Vesta - an asteroid in 3D

10 March 2011

Test run for the arrival of the Dawn spacecraft in the asteroid belt

What might asteroid Vesta look like? In a new animation, researchers at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) have recreated the asteroid in 3D. In the animation, the asteroid is irregularly shaped, has a slight indentation at its South Pole and numerous impact craters. In July 2011, after a four year journey, NASA's Dawn spacecraft will reach the asteroid, which circles the Sun in the main asteroid belt between the orbits of Mars and Jupiter. This will be like taking a journey into the past because Vesta is a celestial body that has not changed much since the formation of the Solar System.

"It will be the first time that we get so close to such an ancient celestial body," says Ralf Jaumann from the DLR Institute of Planetary Research. "With Vesta, we have the opportunity to learn what happened when the planets were first formed from a cloud of dust." The asteroid was discovered by German astronomer Heinrich Olbers on 29 March 1807. Spectral measurements performed using ground-based telescopes suggest that the celestial body could consist of a firm crust of rocks of various compositions, a mantle and a core - the same as the Earth-like planets. Shortly after its formation 4.6 billion years ago, Vesta is suspected to have been completely molten. In the following 50 million years, the asteroid cooled down and the rocks separated according to their various densities, causing the heavier material to move towards the interior. "After this process, however, not much more happened on Vesta," explains Jaumann, a planetary geologist.

Pieces of asteroids found on Earth

Principally in the Sahara and the Antarctic, explorers have come across meteorites whose chemical compositions match the components of Vesta. This is what the spectral analyses of the meteorites and of Vesta suggest. "We are fairly sure that we have samples of Vesta here on Earth," says Jaumann. Planetary research scientists believe that, at some time in the past, another asteroid collided with Vesta, resulting in a 13-kilometre-deep crater on Vesta along with 50 new small asteroids, with numerous tiny fragments finding their way to Earth. So far, of the multitude of meteorites found on Earth, only a few can be classified as belonging to the Moon, Mars and Vesta; the origin of others remains uncertain. The fact that some samples can clearly be classified as originating from Vesta is a stroke of luck for Solar System research.

Bulges and indentations: a picture of Vesta

Vesta is particularly exciting for planetary researchers because it has changed little since its formation and has also spread its material as far as Earth. This is why NASA's Dawn spacecraft, powered by ion propulsion, is carrying three different instruments to the main asteroid belt between Mars and Jupiter. Alongside a mapping spectrometer from the Italian space agency (Agencia Spaziale Italia; ASI) and a gamma ray and neutron detector built by the Los Alamos National Laboratory, is a 'German built camera system, referred to as a 'framing camera'. In August, this camera will obtain images of the asteroid from orbit at a distance of about 2400 kilometres, returning data that will be processed at the DLR Institute of Planetary Research to produce a preliminary 3D terrain model. "Then we will slowly spiral down to an altitude of 660 kilometres," says DLR researcher Thomas Roatsch, responsible for planning and processing the 3D images of Vesta. "From there, we will obtain more detailed images at a resolution of 60 metres per pixel." Towards the end of its visit, Dawn will orbit Vesta at a distance of only 200 kilometres from its surface. During this phase, the gamma ray and neutron detector will

determine its chemical composition and Vesta's gravity field will be determined using high-accuracy navigation to reveal the structure of Vesta's interior.

DLR researchers have been able to test their stereo imaging software using the animation of Vesta. "Admittedly, we have used this software for the Moon, Mars and Mercury, but each mission has its own peculiarities," says Roatsch. For the virtual rehearsal, the research scientists obtained simulated images of the asteroid's surface from Dawn's optical navigation lead, Nick Mastrodemos, at NASA's Jet Propulsion Laboratory. These were based on images acquired by the Hubble Space Telescope. With this material, Roatsch and his team calculated the likely shape of Vesta. However, it still took the DLR researchers several weeks for Vesta, with its bulges and indentations, to rotate in their 3D animation. At the same time, an American team from the Planetary Science Institute in Tucson, Arizona was working on a 3D model of Vesta, using the same database but a different method. There were only slight differences between the two terrain models. "We know that our data processing can achieve the required level of accuracy," says Roatsch.

A long journey to the 'wet' asteroid Ceres

Planetary scientists realise that, until now, these are only test runs for the actual mission. "We will not really know what Vesta looks like until Dawn reaches the asteroid," says Carol Raymond, a scientist at NASA's Jet Propulsion Laboratory and Deputy Principal Investigator for the Dawn mission. The spacecraft will orbit the asteroid for about a year, recording and analysing it as accurately as possible. DLR researchers hope to be able to map Vesta as completely as possible. But this will not be the end of the spacecraft's long journey; it will continue to visit the asteroid Ceres, very different from Vesta. Ceres is the largest asteroid discovered so far, orbiting the Sun at up to 450 million kilometres – further than Vesta. Under its thin outer crust, Ceres is thought to have a mantle of water ice and solidified volatiles, which makes up around 25 percent of its mass, surrounding a silicate core.The surface structure of the 'wet' asteroid is still unknown; it may have a thin atmosphere. In February 2015, Dawn will move into orbit around Ceres. "With the Dawn mission, we will get a picture of what happened in the first few million years after the formation of the planets," says Jaumann. "You could say that we are going back in time to the early Solar System".

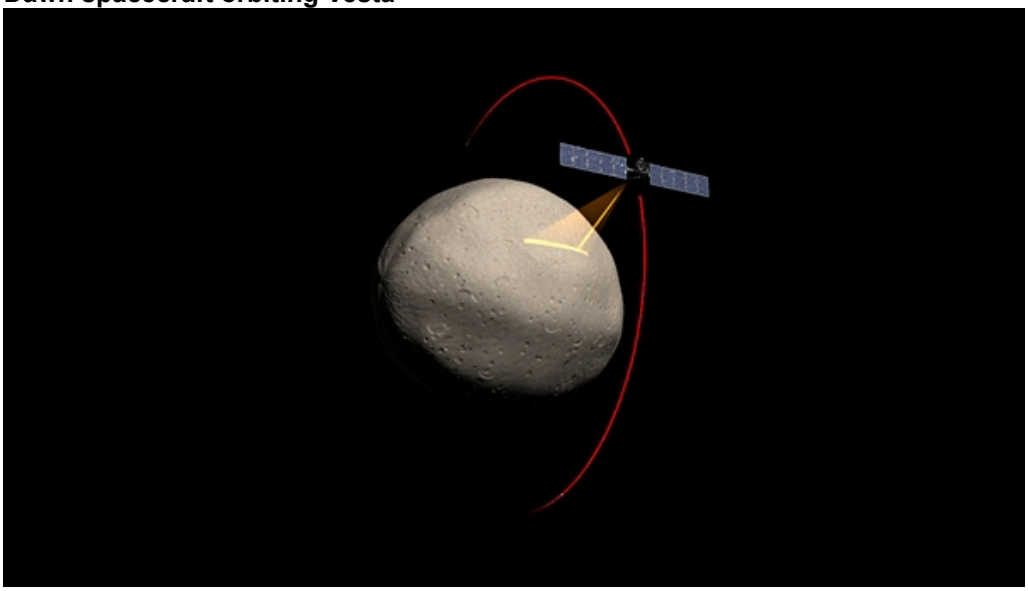
The Dawn mission to Vesta and Ceres is managed by NASA's Jet Propulsion Laboratory, a division of the California Institute of Technology in Pasadena, for NASA's Science Mission Directorate, Washington. The University of California, Los Angeles, is responsible for overall Dawn mission science. The Dawn framing cameras have been developed and built under the leadership of the Max Planck Institute for Solar System Research, Katlenburg-Lindau, Germany, with significant contributions by DLR German Aerospace Center, Institute of Planetary Research, Berlin, and in coordination with the Institute of Computer and Communication Network Engineering, Braunschweig. The Framing Camera project is funded by the Max Planck Society, DLR, and NASA/JPL.

Contacts

Manuela Braun
German Aerospace Center (DLR)
Media Relations Section
Tel.: +49 2203 601-3882
Fax: +49 2203 601-3249
Manuela.Braun@dlr.de

Prof.Dr. Ralf Jaumann
German Aerospace Center (DLR)
Institute of Planetary Research, Planetary Geology
Tel.: +49 30 67055-400
Fax: +49 30 67055-402
Ralf.Jaumann@dlr.de

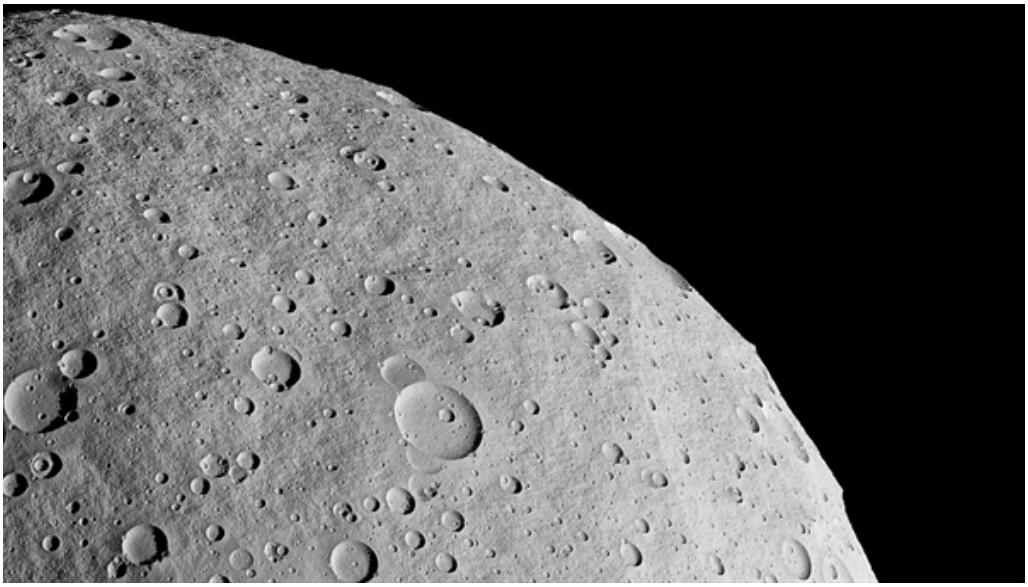
Dawn spacecraft orbiting Vesta



NASA's Dawn spacecraft, powered by ion propulsion, is carrying three different instruments to the main asteroid belt between Mars and Jupiter. Alongside a spectrometer from the Italian space agency (Agencia Spaziale Italia; ASI) and a gamma ray and neutron detector from the Los Alamos National Laboratory, is a German camera system, referred to as a 'framing camera', on board.

Credit: NASA/JPL.

A virtual Vesta



As a basis for the animation of the virtual Vesta, the researchers obtained 'simulated' images of the asteroid's surface from NASA. These were based on images acquired by the Hubble Space Telescope. This material allowed the researchers to calculate the likely shape of Vesta.

Credit: NASA/JPL.