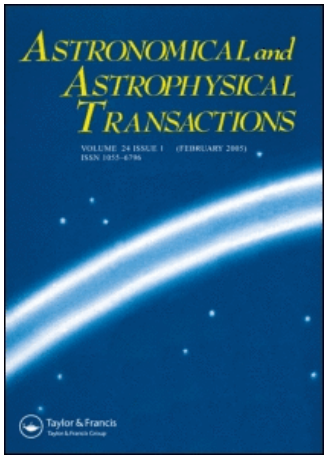

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THE CALENDAR OF THE GREEK ORTHODOX CHURCH

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At the Orthodox Church Council in 1923 in Constantinople a proposal concerning the reform of the calendar, elaborated by the Serbian astronomer Milutin Milanković together with professor Maksim Trpković, was submitted, providing for a more exact calendar than the Gregorian one. Instead of three days in 4 centuries one should omit 7 days in 9 centuries or 0.0077 days per year. This means that only 2 years out of 9 ending the centuries would be leap years. The rule is that those years whose ordinal number ends with two zeros are leap years only provided that the number of centuries they belong to, divided by 9, yields the remainder 2 or 6. For instance the year 2000, ending the 20th century, is a leap year since 20 divided by 9 equals to 2 plus the remainder 2. Milanković's proposal implies a much smaller difference, with respect to the true tropical year, than the Gregorian calendar. Further improvements concerning the approach to the duration of the tropical year are not necessary since that duration itself undergoes changes over longer periods.

Keywords: Calendar; Milanković; celestial mechanics

1 INTRODUCTION: MILUTIN MILANKOVIĆ'S WORK IN ASTRONOMY

Milutin Milanković (Dalj, May 28, 1879–Belgrade, December 12, 1958) went down in the History of Science as the man who proposed an astronomical theory for the explanation of the Ice Ages, which is presently referred to as the Milanković hypothesis. He calculated the variations of the fluctuations of solar insolation caused by the variation of the orbital parameters of the motion of the Earth, and he hypothesized that these demarcate the major climatic events, like the Ice Ages. Milanković elucidated also the history of the Earth's climate as well as that of other planets, being in addition the author of the mathematical theory of climate and of the Earth's pole motion. He promoted Celestial Mechanics by introducing into it vector calculus, besides making several original contributions to the solution of the three-body problem. Since 1909 Milanković was teaching astronomical subjects at Belgrade University. He authored university textbooks: *Celestial Mechanics, History of Astronomical Science from its Beginnings up to 1727* and *Astronomical Theory of Climatic Changes and its Application to Geophysics,* the last one being dedicated to post-graduate students and doctoral candidates. Milanković made also important contribution to the

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popularization of Astronomy, his book *Through the Universe and Centuries* has gone through several editions.

2 THE GREGORIAN CALENDAR AND THE MILANKOVIĆ PROPOSAL: THE NEW RECTIFIED JULIAN CALENDAR

In Europe, from the 16th to the 20th Century the astronomically more accurate Gregorian calendar became accepted only with a great difficulty. The Roman Catholic countries applied it almost immediately, but not the Protestant and the Orthodox ones. The German and Danish Protestants accepted it in 1700, the British in September 1752, and the Swedes in 1753. The Orthodox countries accepted it, one after the other, only in early 20th Century, and only because the old calendar was isolating them calendrically from the rest of Europe. We note that Orthodoxy did not accept the Gregorian calendar, but during an all-orthodox Congress by the oecumenical Patriarch Meletios IV, which took place in **Constantinople** (May 1923), it suggested a new calendrical cycle of 900 years. This cycle is more accurate than the Gregorian cycle of 400 years. This was a proposal of the famous Serbian astronomer Milutin Milanković in collaboration with professor Maksim Trpković. **The proposition stated that from the years ending a century, only the ones whose number of century gives remainder 2 or 6 when divided by 9 will be considered leap**. For the other years the Julian rule continues to be valid. that is, instead of the leap years 400, 800, 1200, 1600, 2000 etc. of the Gregorian calendar, it considered as leap the years 200, 600, 1100, 1500, 2000 etc. In this calendar, a cycle of 900 years contains 218 leap ones, the average duration of the tropical year being approximated thus with the number 365.24222222 . . . days, that is the error amounts to approximately 2.03 seconds annually. This means that astronomically it is the most accurate from all the proposed calendars up to now! If it has not been adopted by the rest of the Christian Churches, the reasons are certainly non-scientific. The New Rectified Julian calendar was adopted on 10 March 1924, which was identified with 23 March 1924, because the difference from reality had since then increased to 13 days.

Milanković made a great contribution to the organization of Astronomy in Yugoslavia. From 1936 till 1939 he was the president of the first National Committee for Astronomy through which Yugoslavia became a member of the International Astronomical Union (I.A.U.). He was a part-time Director of the Belgrade Astronomical Observatory up to January 27, 1951, when he became full-time Director, a post he held until June 26, 1951.

3 THE CANON OF EARTH INSOLATION

Milanković began occupying himself with the astronomical origins of climate changes and the mathematical theory of climate after settling in Belgrade, publishing in 1912 *A Contribution to the Mathematical Theory of Climate,* in 1913 *On the Application of the Mathematical Theory of Warmth Transmission to the Problems of Cosmic Physics* and in 1916 *Investigation on the Climate of Mars.* In his *Théorie mathématique des phenomenes thérmiques produits par la radiation solaire* (Mathematical Theory of the Thermal Phenomena Caused by the Solar Radiation) Milanković develops a theory based on the principles of Celestial Mechanics and Theoretical Physics which explains the distribution of the solar radiation through-out interplanetary space and over planetary surfaces. He indicates also the connection between the insolation and temperature of the planetary layers and brings out daily, annual and secular changes of the insolation. In 1926 he published the research paper *Investigation in the Thermic Constitution of the Planetary Atmospheres.* In all of these works he devoted particular

attention to the climate of the planet Mars, establishing beyond doubt the mean annual temperature on this planet's surface to be about -17°C. His researches on the Mars climate as well as his prediction of the non-existence on this planet of any highly developed life, have been verified by some modern cosmic investigations. As for the exploration of Mars, Milanković's scientific works have been made use of in the studies and discussion on the liquid water on Mars, on its crust and atmosphere, surface temperature and climate as well as on the astronomical theory of climate changes on that planet. In his *Canon* Milanković collected the results of his longstanding researches, demonstrating the long-period cyclical changes in the Earth climate and the occurence of Ice Ages as being a consequence of the following causes:

(a) Changes of Earth's axis inclination between 22° and 24.5° with a 41,000 year period, owing to which the insolation on any particular point on the Earth's surface undergoes changes too;
(b) Changes of the eccentricity of the Earth's orbit about the Sun, with a 100,000 year period, bringing about changes in the Earth's distance from the Sun, which in turn gives rise to changes in the duration of the seasons;
(c) Precession, causing the point of the winter solstice to be shifted along the Sun's annual apparent path, affecting the duration of the seasons with a 22,000 year period.

In order to solve the problem of the occurence of the Ice Ages in the Quaternary, Milanković in 1932 arrived at his famous differential equation of the Earth's poles, motion. He found that some 300 million years ago, the Earth's North pole was in the Pacific ocean at 20° N latitude and 168° E longitude. At present also the North pole is moving towards its equilibrium point in Siberia, near the location of the Pechora river flowing into the Arctic Ocean. The most important of Milanković's work is *Kanon der Erdbestrahlung und seine Anwendung auf das Eiszaitenproblem* (The Canon of the Earth's Insolation and its Application to the Ice Ages Problem). It is his capital scientific work, a monograph, comprising results of his researches previously published in 28 research works. In this monograph these results are assembled in one whole, together with new analyses and supplements, including numerous examples and applications of his theory. In this capital work Milanković presents mathematical theory of the Earth's climate (applicable also to other planets), explaining the origin of the Ice Ages and exposing his theory of the Earth's poles' motion. Milanković began the writing of the Canon on March 30, 1939, finishing it in the first half of February 1941. Milutin Milanković is the most distinguished Serbian astronomer. In honour to his scientific achievements in Astronomy a crater on the far side of the Moon (coordinates $+170^{\circ}$, $+77^{\circ}$) was given his name at the 14th IAU General Assembly in Brighton in 1970. His name has been given also to a crater on Mars (coordinates $+147^{\circ}$, $+55^{\circ}$) at the 15th IAU General Assembly in Sidney in 1973. In 1982 a small planet, provisorily designated 1936 GA, discovered in 1930 by M. Protić and P. Djurković, received its permanent name: 1605 Milankovitch.

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