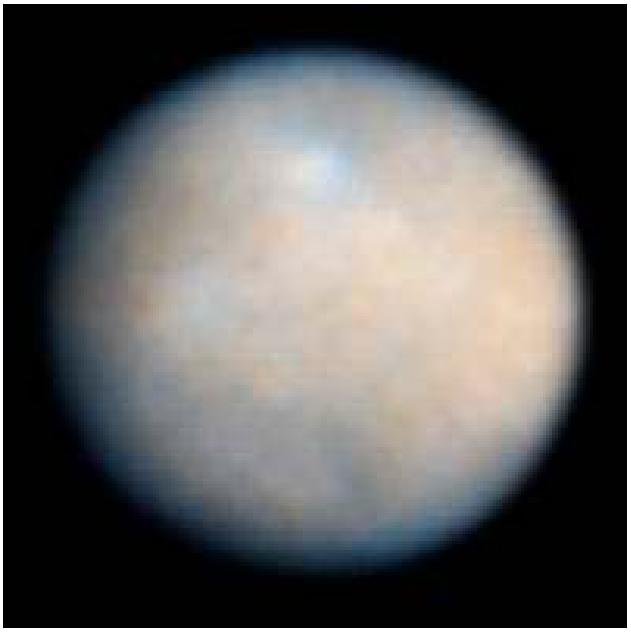
WATER DETECTED ON DWARF PLANET CERES



Scientists using the Herschel Space Observatory have made the first definitive detection of water vapour on the largest and roundest object in the asteroid belt, the dwarf planet Ceres. It is the first time water vapour has been unequivocally detected on Ceres or any other object in the asteroid belt and provides proof that Ceres has an icy surface and an atmosphere. **Herschel is a European Space Agency (ESA) mission** with important NASA contributions. Data from the infrared observatory suggest that plumes of water vapour shoot up from Ceres when portions of its icy surface warm slightly. **The results come at the right time for NASA's Dawn mission**, which is on its way to Ceres now after spending more than a year orbiting the large asteroid Vesta. **Dawn is scheduled to arrive at Ceres in the spring of 2015**, where it will take the closest look ever at its surface. With a spacecraft on the way to Ceres it won't be long before getting more context on this intriguing result. Dawn will map the geology and chemistry of the surface in high resolution, revealing the processes that drive the outgassing activity.

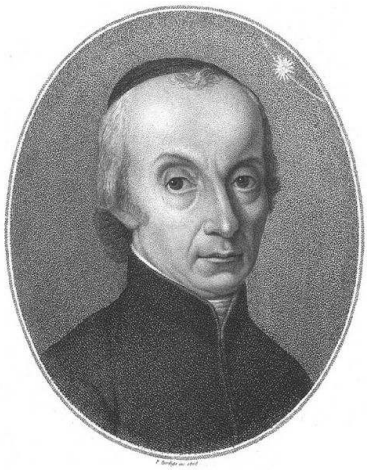
For the last century, Ceres was known as the largest asteroid in our solar system. But in 2006, the International Astronomical Union, the governing organization responsible for naming planetary objects, **reclassified Ceres as a dwarf planet** because of its large size. It is roughly 950 kilometres in diameter. **When it first was spotted in 1801, astronomers thought it was a planet orbiting between Mars and Jupiter**. Later, other cosmic bodies with similar orbits were found, **marking the discovery of our solar system's main belt of asteroids**. **Johann Elert Bode**, in 1772, first suggested that an undiscovered planet could exist between the orbits of Mars and Jupiter. **Johannes Kepler** had already noticed the gap between Mars and Jupiter in 1596. Bode based his idea on the **Titius–Bode law** — a hypothesis Johann Daniel Titius first proposed 1766 — observing that there was a regular pattern in the semi-major axes of the orbits of known planets. "...supposing the distance of the Earth from the Sun to be divided into ten equal Parts, of these the distance of Mercury will be about four, of Venus seven, of Mars fifteen, of Jupiter fifty two, and that of Saturn ninety six". This sequence is only marred by the large gap between Mars and Jupiter. The pattern predicted that the missing planet ought to have an orbit near 2.8 **Astronomical Units**.

Johann Elert Bode (1747 – 1826) was a German astronomer known for his reformulation and popularization of the Titius-Bode law. Bode determined the orbit of Uranus and suggested the planet's name.

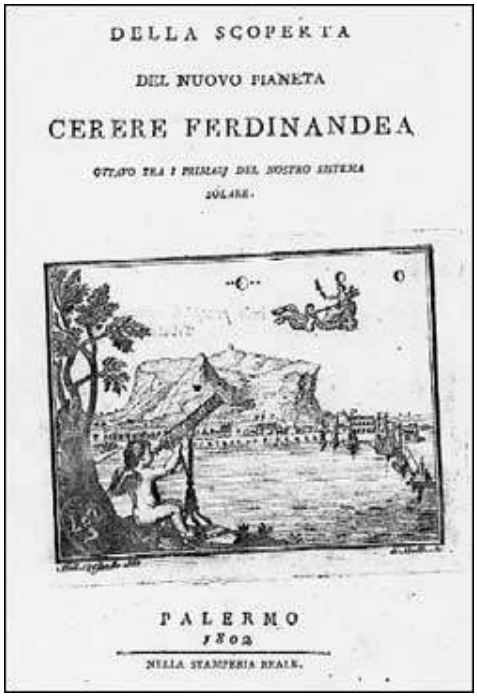
Planet	k	T-B rule distance (AU)	Real distance (AU)	% error (using real distance as the accepted value)
Mercury	0	0.4	0.39	2.56%
Venus	1	0.7	0.72	2.78%
Earth	2	1.0	1.00	0.00%
Mars	4	1.6	1.52	5.26%
Ceres[1]	8	2.8	2.77	1.08%
Jupiter	16	5.2	5.20	0.00%
Saturn	32	10.0	9.54	4.82%
Uranus	64	19.6	19.2	2.08%
Neptune	128	38.8	30.06	29.08%
Pluto[2]	256	77.2[2]	39.44	95.75%

The law relates the semi-major axis of each planet outward from the Sun in units such that the Earth's semi-major axis is equal to 10. That is: a = 4 + n, where n = 0, 3, 6, 12, 24 ... There is no solid theoretical explanation of the Titius–Bode law, but if there is one it is possibly a combination of orbital resonance and shortage of degrees of freedom: any stable planetary system has a high probability of satisfying a Titius–Bode-type relationship. It may simply be a mathematical coincidence rather than a "law of nature" and science journals no longer accepts papers attempting to provide improved versions of the law.

Giuseppe Piazzi at the Academy of Palermo, Sicily, discovered Ceres on 1 January 1801. He was searching for the 87th star in the Catalogue of the Zodiacal stars of **Abbé Nicolas Louis de LaCaille**, Piazzi found a moving star-like object, which he first thought was a comet. Piazzi observed Ceres a total of 24 times, the final time on 11 February 1801 and announced his discovery on 24 January 1801 in letters to only two fellow astronomers, his compatriot **Barnaba Oriani** of Milan and Bode of Berlin. Piazzi originally suggested the name Cerere Ferdinandea for his discovery, after the goddess Ceres (Roman goddess of agriculture) and King Ferdinand III of Sicily. "Ferdinandea", however, was not acceptable to other nations and was dropped. Although he first reported it as a comet, he added "since its movement is so slow and rather uniform, it has occurred to me several times that it might be something better than a comet". In April, Piazzi sent his complete observations to **Oriani**, Bode, and **Jérôme Lalande** in Paris. The information was published in the September 1801 issue of the *Monatliche Correspondenz*.



Giuseppe Piazzi (1746 – 1826) borne in Ponte in Valtellina, was an Italian Catholic priest, a mathematician and astronomer. He established an observatory at Palermo, now the Osservatorio Astronomico di Palermo. Perhaps his most famous discovery was the first asteroid, Ceres.


DELLA SCOPERTA
DEL NUOVO PIANETA
CERERE FERDINANDEA
OTTAVO TRA I PRIMARJ DEL NOSTRO SISTEMA SOLARE.
PALERMO
NELLA STAMPERIA REALE.

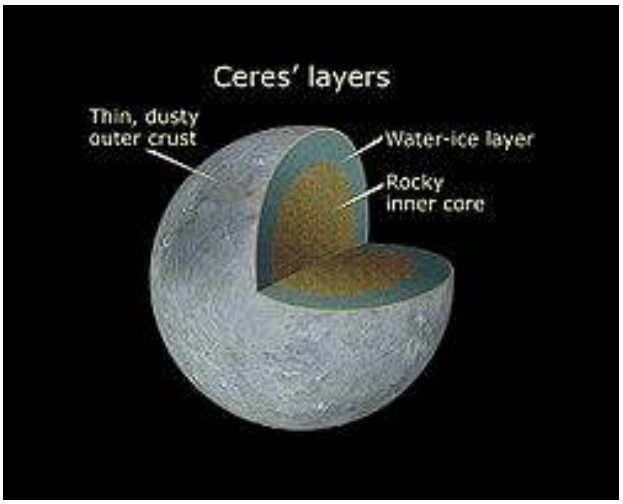
Piazzi's book "Della scoperta del nuovo pianeta Cerere Ferdinandea" outlining the discovery of Ceres, dedicated the new "planet" to Ferdinand I of the Two Sicilies

By this time Ceres was too close to the Sun's glare for other astronomers to confirm Piazzi's observations and it was lost. To recover Ceres, **Carl Friedrich Gauss**, the then 24 years old mathematician, developed an efficient method of orbit determination. In only a few weeks, he predicted the path of Ceres and sent his results to **Heinrich Olbers** who, on 31 December 1801, found Ceres again at the predicted position.

Ceres (bottom left), the Moon and the Earth, shown to scale

Scientists believe Ceres contains rock in its interior with **a thick mantle of ice that, if melted, would amount to more fresh water than is present on all of Earth**. The materials making up Ceres likely date from the first few million years of our solar system's existence and accumulated before the planets formed. Until now, ice had been theorized to exist on Ceres but had not been detected conclusively. It took Herschel's far-infrared vision to see, finally, a clear spectral signature of the water vapour. But Herschel did not see water vapour every time it looked. While the telescope spied water vapour four different times, on one occasion there was no signature.

Here is what scientists think is happening: when Ceres swings through the part of its orbit that is closer to the sun, a portion of its icy surface becomes warm enough to cause water vapour to escape in plumes at a rate of about 6 kilograms per second. When Ceres is in the colder part of its orbit, no water escapes. The strength of the signal also varied over hours, weeks and months, because of the water vapour plumes rotating in and out of Herschel's views as the object spun on its axis. This enabled the scientists to localize the source of water to two darker spots on the surface of Ceres, previously seen by NASA's Hubble Space Telescope and ground-based telescopes. The dark spots might be more likely to outgas because dark material warms faster than light material. Only a few Cererian surface features have so far been unambiguously detected. **One of the dark spots has been nicknamed "Piazzi" in honour of the discoverer**.



When the Ion propelled Dawn spacecraft arrives at Ceres next year, it will look at these features. AK