 58%-62%; mo 16.3.-1352 186.45 Cit 4%-41%;
  dt=14.32 s=6.1 l=77-94 z=0.1-2.9
- su 30.12.-1350 290.24 Sra 36%-45%; mo 14.1.-1349 125.57 Mag 119%-127%;
  dt=15.12 s=6.1 l=58-94 z=-3.0-2.9
- su 6.8.-1342 143.04 PPh 8%-10%; mo 20.8.-1342 336.78 UBh 2%-15%;
  dt=13.87 s=6.0 l=91-93 z=2.5-2.9
- su 13.3.-1334 2.96 Asv 23%-54%; mo 27.3.-1334 196.81 Sva 52%;
  dt=14.22 s=5.9 l=59-94 z=-3.0-2.9
- su 30.12.-1331 290.39 Sra 34%-49%; mo 14.1.-1330 124.94 Mag 2%;
  dt=14.45 s=5.9 l=59-94 z=-3.0-3.0

x- su 28.10.-1328 226.41 Anu 1%-3%; mo 12.11.-1328 61.79 Mrg 105%-139%;
  dt=14.97 s=5.8 l=88-93 z=2.0-2.8

- su 17.10.-1327 215.07 Anu 5%-66%; mo 2.11.-1327 50.84 Roh 12%-34%;
  dt=15.43 s=5.8 l=59-90 z=-3.0-2.3
- su 4.6.-1320 82.47 Pun 0%-24%; mo 19.6.-1320 277.18 UAs 87%-114%;
  dt=15.43 s=5.7 l=67-90 z=-1.6-2.4

-* su 4.6.-1320 82.47 Pun 25%-31%; mo 19.6.-1320 277.18 UAs 44%-82%;
  dt=15.43 s=5.7 l=59-66 z=-3.0--1.8

- su 17.8.-1305 153.31 UPh 80%-81%; mo 31.8.-1305 347.12 Rev 4%-9%;
  dt=13.92 s=5.6 l=92-93 z=2.8-2.9
- su 31.1.-1295 322.60 PBh 1%-6%; mo 15.2.-1295 157.55 UPh 4%-29%;
  dt=14.97 s=5.4 l=60-64 z=-3.0--2.3
- su 21.1.-1294 312.03 Sat 7%-21%; mo 4.2.-1294 146.33 PPh 14%;
  dt=14.40 s=5.4 l=90-92 z=2.5-2.9

x- su 8.11.-1291 236.95 Jye 3%-46%; mo 23.11.-1291 72.79 Ard 33%;
  dt=15.60 s=5.4 l=60-92 z=-3.0-2.9

- su 14.4.-1280 33.79 Krt 14%-55%; mo 28.4.-1280 227.58 Jye 90%;
  dt=14.40 s=5.3 l=61-92 z=-3.0-2.9
- su 1.2.-1276 322.75 PBh 59%-101%; mo 15.2.-1276 156.92 UPh 21%;
  dt=14.23 s=5.2 l=61-92 z=-3.0-2.9
- su 30.11.-1274 259.25 PAs 0%-1%; mo 15.12.-1274 94.72 Pus 163%;
  dt=15.09 s=5.2 l=68-80 z=-1.7-0.6
- su 22.2.-1259 343.82 UBh 1%-3%; mo 9.3.-1259 178.50 Cit 15%-41%;
  dt=14.97 s=5.1 l=87-91 z=2.1-2.9
- su 18.9.-1251 185.16 Cit 51%-94%; mo 2.10.-1251 19.34 Bha 3%-66%;
  dt=14.04 s=5.0 l=64-90 z=-2.4-2.8

- su 7.7.-1247 113.26 Asl 7%-91%; mo 22.7.-1247 307.45 Sat 21%;
  dt=14.79 s=4.9 l=69-91 z=-1.6-2.9
- su 11.12.-1237 269.84 UAs 76%-98%; mo 27.12.-1237 105.63 Pus 33%;
  dt=15.55 s=4.8 l=62-90 z=-3.0-2.8
- su 10.10.-1234 207.07 Vis 2%-4%; mo 24.10.-1234 41.29 Roh 3%-122%;
  dt=13.87 s=4.8 l=72-90 z=-0.9-2.9
- su 17.5.-1226 64.25 Mrg 3%-32%; mo 31.5.-1226 258.14 PAs 132%;
  dt=14.59 s=4.7 l=62-90 z=-3.0-3.0
- su 5.3.-1222 354.47 Rev 19%-47%; mo 19.3.-1222 188.25 Sva 53%;
  dt=14.08 s=4.7 l=62-89 z=-3.0-2.8
- su 16.5.-1207 63.75 Mrg 66%-83%; mo 31.5.-1207 258.22 PAs 7%;
  dt=15.17 s=4.5 l=63-90 z=-3.0-3.0

x- su 21.10.-1197 217.62 Anu 64%-96%; mo 4.11.-1197 52.08 Roh 70%;
  dt=14.14 s=4.4 l=63-89 z=-3.0-2.9

- su 9.8.-1193 144.39 PPh 3%-6%; mo 23.8.-1193 338.74 UBh 52%;
  dt=14.68 s=4.4 l=88-89 z=2.7-3.0
- su 12.1.-1182 302.50 Dha 79%-92%; mo 28.1.-1182 138.05 PPh 40%;
  dt=15.47 s=4.3 l=64-89 z=-3.0-2.9
- su 19.8.-1175 154.89 UPh 29%-73%; mo 3.9.-1175 349.31 Rev 33%-60%;
  dt=14.54 s=4.2 l=64-89 z=-3.0-3.0
- su 18.6.-1153 94.21 Pus 11%-25%; mo 3.7.-1153 288.87 Sra 45%;
  dt=15.35 s=4.0 l=64-87 z=-3.0-2.8
- su 22.11.-1143 250.42 Mul 86%-94%; mo 6.12.-1143 85.01 Pun 72%;
  dt=14.21 s=3.9 l=65-88 z=-3.0-2.9
- su 28.6.-1135 104.41 Pus 0%-82%; mo 14.7.-1135 299.16 Dha 56%;
  dt=15.27 s=3.8 l=65-81 z=-3.0-1.2
- su 14.2.-1128 334.60 UBh 53%-81%; mo 1.3.-1128 169.84 Has 58%;
  dt=15.41 s=3.7 l=65-87 z=-3.0-2.9
- su 21.9.-1121 186.87 Sva 72%-98%; mo 6.10.-1121 21.47 Bha 75%;
  dt=14.43 s=3.7 l=65-86 z=-3.0-2.7
- su 20.7.-1099 124.94 Mag 0%-3%; mo 4.8.-1099 319.91 Sat 76%;
  dt=15.49 s=3.5 l=66-69 z=-3.0--2.1

-# su 9.5.-1095 56.05 Mrg 4%-40%; mo 23.5.-1095 249.23 Mul 15%-22%;
  dt=13.93 s=3.4 l=72-86 z=-1.2-2.9

- su 25.12.-1089 283.20 Sra 79%-95%; mo 9.1.-1088 117.76 Asl 76%;
  dt=14.27 s=3.4 l=66-86 z=-3.0-2.9
- su 31.7.-1081 135.30 PPh 34%-57%; mo 16.8.-1081 330.38 PBh 84%;
  dt=15.35 s=3.3 l=66-85 z=-3.0-2.8
- su 18.3.-1074 6.06 Asv 5%-31%; mo 3.4.-1074 200.99 Vis 89%;
  dt=15.37 s=3.2 l=67-86 z=-3.0-2.9

x- su 23.10.-1067 219.43 Anu 1%-101%; mo 7.11.-1067 54.13 Mrg 81%;
  dt=14.33 s=3.2 l=67-84 z=-3.0-2.4

- su 18.4.-1066 35.86 Krt 1%-19%; mo 3.5.-1066 230.40 Jye 8%;
  dt=15.24 s=3.2 l=70-85 z=-2.0-2.7
- su 26.1.-1034 315.59 Sat 46%-66%; mo 10.2.-1034 150.00 UPh 89%;
  dt=14.35 s=2.9 l=68.2-85.4 z=-3.0-3.0

x- su 14.11.-1031 241.35 Mul 9%-40%; mo 28.11.-1031 76.03 Ard 83%;
  dt=14.37 s=2.9 l=68.3-85.3 z=-3.0-3.0

- su 1.9.-1027 166.79 Has 16%-40%; mo 17.9.-1027 2.23 Asv 101%;
  dt=15.42 s=2.8 l=68.4-85.2 z=-3.0-3.0
- su 2.7.-1005 106.87 Asl 44%-54%; mo 16.7.-1005 300.34 Dha 1%-52%;
  dt=13.90 s=2.6 l=75.6-84.6 z=-0.5-2.9

- su 28.2.-980 347.37 Rev 29%-45%; mo 14.3.-980 181.61 Cit 113%;
  dt=14.49 s=2.4 l=69.6-84.0 z=-3.0-2.9
- su 17.12.-977 274.27 UAs 90%-93%; mo 31.12.-977 108.76 Asl 88%;
  dt=14.17 s=2.4 l=69.6-84.0 z=-3.0-3.0
- su 4.10.-973 198.95 Sva 40%-53%; mo 20.10.-973 34.69 Krt 108%;
  dt=15.45 s=2.4 l=69.7-83.9 z=-3.0-3.0
- su 22.5.-947 67.66 Ard 50%-67%; mo 6.6.-947 261.58 PAs 44%;
  dt=14.65 s=2.2 l=70.3-83.3 z=-3.0-3.0
- su 1.4.-926 18.49 Bha 17%-21%; mo 16.4.-926 212.62 Vis 147%;
  dt=14.67 s=2.0 l=70.8-82.8 z=-3.0-3.0
- su 21.3.-925 7.68 Asv 48%-58%; mo 5.4.-925 202.41 Vis 10%;
  dt=15.30 s=2.0 l=70.8-82.8 z=-3.0-3.0
- su 18.1.-922 306.90 Sat 21%-35%; mo 1.2.-922 141.09 PPh 101%;
  dt=14.04 s=2.0 l=70.9-82.7 z=-3.0-2.9

x- su 5.11.-919 231.64 Jye 31%-54%; mo 21.11.-919 67.53 Ard 75%-108%;
  dt=15.45 s=2.0 l=71.0-82.6 z=-3.0-2.9

- su 31.3.-907 18.00 Bha 1%-14%; mo 16.4.-907 212.69 Vis 21%;
  dt=15.23 s=1.9 l=71.2-73.8 z=-3.0--1.6
- su 24.6.-893 98.23 Pus 1%-14%; mo 8.7.-893 292.14 Sra 90%;
  dt=14.55 s=1.8 l=71.5-82.1 z=-3.0-3.0
- su 15.9.-879 179.89 Cit 10%-39%; mo 30.9.-879 14.25 Bha 143%;
  dt=14.21 s=1.7 l=71.8-81.8 z=-3.0-3.0
- su 4.9.-878 168.67 Has 34%-38%; mo 19.9.-878 3.55 Asv 14%-20%;
  dt=14.92 s=1.7 l=71.8-81.8 z=-3.0-3.0
- su 4.7.-875 108.47 Asl 26%-38%; mo 19.7.-875 302.41 Dha 101%-104%;
  dt=14.37 s=1.6 l=71.9-81.7 z=-3.0-2.9

-* su 22.4.-871 38.49 Krt 82%-83%; mo 7.5.-871 233.13 Jye 0%-13%;
  dt=15.37 s=1.6 l=78.8-81.6 z=1.2-2.9

- su 3.5.-853 48.68 Roh 7%-8%; mo 19.5.-853 243.32 Mul 59%;
  dt=15.30 s=1.5 l=72.4-81.2 z=-3.0-2.9
- su 30.12.-829 286.42 Sra 44%-49%; mo 15.1.-828 122.12 Mag 112%;
  dt=15.45 s=1.3 l=72.8-80.8 z=-3.0-3.0
- su 18.10.-825 212.21 Vis 8%-27%; mo 2.11.-825 46.90 Roh 149%;
  dt=14.33 s=1.3 l=72.9-80.7 z=-3.0-2.9
- su 6.10.-824 200.79 Vis 47%-48%; mo 21.10.-824 36.06 Krt 27%;
  dt=15.04 s=1.3 l=72.9-80.7 z=-3.0-2.9
- su 6.8.-821 139.50 PPh 10%-20%; mo 21.8.-821 333.58 UBh 138%;
  dt=14.28 s=1.3 l=73.0-80.6 z=-3.0-2.9
- su 15.6.-781 89.32 Pun 0%-11%; mo 1.7.-781 284.08 Sra 66%-90%;
  dt=15.34 s=1.1 l=73.7-78.3 z=-3.0-1.4

-# su 15.4.-778 30.96 Krt 0%-1%; mo 29.4.-778 224.32 Anu 124%-152%;
  dt=13.92 s=1.0 l=75.5-79.9 z=-1.3-3.0

- su 31.1.-774 318.84 Sat 11%-18%; mo 16.2.-774 154.23 UPh 126%;
  dt=15.36 s=1.0 l=73.8-79.8 z=-3.0-2.9

x- su 8.11.-770 233.44 Jye 37%-56%; mo 23.11.-770 68.94 Ard 28%;
  dt=15.13 s=1.0 l=73.9-79.7 z=-3.0-2.9

- su 7.9.-767 171.11 Has 19%-24%; mo 21.9.-767 5.40 Asv 160%;
  dt=14.20 s=1.0 l=73.9-79.7 z=-3.0-3.0
- su 30.11.-734 255.34 PAs 42%-47%; mo 15.12.-734 90.89 Pun 20%-27%;
  dt=15.31 s=0.8 l=74.5-79.1 z=-3.0-2.8
- su 10.10.-713 203.37 Vis 16%-24%; mo 24.10.-713 37.83 Krt 171%;
  dt=14.13 s=0.7 l=74.8-78.8 z=-3.0-2.8

- su 17.7.-708 120.00 Mag 31%-35%; mo 1.8.-708 314.70 Sat 8%-9%;
dt=15.22 s=0.7 l=74.9-78.7 z=-3.0-2.8
-* su 1.1.-679 288.10 Sra 90%-94%; mo 16.1.-679 123.57 Mag 31%;
dt=15.35 s=0.5 l=75.3-78.3 z=-3.0-2.7
- su 27.5.-668 70.87 Ard 57%-60%; mo 11.6.-668 264.90 PAs 6%;
dt=14.85 s=0.5 l=75.4-78.2 z=-3.0-2.9
- su 6.4.-647 22.00 Bha 18%-20%; mo 21.4.-647 216.00 Anu 62%;
dt=14.50 s=0.4 l=75.7-78.0 z=-3.0-2.9
- su 3.2.-625 320.46 PBh 86%-87%; mo 18.2.-625 155.73 UPh 44%;
dt=15.38 s=0.3 l=75.9-77.7 z=-3.0-2.9
- su 3.12.-623 258.07 PAs 10%-11%; mo 17.12.-623 92.50 Pun 140%-151%;
dt=14.04 s=0.3 l=76.0-77.7 z=-3.0-2.7
- su 20.7.-578 121.80 Mag 90%; mo 4.8.-578 316.33 Sat 63%;
dt=14.93 s=0.0 l=76.85 z=0
-* su 7.3.-571 352.19 Rev 92%; mo 22.3.-571 187.22 Sva 67%;
dt=15.41 s=0.0 l=76.85 z=0
- su 15.1.-531 301.52 Dha 62%; mo 29.1.-531 135.59 PPh 59%;
dt=13.90 s=0.0 l=76.85 z=0
- su 21.8.-524 152.94 UPh 31%; mo 5.9.-524 347.89 Rev 87%;
dt=15.07 s=0.0 l=76.85 z=0
-* su 9.4.-517 23.31 Bha 34%; mo 24.4.-517 218.15 Anu 101%;
dt=15.45 s=0.0 l=76.85 z=0
- su 17.2.-477 333.63 UBh 23%; mo 3.3.-477 167.48 Has 73%;
dt=13.94 s=0.0 l=76.85 z=0
- su 23.9.-470 184.73 Cit 1%; mo 8.10.-470 20.08 Bha 99%;
dt=15.25 s=0.0 l=76.85 z=0
- su 16.12.-456 270.37 UAs 85%; mo 31.12.-456 105.44 Pus 35%;
dt=14.78 s=0.0 l=76.85 z=0
x- su 25.10.-416 217.14 Anu 23%; mo 9.11.-416 52.79 Roh 103%;
dt=15.31 s=0.0 l=76.85 z=0
- su 1.6.-408 74.34 Ard 54%; mo 16.6.-408 268.75 UAs 33%;
dt=15.06 s=0.0 l=76.85 z=0
- su 18.1.-401 303.09 Dha 76%; mo 2.2.-401 137.83 PPh 69%;
dt=14.58 s=0.0 l=76.85 z=0
- su 27.11.-362 249.93 Mul 57%; mo 13.12.-362 85.70 Pun 102%;
dt=15.34 s=0.0 l=76.85 z=0
- su 15.9.-339 176.13 Cit 87%; mo 30.9.-339 10.52 Asv 9%;
dt=14.43 s=0.0 l=76.85 z=0
- su 13.3.-311 356.35 Rev 58%; mo 27.3.-311 190.42 Sva 119%;
dt=14.43 s=0.0 l=76.85 z=0
- su 29.12.-308 282.76 Sra 32%; mo 14.1.-307 118.45 Asl 105%;
dt=15.37 s=0.0 l=76.85 z=0
- su 18.10.-285 208.36 Vis 73%; mo 2.11.-285 43.10 Roh 16%;
dt=14.58 s=0.0 l=76.85 z=0
- su 16.7.-252 116.19 Asl 22%; mo 30.7.-252 309.94 Sat 6%;
dt=14.31 s=0.0 l=76.85 z=0
x- su 19.11.-231 241.03 Mul 93%; mo 4.12.-231 76.00 Ard 18%;
dt=14.70 s=0.0 l=76.85 z=0
- su 7.9.-227 167.53 Has 86%; mo 21.9.-227 1.57 Asv 12%;
dt=14.12 s=0.0 l=76.85 z=0
- su 4.3.-180 347.10 Rev 71%; mo 19.3.-180 182.00 Cit 1%;
dt=15.25 s=0.0 l=76.85 z=0

- su 2.1.-177 285.31 Sra 32%; mo 16.1.-177 119.67 Asl 90%;
  dt=14.08 s=0.0 l=76.85 z=0
- su 22.12.-177 273.84 UAs 61%; mo 6.1.-176 108.85 Asl 6%;
  dt=14.79 s=0.0 l=76.85 z=0
- su 10.10.-173 199.68 Sva 53%; mo 24.10.-173 33.90 Krt 25%;
  dt=14.05 s=0.0 l=76.85 z=0

-# su 28.5.-166 68.29 Ard 40%; mo 11.6.-166 261.47 PAs 61%;
  dt=13.85 s=0.0 l=76.85 z=0

- su 19.8.-133 147.65 UPh 9%; mo 3.9.-133 342.82 UBh 24%;
  dt=15.50 s=0.0 l=76.85 z=0
- su 3.2.-123 317.71 Sat 15%; mo 17.2.-123 151.91 UPh 154%;
  dt=14.16 s=0.0 l=76.85 z=0

x- su 11.11.-119 232.35 Jye 49%; mo 25.11.-119 66.66 Mrg 30%;
  dt=13.98 s=0.0 l=76.85 z=0

- su 29.6.-93 98.37 Pus 90%; mo 14.7.-93 292.07 Sra 24%;
  dt=14.26 s=0.0 l=76.85 z=0
- su 20.9.-79 179.38 Cit 10%; mo 5.10.-79 14.83 Bha 39%;
  dt=15.48 s=0.0 l=76.85 z=0
- su 4.1.-47 287.06 Sra 10%; mo 19.1.-47 121.75 Mag 159%;
  dt=14.40 s=0.0 l=76.85 z=0
- su 23.10.-25 211.74 Vis 72%; mo 7.11.-25 47.39 Roh 44%;
  dt=15.39 s=0.0 l=76.85 z=0

# O: Mars Retrograde in Jyeṣṭhā, Saturn Tormenting Rohiṇī

This list shows dates between 3500 BCE and 1 BCE on which Mars became retrograde in Jyeṣṭhā and ran towards Anurādhā while Saturn was near Rohiṇī. Positions of Mars and Saturn are given in the Lahiri zodiac, in which the star Jyeṣṭhā / Antares is near 226° and Anurādhā / Dschubba near 219°.

Note, Mars retrograde in Jyeṣṭhā / Anurādhā is astronomically incompatible with a super-conjunction near Jyeṣṭhā (explained on p. 313ff.).

28. 2.-2829 sa=48.81, ma=218.50
6. 3.-2387 sa=53.07, ma=221.92
14. 3.-1945 sa=52.58, ma=225.50
9. 3.-1740 sa=37.47, ma=221.31
20. 3.-1503 sa=56.83, ma=229.04
16. 3.-1298 sa=39.84, ma=224.79 (note super-conjunction in June/July -1295)
27. 3.-1061 sa=56.55, ma=232.59 (note super-conjunction in May -1060)
23. 3. -856 sa=41.29, ma=228.17
30. 3. -414 sa=44.11, ma=231.72 (note morning cluster in April -421)

# Bibliography

Abhyankar, K(rishna) D(amodar), "Antiquity of the Vedic Calendar", in: *Bulletin of the Astronomical Society India* (1998) 26, p. 61-66.

Abhyankar, K(rishna) D(amodar), "A Search for the Earliest Vedic Calendar", in: *Indian Journal of History of Science* (1993) 28, 1, p. 1-14.

Abhyankar, K(rishna) D(amodar), and G.M. Ballabh, "Astronomical and Historical Epoch of Kaliyuga", in: Shastri, A. M. (ed.), *Mahābhārata.*

Abhyankar, K.D., and G.M. Ballabh, "Kaliyuga, Saptarṣi, Yudhiṣṭhira and Laukika Eras", in: *Indian Journal of History of Science* 31(1), 1996.

Achar, B. Narahari, "Comments on "The Pleiades and the Bears viewed from inside the Vedic texts"", in: *Electronic Journal of Vedic Studies* Vol. 6 (2000), issue 2 (December), http://www.ejvs.laurasianacademy.com/ejvs0602/ejvs0602.txt

Achar, B. Narahari, "Date of the Mahābhārata War based on Simulations using Planetarium Software", www.omilosmeleton.gr/pdf/en/indology/narahari01.pdf (download on 15th Oct. 2010).

Achar, B. Narahari, *Date of the Mahābhārata War using Planetarium Software* (2014), www.scribd.com/doc/238194696/Date-of-Mahabharata-War-using-planetarium-software (download on 7th Sept. 2014).

Achar, B. Narahari, "On Exploring the Vedic Sky with Modern Computer Software", in: *Electronic Journal of Vedic Studies* Vol. 5 (1999), issue 2 (December), http://www.ejvs.laurasianacademy.com/ejvs0502/ejvs0502.txt.

Achar, B. Narahari, "On the Astronomical Basis of the Date of Śatapatha Brāhmaṇa: A Re-examination of Dikshit's Theory", in: *Indian Journal of History of Science* 35(1), 2000, 1-19.

Achar, B. Narahari, *Reclaiming the Chronology of Bharatam*, 2006, http://sites.google.com/site/sarasvati96/reclaimingthechronologyofbharatam:narahariachar%28july2006%29.

Agarwal, Vishal, “A Reply to Michael Witzel’s ‘Ein Fremdling im Rgveda’ (*Journal of Indo-European Studies*, 2003, Vol. 31, No.1-2: p. 107-185, 2003)”, http://www.omilosmeleton.gr/pdf/en/indology/ReplytoWitzelJIES.pdf.

Agarwala, G. C. und K. L. Verma, *Age of Bharata War*, Delhi, 1979 (MLBD).

Aiyer, V(elandai) G(opala), *Chronology of Ancient India*, 1903; Neuauflage 1987 (Sanjay Prakashan).

Allchins, B. und R., *Origins of a Civilization*, 1997 (Viking Penguin).

(Atharvavedapariśiṣṭa): Bolling, George Melville, und Julius von Negelein, *The Pariśiṣṭas of the Atharvaveda*, vol. 1, parts 1 and 2, Leipzig : Harrassowitz 1909-1910.

Bailly, M., *Traité de l’astronomie indienne et orientale*, Paris, 1787.

Balakrishna, S., “Dating Mahabharata – Two Eclipses in Thirteen Days”, http://www.boloji.com/astro/00325.htm.

Basham, A. L., *The Wonder That Was India*, London, 1967 (Sidgwick & Jackson).

Bentley, John, *Hindu Astronomy*, Delhi, 1990 (Shri Publikations, Neuauflage).

*Bhāgavata Purāṇa*, with Sanskrit commentary of Śrīdharācārya, ed. Sri Puranam Hayagriva Sastry, 1850.

Bhat, M. Ramakrishna, *Varāhamihira’s Bṛhatsaṃhitā*, Delhi, 1997 (1981).

Bhatnagar, P(ushkar), *Dating the Era of Lord Ram: Discover the Actual Dates of the Lifetime of Lord Ram*, 2004 (M/S Rupa & Co).

Bhattacharya, Tarakeshwar, “The Bhārata Battle”, in: *Journal of the Ganganath Jha Research Institute*, VIII (1950-51), p. 1-78 und 315-353.

Billard, Roger, “Āryabhaṭa and Indian Astronomy”, in: *Indian Journal of History of Science* 12, p. 207-224.

*Bundahishn, Greater*, übersetzt von Bhramgore Tehmuras Anklesaria, Bombay, 1956, http://www.avesta.org/mp/grb1.htm.

Burgess, Ebenezer, *The Sûrya Siddhânta. A Text-book of Hindu Astronomy*, Delhi, 1860 (Reprint 2000, Motilal Banarsidass).

Chandra Hari, K., “On the Origion of ‘Kaliyugādi’ Synodic Super-Conjunction”, in: *Indian Journal of History of Science* 33 (3) 1998.

Chandrashekhar, A., “Dating the era of Lord Ram by Mr. Pushkar Bhatnagar” (Rezension), 2006, http://chandrashekhar.sulekha.com/blog/post/2006/09/dating-the-era-of-lord-ram-a-book-review.htm.

Clarke, John, *Physical Science in the Time of Nero, being a translation of the Quaestiones Naturales of Seneca*, London, 1910.

Cole, Robert, und V. N. Narasimmiyengar, “Three Maisur Copper Grants”, in: *Indian Antiquary* I(1872), p. 375-379.

Daftari, K(esheo) L(akshman), *The Astronomical Method and its Applicaton to the Chronology of Ancient India*, Bangalore, 1942.

Dasan, Ramasamy Ramanuja, “Like a Diamond in the Sky”, http://saranagathi.org/blogs/sadagopan-iyengar/like-a-diamond-in-the-sky/.

Dikshit, S(ankara) B(alkrishna), *Bharatiya Jyotish Sastra (History of Indian Astronomy)* (Tr. from Marathi), Govt. of India, 1969, part I & II.

Elfenbein, J. H., “A periplous of the 'Brahui problem'”, in: *Studia Iranica* 16, 1987, 215-233.

Elst, Koenraad, “Astronomical Evidence and the Upanishads”, http://koenraadelst.blogspot.ch/2013/12/astronomical-evidence-and-upanishads.html .

Erdosy, George, (ed.), *The Indo-Aryans of Ancient South Asia*, Berlin/New York, 1995 (de Gruyter).

Fabri, C. L. (Hrsg.), *Annual Reports of the Archaeological Survey of India for the Years 1930-31, 1931-32, 1932-33 & 1933-34*, Part One.

Farmer, Steve, Richart Sproat, and Michael Witzel, “The Collapse of the Indus-Script Thesis: The Myth of a Literate Harappan Civilization”, in: *Electronic Journal of Vedic Studies (EJVS)*, 11 – 2 (2004), p. 91-57, http://www.ejvs.laurasianacademy.com/ejvs 1102/ejvs1102article.pdf.

Fleet, J(ohn) F(aithful), “Sanskrit and Old Canarese Inscriptions”, in: *Indian Antiquary* IV(1875).

Fleet, J(ohn) F(aithful), “Spurious Indian Records”, in: *Indian Antiquary* XXX(1901), p. 201-223.

Garbe, Richard, *Indien und das Christentum. Eine Untersuchung der religionsgeschichtlichen Zusammenhänge*, Tübingen (Mohr), 1914.

Gaur, A. S., Sundaresh und Sila Tripati, “An ancient harbour at Dwarka: Study based on the recent underwater explorations”, in: *Current Science*, vol. 86, no. 9, 10 May 2004, p. 1256-60, http://www.ias.ac.in/currsci/may102004/1256.pdf.

Gaur, A.S., Sundaresh, P. Gudigar, Sila Tripati, K.H. Vora and S.N. Bandodker, “Recent Underwater Explorations at Dwarka and Surroundings of Okha Mandal”, in: *Man and Environment*, XXV (I) – 2000, p. 67-74, http://drs.nio.org/drs/bitstream/2264/479/1/Man_Environ_25_67.pdf.

Gugler, Thomas K., *Anmerkungen zur Historizität des Kṛṣṇa*, 2005, Norderstedt (GRIN).

Gupta, M(ohan), “The Date of Mahābhārata War. Purāṇic and Astronomical Evidence”, in: Shastri, A.M., *Mahābhārata*.

Gupta, S(warajya) P(rakash), and Ramachandran, Kattalai Subrahmanyam, *Mahabharata. Myth and Reality. Differing views*, Delhi, 1976 (Agam Prakashan; distributed by D. K. Publishers' Distributors). Das vollständige Buch ist auch online zu finden unter: http://abob.libs.uga.edu/bobk/maha/.

Gupta, S(warajya) P(rakash), “Longer chronology of the Indus-Saraswati Civilization”, in: *Puratattva*, No. 23, 1992-93, pp. 21-29; s. auch http://www.hindunet.org/hindu_history/sarasvati/html/civilizationdates.htm.

Holay, V. P., “The Year of Kaurava-Pāṇḍava War”, in: Shastri, A. M. (ed.), Mahābhārata.

Hopkins, E. Washburn, “Epic Chronology”, in: *Journal of the American Oriental Society*, vol. xxiv (1903).

Hunger, Hermann, und David Pingree, *Astral Sciences in Mesopotamia*, Handbuch der Orientalistik, Bd. 44, Brill, 1999.

Hunger, Hermann, and David Pingree, *MUL.APIN. An Astronomical Compendium in Cuneiform*, AfO, Beiheft 24, Horn/Österreich, 1989.

Iyengar, R(angachar) N(arayana), “A Profile of Indian Astronomy before the Siddhāntic Period”, paper presented at the ISERVE Conference at Hyderabad on 14-12-2007, http://hinduonline.co/DigitalLibrary/SmallBooks/RootsOfHinduAstronomyRNIyengarEng.pdf

Iyengar, “Dhruva the Ancient Indian Pole Star: Fixity, Rotation and Movement”, in: *Indian Journal of History of Science*, 46.1 (2011) 23-39.

Iyengar, R(angachar) N(arayana), “Internal Consistency of Eclipses and Planetary Positions in Mahābhārata”, in: *Indian Journal of History of Science*, 38.2 (2003) 77-115.

Iyengar, R(angachar) N(arayana), *Parāśaratantra. Ancient Sanskrit Text on Astronomy and Natural Sciences*, reconstructed text with translation and notes, Jain University Press, 2013.

Iyengar, R(angachar) N(arayana), “Some Celestial Observations associated with Kṛṣṇa-Lore”, in: *Indian Journal of History of Science*, 41.1 (2006) 1-13.

Kalyanaraman, S., *Rigveda and Sarasvati-Sindhu Civilization*, Aug. 1998, http://www.hindunet.org/hindu_history/sarasvati/rvsarasvati.pdf, http://www.hindunet.org/hindu_history/sarasvati/html/rvssc.htm

Kandula, S(atya) S(arada), “Casting Sri Rama’s Jataka Chakram”, ancientindians.net/2010/06/29/casting-sri-ramas-jataka-chakram/, 15. Juli 2010.

Kaul, A(vtar) K(rishen) (jyotirved), Kritik an Bhatnagars Datierung der Geburt Rāmas: E-mail an die yahoo groups *WAVES- Vedic*, *vedic_research_institute*, *hindu_calendar*, *indian_astrology_group_ daily_digest* und *hinducivilization*. Am bequemsten hier nachzulesen: www.hitxp.com/articles/history/birth-date-rama-born/.

Kazanas, Nicholas, "Final Reply", in: *Journal of IE Studies*, 2003, vol. 31, 1&2 (187-240).

Kazanas, Nicholas, "Rigvedic town and ocean: Witzel vs Frawley", 2002,
http://www.omilosmeleton.gr/pdf/en/indology/RigVedicTownand Ocean.pdf

Koch, Dieter, *Der Stern von Bethlehem*, 2009[2], Frankfurt am Main (Verlag der Häretischen Blätter).

Koch, Johannes, *Neue Untersuchungen zur Topographie des babylonischen Fixsternhimmels*, Wiesbaden, 1989 (Harrassowitz).

Kochhar, Rajesh, *The Vedic People*, Hyderabad, 1997 (Orient Longman).

Kollerstrom, Nick, "The Star Zodiac of Antiquity", in: *Culture & Cosmos*, Vol. 1, No.2, 1997),
http://www.astrozero.co.uk/astroscience/documents/nick_kollerstr om_star_zodiac_of_antiquity.pdf, 1. Feb. 2011.

Kuppanna Sastry, T. S., *Pañcasiddhāntikā of Varāhamihira*, P. P. S. T. Foundation, Adyar, Madras, 1993.

Kuppanna Sastry, T. S., "The Main Characteristics of Hindu Astronomy in the Period corresponding to Pre-Copernican European Astronomy", in: *Indian Journal of History of Science*, 9.1 (1974) 31-44.

Lal, B(raj) B(asi), "Mahabharata and Archaeology", in: Gupta/ Ramachandran.

Lal, B(raj) B(asi), "This is How an Archaeologist Looks at the Historicity of the *Mahābhārata*", in: Shastri, A. M., *Mahābhārata*.

Leow Choon Lian, "Indian Calendars", 2000/2001, National University of Singapore, http://www.math.nus.edu.sg/aslaksen/ projects/lcl.pdf

Mackay, E. J. H., “Excavations at Mohenjo-daro”, in: Fabri.

Michiner, John E., *Traditions of the Seven Ṛṣis*, 2000 (corrected version), Delhi (Motilal Banarsidass).

Misra, V(idya) D(har), “Mahābhārata and Archaeology”, in: Shastri, A. M., *Mahābhārata*.

(Mahābhārata), *The Mahābhārata. For the First Time Critically Edited*, 19 vols. (Pune: Bhandarkar Oriental Institute, 1933-1966), edited by V. S. Sukthankar, S. K. Belvalkar, and P. L. Vaidya, general editors, and Franklin Edgerton, Raghu Vira, S. K. De, R. N. Dandekar, H. D. Velankar, V. G. Paranjpe, and R. D. Karmarkar.

(Mahābhārata), *Srimanmahabharatam. A New Edition Mainly Based on the South Indian Texts, With footnotes and Reandings*, edited by T. R. Krishnacharya & T. R. Vyasacharya, 8 vols., 1906-1910, Bombay. http://mahabharata-resources.org/

(Mahābhārata), *Mahābhārata with the commentary “Bhāvadīpa” of Nīlakaṇṭha*, published by Gopal Narayan and Co., Bombay, 1901. http://mahabharata-resources.org/

(Mahābhārata), *The Mahabharata of Krishna-Dwaipayana Vyasa*, translated by Kisari Mohan Ganguli, 1883 – 1896, http://www.sacred-texts.com/hin/maha/index.htm.

(Mitra, Rājendralāla), *The Taittirīya Brāhmaṇa of the Black Yajur Veda with the Commentary of Sayanacharya*, 2 Bde., Calcutta, 1859.

Moehlman, Patricia D., (ed.), *Equids, Zebras, Asses, and Horses. Status Survey and Conservation Action Plan*, Gland, Switzerland, and Cambridge, UK, 2002 (IUCN – The World Conservation Union) (http://data.iucn.org/dbtw-wpd/ edocs/2002-043.pdf)

Müller, Max, *On Ancient Hindu Astronomy and Chronology*, Oxford, 1862.

Murthy, S.S.N, “The Questionable Historicity of the Mahabharata”, in: *Electronic Journal of Vedic Studies (EJVS)*, vol. 10 (2003), issue 5, http://www.ejvs.laurasianacademy.com/ejvs1005/ejvs1005article.pdf.

Narasimmiyengar, V. N. und R. Cole, “Three Maisur Copper Grants”, in: *Indian Antiquary* I(1872), p. 375-379;

Neugebauer, O., und D. Pingree, *The Pañcasiddhāntikā of Varāhamihira*, part I and II, København, 1970.

Papke, Werner, *Die Keilschriftserie MUL.APIN, Dokument wissenschaftlicher Astronomie im 3. Jahrtausend*, Dissertation, Tübingen, 1978.

Pargiter, Frederick Eden, *Ancient Indian Historical Tradition*, 1922, London (Oxford University).

Pargiter, Frederick Eden, *The Purāṇa Text of the Dynasties of the Kali Age*, 1913, London (Oxford University Press).

Pingree, David, *Census of the Exact Sciences*, Series A ii, 1971, Philadelphia.

Pingree, David, *Jyotiḥśāstra. Astral and Mathematical Literature*, 1981, Wiesbaden (Otto Harrassowitz).

Pingree, David, “Mulapin and Vedic Astronomy”, in: *DUMU- $E_2$-DUB-BA-A*, (ed.) Behrens, H., Loding, D., and Roth, M. (Philadelphia, 1989), p. 439-445.

Pingree, David, “The Mesopotamian Origin of Early Indian Mathematical Astronomy”, in: *Journal for the History of Astronomy*, vol. 4 (1973), p. 1 - 12.

Playfair, John, *The Works of John Playfair*, Bd. 3, Edinburgh, 1822.

Rackham, H, *Cicero in Twenty-Eight Volumes*, vol. XIX, *De natura deorum*, London 1967.

Raghavan, K. Srinivasa, *The Date of the Mahabharata War and the Kali Yugadhi* (sic!), 1969 (Saka 1891), Srinivasanagar.

Ramakrishna Bhat, M., *Varāhamihira's Bṛhat Saṃhitā*, 2 vols. MLBD, Delhi, 1997.

Raman, B(angalor) V(enkata), *Notable Horoscopes*, 1991[6] (South Asia Books).

Rao, S(hikaripura) R(anganatha), *Dawn and Devolution of the Indus Civilization*, Delhi, 1991 (Aditya).

Rao, S(hikaripura) R(anganatha), *The Lost City of Dvārakā*, 1999, New Delhi (Aditya Prakashan).

Rau, Wilhelm, *Zur vedischen Altertumskunde* 1983, Wiesbaden (Akademie Mainz).

Reijs, Victor M.M., "Extinction angle and heliacal events", http://www.iol.ie/~geniet/eng/extinction.htm, 2003, viewed March, 30th, 2009.

Rice, L., "Two New Chalukya Grants. With Comparison of the Professed Grants by Janamejaya of the Sarpa Yâga", in: *Indian Antiquary* VIII(1879), p. 89-99.

Roy, S. B., "Mahābhārata and Astronomy", in: Gupta/Ramachandran.

Saha, M.N., and Lahiri, N.C., *Report of the Calendar Reform Committee*, C.S.I.R., New Delhi, 1955.

Sankar, K. G., "Some Problems of Indian Chronology", in: *Annals of the Bhandarkar Oriental Research Institute*, vol. XII, July 1931, part IV, p. 301-361.

Sarma, K. Ven(kateswara) (ed.), *Vedāṅga Jyotiṣa of Lagadha in its Rk and Yajus Recensions*, with the translation and notes of Prof. T. S. Kuppanna Sastry, Indian National Science Academy, 1985.

(Sastry, A. M.), *The Taittiriya Brahmana with the Commentary of Bhattabhaskaramisra*, 2 Bde, Mysore, 1908.

Schaefer, Bradley, "Astronomy and the limit of vision", in: *Vistas in astronomy*, 36:311, 1993.

Schaefer, Bradley, "New methods and techniques for historical astronomy and archaeoastronomy", in: *Archaeoastronomy*, Vol. XV, 2000, page 121-136.

Sengupta, P(rabodh) C(handra), *Ancient Indian Chronology*, 1947, University of Calcutta.

Sethna, K. D., *Problems of Ancient India*, 2000, New Delhi (Aditya Prakashan).

Sharan, A. M., "The Mahabharata War in 2156 BC is Ancient Indian History", www.engr.mun.ca/~asharan/bihar/MBH2.htm.

Sharma, S(uresh) K., *Encyclopaedia of Kashmir: Nehru and Kashmir*, vol. 6, Delhi, 1995.

Sharma, Virendra Nath, "Model of Planetary Configurations in the Mahābhārata: An Exercise in Archaeoastronomy", in: *Archaeo-astronomy* IX(1-4), 1986, p. 88-98.

Sharma, Virendra Nath, "On Astronomical References in the Mahābhārata", http://www.uwfox.uwc.edu/users/vsharma/pdf/MAHABHARATA%20IN%20Roman.pdf.

Shastri, A(jay) M(itra) (ed.), *Mahābhārata. The End of an Era (Yugānta)*, New Delhi, 2004.

Shastri, A(jay) M(itra), "Prāgjyotisha in the Mahābhārata", in: Shastri, A. M. (ed.), *Mahābhārata*.

Simon, J. L., P. Bretagnon, J. Chapront, M. Chapront-Touze', G. Francou, and J. Laskar, "Numerical Expressions for precession formulae and mean elements for the Moon and the planets", in: *Astronomy and Astrophysics* 282, 663-683 (1994).

Simoons, Frederick J., *Plants of life, plants of death*, 1998.

Sreenadh, O. G., "A Planetary position given in Mahabharata", http://www.ancientindianastrology.com/cmsa/index.php?option=com_content&view=article&id=152:a-planetary-position-given-in-mahabharata

Sule, Aniket, Mayank Vahia, Hrishikesh Joblekar, Sudha Bhujle, "Saptarṣi's visit to different Nakṣatras: Subtle effect of Earth's precession", in: *Indian Journal of History of Science*, 2007, vol. 42; No. 2, pp. 133-148.

Tacitus, Cornelius, *Dialogus, Agricola, Germania* (ed. T. E. Page & W.H.D. Rouse), London/New York, 1914.

Tewari, Rakesh, "The origins of Iron-working in India: New evidence from the Central Ganga Plain and the Eastern Vindhyas", http://www.archaeologyonline.net/artifacts/iron-ore.html.

Thibaut, G., and Mahâmahopâdhyâya Sudhâkara Dvivedî, *The Pañchasiddhântikâ. The Astronomical Work of Varâha Mihira*, the text, edited with an original commentary in Sanskrit and an English tanslation and introduction, 1889, Benares.

Thilo, G., *Servii Grammatici qui feruntur in Vergilii Bucolica et Georgica Commentarii*, Leipzig 1887.

Thurston, Hugh, *Early Astronomy*, 1994, New York/Heidelberg/ Berlin (Springer).

Upadhyay, Arun, "Janamejaya inscriptions of 3014 BC", http://xa.yimg.com/kq/groups/17588172/1606695095/name/Janamejaya.doc .

Vallālasena, *Adbhutasāgara*, ed. Murali Dhara Jha Jyautishacharya, Benares, 1905.

Venkatachelam, K(ota), *The Age of the Mahabharata War*, 1991.

Venkatachelam, K(ota), *The Plot in Indian Chronology*, 1953.

Vaidya, C. V., *The Mahabharata. A criticism*, New Delhi, 1983 (Cosmo Publications).

Varma, K. C., in: Gupta/Ramachandran.

[Śrīmad]viṣṇupurāṇam. With the commentary of Ratnagarbha Bhaṭṭācārya called Vaiṣṇavākūtacandrikā. Bombay: Śaka 1824 [1902].

Vora, K. H., A. S. Gaur, David Price and Sundaresh, "Cultural sequence of Bet Dwarka island based on thermoluminescence dating", in: *Current Science*, vol. 82, no. 11, 10 June 2002, p. 1351-56, http://www.ias.ac.in/currsci/jun102002/1351.pdf.

Winternitz, Moriz, *Geschichte der indischen Literatur*, 1. Bd., 1909[2], Leipzig (Amelangs).

Witzel, Michael, "Autochthonous Aryans? The Evidence from Old Indian and Iranian Texts", in: *Electronic Journal of Vedic Studies*, 7-3 (2001), issue 3, http://www.people.fas.harvard.edu/~witzel/EJVS-7-3.pdf.

Witzel, Michael, "Early Sanskritization. Origins and Development of the Kuru State", in: *Electronic Journal of Vedic Studies*, 1-4 (1995), http://www.ejvs.laurasianacademy.com/ejvs0104/ejvs0104article.pdf

Witzel, "Ṛgvedic history: poets, chieftains and polities", in: Erdosy, George, *The Indo-Aryans of Ancient South Asia*, p. 307-352.

Witzel, Michael, "The Harappa / Veda Discussion", 2002, http://sgm.site50.net/AryanInvasions.html.

Witzel, Michael, "The Pleiades and the Bears viewed from inside the Vedic texts", in: *Electronic Journal of Vedic Studies* Vol. 5 (1999), issue 2 (December), http://www.ejvs.laurasianacademy.com/ejvs0502/ejvs0502.txt.

Witzel, Michael, "The Harappa/Veda Discussion", http://sgm.site50.net/aryaninvasions.pdf.

Zarins, Juris, *The Domestication of Equidae in Third Millennium B.C. Mesopotamia*, a Ph. D. thesis submitted to the Department of Near Eastern Languages and Civilizations, University of Chicago, 1976, Chicago.