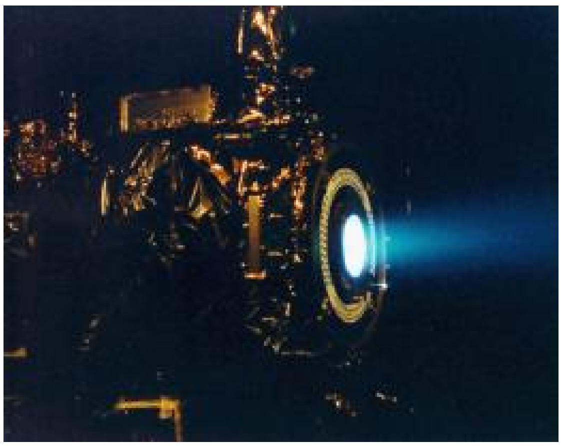
Gentle nudges towards Vesta

August 2 2011, By Helmut Hornung



Unconventional engine: An ion engine provides Dawn with the propulsion it needs. Credit: Nasa/JPL

The Dawn space probe entered into an orbit around the planetoid Vesta. The planetoid is 2.3 times further from the Sun than the Earth. Dawn used the force of gravity to get there. And an ion engine.

In this way, Dawn spiralled on and on into the solar system and on 18 February 2009 passed the neighbouring planet Mars at a distance of only 565 kilometres. In doing so, it obtained important “fuel” from the red planet: gravitation. Because during the so-called swing-by manoeuvre – also called gravity assist – Dawn flew through Mars’ gravitational field. This changed the trajectory of the space craft as well as its travel speed. The engineers had computed the rendezvous in such a way that Dawn speeded up and then spiralled even further into space. (And the gravity assist also affected the orbit of Mars, incidentally – albeit by an immeasurably small amount.)

The manoeuvre near Mars gave scientists the opportunity to test the scientific instruments, including two cameras whose construction and development had been headed by researchers at the Max Planck Institute for Solar System Research in Katlenburg-Lindau near Göttingen. Back in 2009 it was already clear that these Framing Cameras (FCs) worked perfectly. The name comes from the light-sensitive built-in sensor which provides a square frame of the region photographed.

In addition to the two camera eyes, the terrestrial spy is also equipped with two spectrometers for charting the mineral composition of Vesta: the Gamma Ray and Neutron Spectrometer GRaND will help to detect the elements oxygen, magnesium, aluminium, silicon, calcium, titanium and iron. The VIR spectrograph investigates the visible and infrared electromagnetic radiation which Vesta reflects into space. VIR was made available by the Italian space agency ASI and developed and constructed by the company Galileo Avionica; GRaND originates from the workshops of the Los Alamos National Laboratory in New Mexico (USA).

Dawn is one of a new generation of space craft with innovative technology. In the course of this programme of discovery NASA has already flown a series of successful missions, such as the probes Near (it landed on the asteroid Eros on 12 February 2001) and Deep Impact (which hurled an impactor onto the nucleus of the comet Tempel 1 on 4 July 2005). One of Dawn’s special features is its propulsion, which is reminiscent of the science fiction series Star Trek.

Like the Starship USS Enterprise, the space probe obtains its propulsion from an electric power drive. The fuel tank contains 425 kilogrammes of xenon. The atoms of this noble gas are pumped into a chamber where they are ionized, i.e. an electron is taken from each of them; the energy for this originates from electricity generated by means of solar panels. This "treatment" leaves behind positively charged ions. At the opening of each of the three thrusters there are two molybdenum grids – one of them positively charged, the other one is negative. This charge gradient gives rise to electromagnetic fields and hurls the ions in the form of a beam out into space with a speed of 100,000 kilometres per hour.

This generates a recoil, but one which achieves only one ten thousandth of the thrust of a conventional rocket engine. If directed against the hand, it would feel like the pressure exerted by a sheet of paper. But little strokes fell mighty oaks: Nasa's engineers want to operate Dawn's ion engine for around 50,000 hours overall. This corresponds to more than five years of continuous operation and is an achievement record for a space probe.

On 16 July, Vesta's gravity shackles captured Dawn. The probe was then still around 16,000 kilometres away from the planetoid. It will now accompany the asteroid for a few months and venture step-by-step into increasingly lower orbits. At the end of its visit – probably in July 2012 – the vehicle will be less than 200 kilometres above the surface of the planetoid. Hopefully Dawn will then have amassed a lot more knowledge on the history of the solar system, because the visit to Vesta is like a journey into the past. Asteroids are now assumed to be relicts from the time when the Sun and its planets emerged from the primeval cloud 4.6 billion years ago.

When Dawn has finished its exploration of Vesta its journey is not at an end: it will continue on for a further 1.6 billion kilometres to the spherical dwarf planet Ceres, which is just under a thousand kilometres across. Dawn is set to arrive there as early as February 2015. A favourable constellation of the celestial bodies makes this relatively short flight time possible. In the months following its arrival, Dawn will get to within around 700 kilometres of Ceres' surface.

Skilled star gazers can observe both destinations themselves during the next few weeks: Ceres moves in the Cetus constellation and in the August morning sky it will be exactly in the south. On 5 August, Vesta will be in opposition meaning it will rise at sunset and set at sunrise; at the end of August it may even be possible to see it with the naked eye, while Ceres remains an object for binoculars. But even in the biggest telescope, both celestial bodies will appear only as star-shaped points.

Provided by Max-Planck-Gesellschaft

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