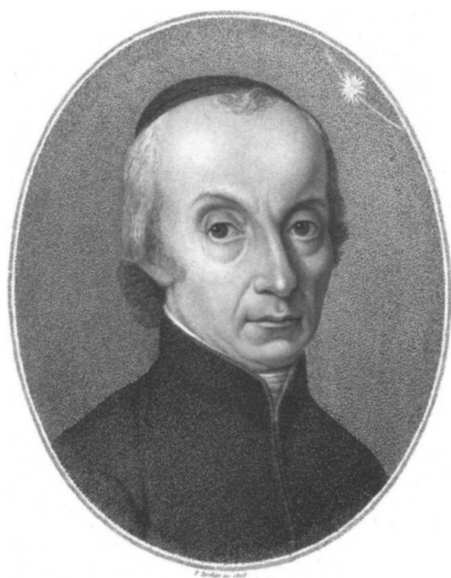


## Chapter 2

### Eleven Planets

Giuseppe Piazzi never expected to see the beginning of the nineteenth century. When he was born, on July 16, 1746, his mother had already given birth to eight children, but most of them had died shortly after coming into the world. To assure the salvation of his new-born soul, Giuseppe was christened almost immediately after his birth in the family house in Ponte Valtellina. The quick christening proved unnecessary, but Piazzi was never a healthy man, despite living a devout life as a member of the Theatine Order.



Giuseppe Piazzi, who discovered the first asteroid (Courtesy Stichting De Koepel)

And now here he was, 54 years old, on the evening of the first day of the new century, peering through the eyepiece of the meridian circle in the observatory in Palermo. Thursday, January 1, 1801 was a crystal clear evening on the north

coast of Sicily. Venus had just set in the southwest; the red planet Mars twinkled high above the southern horizon. And 9 degrees to the south of Mars, in the ‘shoulder of the Bull’ – as he himself described it – Piazzi discovered a new planet. A planet which astronomers had been speculating about for nearly 200 years.

Even stranger, it was a planet that had simply been invented, by German astronomer Johannes Kepler in 1596. Kepler not only was as unhealthy as Piazzi, but also suffered from a stutter and was the son of a convicted witch to boot. He was 25 when he published his *Mysterium cosmographicum*, a rather esoteric book in which he sought the divine idea behind the design of the solar system. Why were there 6 planets instead of 7, or 12? What system lay behind their orbital periods and the distances between them? And above all, what reason could God possibly have had for leaving such a large empty space between the orbits of Mars and Jupiter?

Like the Greek philosopher and mystic Pythagoras, Kepler was convinced that nature must be ordered according to mathematical rules. But the divine code of the solar system remained a mystery. As a last resort, he imagined a new planet in the wide, empty zone between Mars and Jupiter. That made the solar system a little more systematic, but it was still not enough.

Partly thanks to Kepler, who in the early seventeenth century established the laws governing the movements of the planets, their orbits were much better documented 200 years later. But the puzzle of the empty space between Mars and Jupiter remained unsolved. And more and more astronomers started to seriously consider the idea that, somewhere in that space, there had to be an as yet undiscovered planet.

That was largely due to an influential book by another 25-year-old German astronomer, Johann Elert Bode. Bode would later suggest the name Uranus for the planet discovered by William Herschel in 1781. He also became the director of the Berlin observatory and, in 1801, published his *Uranographia*, one of the most significant star atlases in history. But his reputation was already secured when he wrote *Anleitung zur Kenntnis des gestirnten Himmels* in 1772.

In that book Bode described a remarkably simple formula. Take the numerical series 0, 3, 6, 12, 24, 48, and 96, where each number is double that of the one before it. Add four to each number, so that you get 4, 7, 10, 16, 28, 52, and 100. Divide the result by 10 and you get approximately the distances of the planets from the Sun in astronomical units, where one astronomical unit (AU) is equal to the distance from the Earth to the Sun (150 million kilometers). It was amazingly simple, but there was one problem: the formula was only accurate if the fifth number (2.8) was reserved for a planet between the orbits of Mars (at approx. 1.6 AU) and Jupiter (approx. 5.2 AU).

## Quest

Bode did not discover this mathematical rule himself. Six years previously, his compatriot Johann Daniel Titius had described it in a very free translation of a French natural-scientific book. Titius, in his turn, had taken it from the German Christian Wolff, who had mentioned it in 1724, and Wolff was probably familiar with the work of the Englishman David Gregory, who had drawn attention to the extraordinary ratios between the orbits of the planets in 1702. In effect, the idea of an unknown planet between Mars and Jupiter had never really been out of fashion since Kepler's time.

But 'Bode's Law' was not really taken seriously until the discovery of Uranus. Uranus orbits the Sun at an average distance of 2.87 billion kilometers – just over 19 AU. And the eighth number in the series identified by Titius and Bode is 19.6 (192 plus 4 divided by 10)! That could of course not be a coincidence. At the end of the eighteenth century, Bode and his contemporaries were practically convinced that there must, indeed, also be another planet between the orbits of Mars and Jupiter. The big question was: how to find it?

It had to be a small, dark world otherwise it would have been observed long ago with the naked eye. There was nothing else for it but to search the heavens with a telescope for an inconspicuous speck of light moving between the stars. There was one plus point: all of the known planets move around the Sun in more or less the same plane and therefore, seen from the Earth, are always found in one of the 12 constellations of the zodiac. The quest could therefore be restricted to a relatively narrow zone.

The Hungarian nobleman Baron Franz Xaver von Zach, chief astronomer to the Duke of Gotha and director of the observatory in Seeberg, was determined to find the new planet, but soon realized that he could never do it alone. It would need a joint effort – and preferably an international one.

On September 20 and 21, 1800, six astronomers came together at the observatory in Lilienthal to set out a strategy. In addition to Baron von Zach, they were Johann Schröter, Karl Harding, Heinrich Olbers, Ferdinand von Ende, and Johann Gildemeister. They divided the zodiac into 24 equal parts and drew up a list of an additional 18 European astronomers who would join them in the detective work.

Later that year, they sent out the first letters to their selected colleagues in Germany, Denmark, Sweden, Russia, France, Austria, England, and Italy, asking them to take part. It was the most ambitious program of cooperation ever in the history of astronomy. There could be no doubt that the *Himmelpolizei* (Celestial Police), as Von Zach called the group of 24 investigators, would track down the unknown planet.

## Point of Light

Giuseppe Piazzi knew nothing of all this when, early in January 1801, he discovered a small, moving point of light about 9 degrees to the south of Mars. He had been on the list drawn up by the small group in Lilienthal, but for some reason or another he had never received Von Zach's letter. He had heard of the theories about a planet between Mars and Jupiter, but only in passing. After all, Piazzi was a mathematician and not an astronomer. He had not taken much interest in astronomy until 1787, when the Royal Academy in Palermo asked him to set up an observatory.

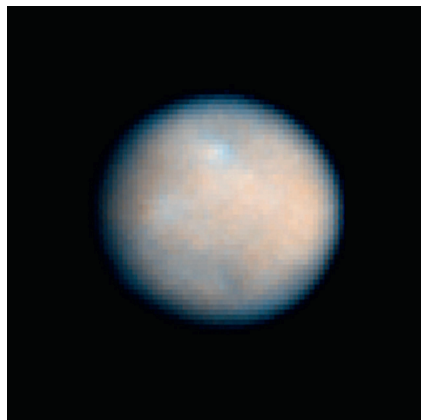
Piazzi had commissioned one of the best telescope-builders in the world, Jesse Ramsden in London, to build a splendid meridian circle for the new observatory. Meridian circles, which are always directed exactly to the south, are exceptionally suited to charting the positions of the stars. Piazzi used the new instrument to produce an accurate stellar catalogue, which would eventually be published in 1803. It was with this telescope that, on January 1, 1801, he measured the position of a large number of faint stars near the zodiacal constellation of Taurus.

It was not until the following day, when Piazzi made a second series of measurements that he realized that one of the stars had moved slightly in his field of vision. He thought that perhaps he had made an error on the first evening, but on January 3 the star had moved slightly again, and again the following night. It all seemed to point to the discovery of a new comet, but there was no sign of the nebulosity that generally surrounds comets.

Once Piazzi had assured himself that he was not mistaken, he announced the discovery of the new comet. He did not, however, give its position: for the moment, at least, it was 'his' find. Once he had made more observations, he could probably calculate the object's path through the solar system before someone else beat him to it. He was still not sure that the sharp little point of light really was a comet. Perhaps he had made an even more important discovery. At the end of January, Piazzi wrote to his good friend and colleague Barnaba Oriani in Milan: 'I have announced this star as a comet, but since there is no sign of the usual nebulosity and it moves in a very slow and even manner, I suspect that it may be something more significant than a comet.'

Piazzi did not have much luck with the follow-up observations. In January, the weather was often bad and in February, the new star was already in the south at the end of the afternoon, as the Sun set. It was impossible to conduct positional measurements with the meridian circle during twilight. To make matters worse, Piazzi became ill. The long nights staring through the telescope had affected his already weak health. By the end of the winter, he had gathered only 24 measurements.

Meanwhile, other astronomers were starting to get impatient. An important new discovery was all very well, but they wanted to see evidence. Piazzi, who was still trying to calculate the object's path, did not want to release his findings yet but, under pressure from the French astronomer Joseph Lalande, he could



Ceres, as imaged by the Hubble Space Telescope (NASA, ESA, J. Parker (Southwest Research Institute), P. Thomas (Cornell University), L. McFadden (University of Maryland, College Park), and M. Mutchler and Z. Levay (STScI))

hardly refuse. As well as being a Theatine monk, brother Giuseppe was also a freemason, and Lalande was Grand Master of the French Lodge of the Nine Sisters, and therefore not someone to argue with. In April, Piazzi sent his findings to Paris, with a copy to Oriani in Milan, but not to Johann Bode in Berlin.

Bode, who was now the director of the observatory in Berlin, had received an earlier letter from Piazzi about the ‘new comet’ and was actually quite certain that it was the planet that Baron von Zach’s *Himmelpolizei* were looking for. Twenty years after he had proposed the name Uranus for the new planet beyond the orbit of Saturn, Bode now came up with the name Juno for the new planet between Mars and Jupiter. And in April, he announced the discovery of the new planet to the press.

Piazzi was furious. How dared the Germans announce the discovery of *his* planet and give it a name? Who had discovered it in the first place? Piazzi himself had thought of calling it Ceres Ferdinandea, after the goddess of Sicily and King Ferdinand IV, the ruler of the island. Fortunately he had the support of Von Zach, who found Ceres an appropriate name, though he thought the addition of ‘Ferdinandea’ was a little excessive.

In the meantime, astronomers in Paris had been working hard analyzing Piazzi’s positional measurements and there appeared to be no more doubt at all: the wandering star that Piazzi had observed in January and February was not a comet but a planet in a more or less circular orbit around the Sun. But Lalande and his colleagues were unable to determine Ceres’ orbit with any great degree of accuracy. Consequently, no one knew where the small planet would appear in the summer months, when it would once again be visible in the morning sky. At the end of 1801, Ceres had still not been rediscovered and Lalande even

began to doubt its existence. After all, he had only a series of numbers. Piazzi was the only one who claimed to have actually seen the elusive object.

The orbit problem was finally solved in elegantly by the mathematical genius Carl Friedrich Gauss. At the age of 24, Gauss had developed a method, which astronomers still use today, of calculating the path of a celestial body from a small number of positional measurements. Using Gauss' predictions, Ceres was found again in December 1801 by Von Zach and, independently from him, by Heinrich Olbers on January 2, 1802 – a year after Piazzi's original observations.

The discovery of the eighth planet in the solar system was a fact. Admittedly, it was a small, faint planet, but just like Uranus – discovered 20 years previously – Ceres complied almost perfectly with Bode's Law. And, as a result, the solar system seemed finally to be losing some of its mystery.

## Fragments



Heinrich Olbers, the discoverer of Pallas (Courtesy George Beekman)

There was therefore great alarm and confusion when, on March 28, 1802, Olbers discovered another planet between the orbits of Mars and Jupiter. Pallas, as the new planet was named, is about the same distance from the Sun as Ceres but its orbit is a little more elongated and is at a slightly more oblique

angle with respect to the orbits of the other planets. Olbers reached a logical conclusion: were Ceres and Pallas perhaps fragments of a former planet? Could that explain why they were so small? And were there other fragments waiting to be discovered in this part of the solar system?

It was indeed curious that, even in the most powerful of telescopes, the new celestial objects remained little points of light, like stars, while all other planets were resolved as small, round disks. This could only mean one thing: Ceres and Pallas could not be more than a few hundred kilometers in diameter. And if more fragments were found, it would be quite illogical to call them all 'planets.' On May 6, 1802, in a presentation at the Royal Society in London, William Herschel therefore suggested referring to Ceres and Pallas forthwith as asteroids ('star-like bodies'). And in a letter to Piazzi he congratulated him on being the first to discover a whole new class of celestial object.

Perhaps the Englishman Herschel was not too keen to share his unique status as the discoverer of a new planet with an Italian and a German. Either way, it showed great insight on his part to derive a complete new population of celestial objects on the basis of observations of only two.

Herschel's proposal found little support among his European colleagues, who enthusiastically welcomed Pallas as the ninth planet. And when Karl Harding discovered Juno on September 1, 1804 and Heinrich Olbers Vesta on March 29, 1807, everyone was in their seventh heaven. In a little over a quarter of a century, no fewer than five new planets (including Uranus) had been discovered – and the *Himmelpolizei* would undoubtedly find more.

But that proved easier said than done. A fifth object (Astraea) was not discovered between the orbits of Mars and Jupiter until December 1845. Neither Herschel, Piazzi, Bode, Von Zach nor Olbers lived to see it. For nearly 40 years, the solar system had 11 planets, which were listed as such in all popular and professional astronomy books published in the first half of the nineteenth century. Starting with the planet nearest to the Sun, they were Mercury, Venus, Earth, Mars, Vesta, Juno, Ceres, Pallas, Jupiter, Saturn, and Uranus. The newcomers were even given stylized symbols like those that have been used to designate the 'classical' planets for many centuries.

After Astraea was discovered, things started to move much faster. Hebe, Iris, and Flora were discovered in 1847, Metis in 1848, and Hygiea in 1849. Five years later, the count had reached 30, and by 1868, no less than 100 objects had been found between the orbits of Mars and Jupiter. They were referred to as minor planets or – as Herschel had proposed – asteroids. And although Ceres, Pallas, Juno, and Vesta continued to enjoy a kind of *status aparte*, everyone realized that it had been a mistake to classify them as full-fledged planets.

The fact that astronomers accepted the 'demotion' of Ceres, Pallas, Juno, and Vesta with such little fuss was not only because those who had discovered them were no longer alive. The most important reason was undoubtedly that, in 1846, a *real* new planet was discovered. And this time it was not by accident. On the contrary.

The Hunt for Planet X

New Worlds and the Fate of Pluto

Schilling, G.

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