

WHEN DID THE ASTEROIDS BECOME MINOR PLANETS?

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Abstract

Pluto is not the first object to be recognized as a planet for decades, only to be "demoted" largely as a result of subsequent discoveries of similar objects. When it was first discovered on 1 January 1801, Ceres was hailed as the "missing" planet. Even after the discoveries of Pallas, Juno, and Vesta, in 1802 through 1807, all were considered planets even though they did not fit in with the other known planets of the solar system because of their inclined, eccentric orbits and small sizes. Like the classical planets, they were assigned symbols as a notational short hand, and astronomy books of the day discussed them as planets. Decades went by without a new "planet" discovery; there seemed no need to alter the system in place. However, as dozens of additional asteroids were discovered between the mid-1840s and 1850s, the idea that the asteroids were planets broke down. At this time a new, simplified system of symbols was introduced; it quickly became apparent that the asteroids formed a new class of solar system bodies, and they were eventually relegated to the status of "minor planet".

Discovery of the Asteroids

On January 1, 1801 Guiseppe Piazzi at the Palermo Observatory discovered a 'star' that had moved from its position the previous night. It was found to be a body at exactly the distance from the Sun predicted by Bode's Law. Piazzi named this new planet Ceres after the Roman goddess of the harvest. Unexpectedly, on March 28, 1802 Heinrich Olbers discovered a second small body, to be named Pallas, while observing Ceres. Its semimajor axis was nearly the same as Ceres, and posed problems for the picture of the solar system that had been emerging over the previous decades.

Neither of these bodies fit the conventional idea of a planet because they were so small that their disks were effectively unobservable. William Herschel determined diameters of 161.6 miles for Ceres and 147 miles for Pallas and declared:

From this, their asteroidal appearance, if I may use that expression, therefore, I shall take my name, and call them Asteroids; reserving for myself, however, the liberty of changing that name, if another, more expressive of their nature should occur.

Thus Herschel argued that Ceres and Pallas were not the same as the other planets.

Other astronomers of the time thought otherwise. These two new additions to the solar system were listed along with the rest of the planets in order of semimajor axis, increasing distance from the Sun, in the almanacs such as Britain's *Nautical Almanac* and the German *Berliner Astronomisches Jahrbuch (BAJ)*. They were also given symbols by their discoverers to be used when recording observations, shown in Table 1

The discoveries of Juno in 1804 and Vesta in 1807 raised concern in astronomers of the day that the asteroids were fragments of a planet that had somehow disintegrated, first proposed by Olbers upon the discovery of Pallas. However, Juno and Vesta were added to the catalog of planets in order of semimajor axis along with Ceres, Pallas, and, in 1846, Neptune.

The acceptance of the first four asteroids was so matter-of-fact that introductory texts such as *First Steps to Astronomy and Geography* lists the planets as, "Eleven: Mercury, Venus, the Earth, Mars, Vesta, Juno, Ceres, Pallas, Jupiter, Saturn, and Herschel." Herschel was an alternate name for Uranus (after its discoverer) used in Britain until the 1850's.

The Scene Becomes Complicated

The fifth asteroid, Astraea was not discovered until late 1845, nearly 39 years after the discovery of Vesta. By the end of 1851 there were 15 asteroids, still listed by semimajor axis. Fourteen of them each had their own symbol. Some of these symbols were quite fanciful and took significant artistic skill to draw. Table 2 shows some of the more difficult to draw asteroid symbols.

Planet	Symbol
Mercury	☿
Venus	♀
Earth	♁
Mars	♂
Vesta	♁
Juno	♃
Ceres	♁
Pallas	♀
Jupiter	♃
Saturn	♄
Uranus	♅

Table 1. The symbols for the 'planets' from 1807 through 1845 in order of semimajor axis (distance from the Sun).

Encke made a major change in the *BAJ* for 1854. He said:

Finally, I want to add that - in view of the complications and difficulties with the recently used planetary symbols - I took the liberty to introduce the encircled numbers instead of symbols.

However, the asteroids Encke was referring to began with Astrea which was given the number (1) and went through (11) Eunomia. Ceres, Pallas, Juno, and Vesta continued to be denoted by their traditional symbols. Ceres through Vesta also continued to be listed along with other major planets, while Astraea through Eunomia, and Neptune were relegated to a section at the end of the *BAJ*.

The new system of symbols was designed to relieve the growing confusion and restore the original intent of the symbols, a quick shorthand way of referring to solar system bodies; *not* to give the asteroids a different status from the rest of the planets.

At least three additional asteroids, 28 Bellona, 35 Leukothea, and 37 Fides, were given old style symbols. The symbol for Leukothea, the most complicated of all, is described as representing an ancient lighthouse. There is no evidence, however, that these symbols were ever used outside of their initial publication.

The acceptance of the new system of symbols was extremely fast. All of the major journals adopted the new symbols by 1861.

The two major almanacs and the reports of the major observatories that printed asteroid ephemerides and observations at this time had interesting reactions to the introduction of the new symbols.

With volume for 1856 the British *The Nautical Almanac*, which had been publishing ephemerides for Ceres, Pallas, Juno, and Vesta in semimajor axis order between the ephemerides of Mars and Jupiter, stopped printing asteroid ephemerides altogether.

The *BAJ* continued to publish the ephemerides of the first four asteroids discovered in semimajor axis order using the old symbols up through the volume for 1866. The ephemerides of the other asteroids were given in numerical order in a section at the end of the almanac along with the ephemeris for Neptune. Similarly, the Paris Observatory accorded Ceres through Vesta a form of 'dual citizenship' with both the planets and the asteroids through the mid-1860's.

Except for the U.S. Naval Observatory, all of the other major publications immediately began publishing their observations in order of their numerical symbol rather than their distance from the Sun. The Paris Observatory also moved the observations of the asteroids to a section separate from the observations of the other planets. While the Royal Greenwich Observatory left the observations

between the observations of Mars and Jupiter, but in numerical order.

The Sizes of the First Three Asteroids Shrink

At the time the description 'minor planet' began to be used, the most widely disseminated values for the diameters of the first four asteroids discovered were Ceres, 2613 km; Pallas, 3380 km; Juno, 2290 km; and Vesta, "not more than 383 km". In 1856, the estimated sizes of the first three asteroids shrunk considerably. The diameters of the first three asteroids are directly comparable to the 2390 km of Pluto. The pre-1855 asteroid diameters, shown in Figure 1, are grossly too large.

Just as the earlier diameters determinations made as 'planets' were way too large, the first 'minor planet' diameters were way too small. In both cases the size determined depended on the assumptions that went into interpreting the data. The question that cannot be answered is, "How much were these assumptions colored by what the observers thought of the bodies they were observing?" In either case, the assumptions made were not necessarily warranted.

The Asteroids are Called 'Minor Planets'

The discussion of what to call these small bodies in the solar system started almost immediately upon their discovery. As mentioned earlier, Herschel called them *asteroids*, while Olbers preferred the term *kleine Planeten* or *minor planets* in English. However, neither of these terms were used much in the literature of the day. The first time a term other than *planet* shows up in a major publication is in the British *The Nautical Almanac and Astronomical Ephemeris* beginning in 1845 which includes the heading of 'Minor Planets, Elements of'. The next time such a term is used is *kleine Planeten* in a paper by Jahn 1854, well after the number of known main belt asteroids had begun to proliferate.

Conclusions

Like Pluto, the asteroids were known from the beginning to be different from the other planets. The initial estimates of their diameters were quite uncertain, but they were generally assumed to be larger than they actually were. However, as long as the number of anomalous objects was small, they were accepted pro-forma as planets. This situation lasted for approximately 45 years.

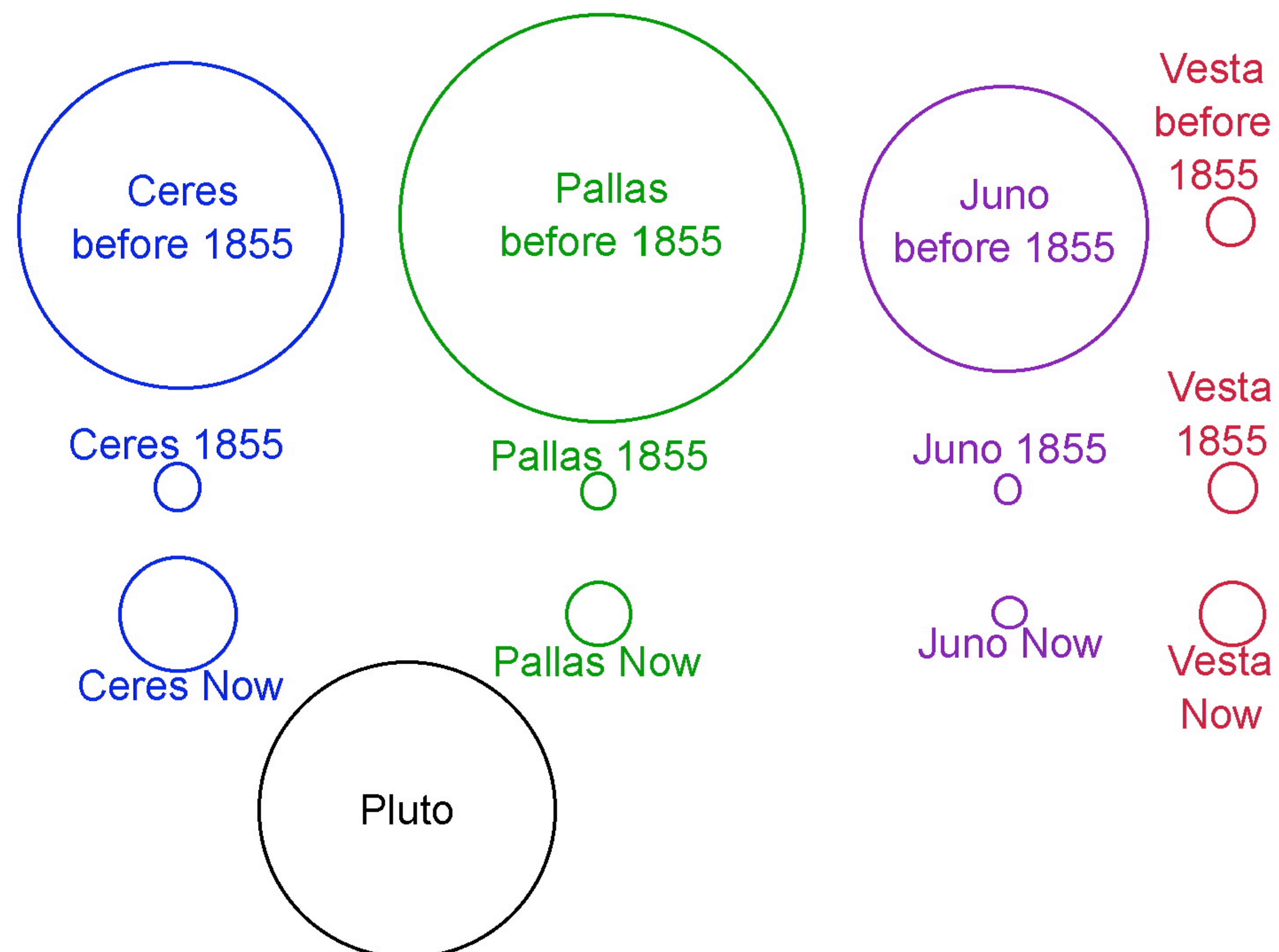


Figure 1. The estimated sizes of the first four asteroids before and after 1855.

Asteroid	Symbol
Hebe	♁
Iris	♁
Flora	♁
Metis	♁
Hygiea	♁
Parthenope	♁
Victoria	♁
Bellona	♁
Leukothea	♁

Table 2. Some of the more difficult to draw symbols for the asteroids.

Once the number of anomalous objects with similar attributes became large enough, however, a new class of solar system objects was formed. The recognition of this new class of objects was demonstrated by:

1. Adoption of a new set of symbols that were predetermined and easy to reproduce.
2. Moving these bodies from the planetary section to a section of their own in ephemerides and tables of observations.
3. A change from display in order of semimajor axis to numerical order
4. Adoption of a collective label for the objects in the class.

Even the largest bodies, Ceres, Pallas, and Vesta, were quickly swept into this class once it became clear that their properties were more similar to those of the new class than they were to the classical planets. The failure of this dual classification is noteworthy because Ceres, the first asteroid discovered, is estimated to contain 25-30% of the total mass of the main asteroid belt, while Pallas and Vesta combined are nearly as massive as Ceres.

The event that appears to have triggered this reevaluation of the status of the asteroids was the introduction of a new set of symbols. These new symbols had nothing to do with judging whether or not the asteroids were planets. Nor is it clear that the name 'minor planet' was initially meant to separate the asteroids from the other planets.