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Asteroid spacecraft Dawn: a change in course near our neighbour, Mars

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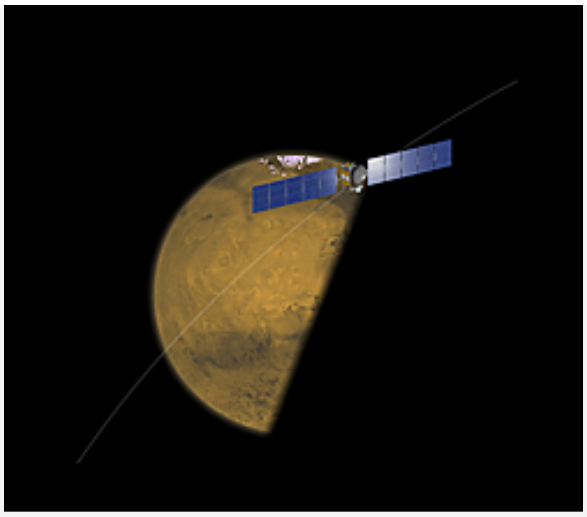


Asteroid spacecraft Dawn: A change in course near Mars

Researchers observe areas of Mars simultaneously using the NASA spacecraft Dawn and the European spacecraft Mars Express

On 18 February 2009 the gravity of Mars, our neighbouring planet, will move the spacecraft Dawn onto the correct path for its onward flight to the asteroid Vesta. During this close fly-by of the red planet, researchers will test the German camera system that is on board the spacecraft. The plan is to compare photographs taken during the fly-by with those taken by HRSC, the stereo camera operated by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) that is on board the ESA spacecraft Mars Express. Dawn will reach its first main target, the asteroid Vesta, in August 2011.

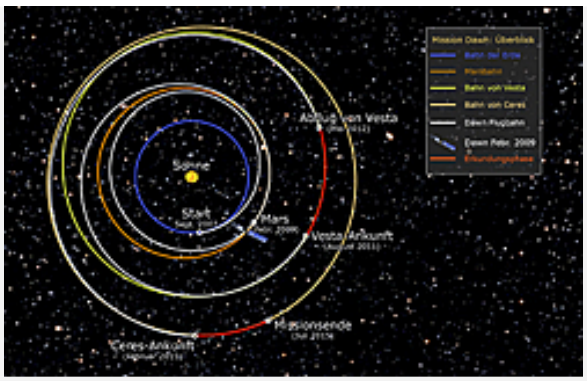
Dawn to come within 565 kilometres of Mars

After a flight time of eighteen months, and having covered a distance of around one billion kilometres, the NASA asteroid spacecraft Dawn will fly past Mars shortly after midnight on Wednesday, 18 February 2009. The spacecraft will approach the Earth's outermost neighbouring planet from the night-side at a speed of almost 20 000 kilometres per hour, and will then reach the day-side via the northern hemisphere and fly over the volcanic region of Tharsis. At 01:27 Central European Time (CET), the time at which the spacecraft makes its closest approach, Dawn will be only 565 kilometres away from the surface of Mars.

Photos of Mars taken almost simultaneously by two different spacecraft

During this Mars fly-by, known as a swing-by manoeuvre, one of Dawn's two cameras, which were developed in Germany, will be switched on for test purposes. Scientists from the Max Planck Institute for Solar System Research (Max-Planck-Institut für Sonnensystemforschung; MPS), who are leading the camera experiment on Dawn, have planned the photographs together with scientists from DLR and the Free University of Berlin. One hour after Dawn's fly-by, the High Resolution Stereo Camera (HRSC) that is operated by DLR on the European spacecraft Mars Express will take pictures of the same regions of Mars.

"The almost simultaneous observations of the same area of Mars will allow us to check the performance of the camera systems on both Dawn and Mars Express with respect to each other", explains Dr. Stefano Mottola from the DLR's Institute of Planetary Research in Berlin, who participated in the development of the two framing cameras on the spacecraft Dawn and is a co-investigator for the mission. "The challenge with this manoeuvre", adds Professor Ralf Jaumann, HRSC Experiment Manager at the DLR and also a co-investigator for Dawn, "was to figure out, together with the flight engineers from the European Space Agency ESA in the space operations centre in Darmstadt, to what degree they had to turn Mars Express to the side to also allow us to photograph this area using the Mars Express stereo camera one hour after the Dawn overflight."



Flight path of NASA's Dawn spacecraft: Past Mars and into the asteroid belt

Force of Mars' gravity moves asteroid spacecraft onto its correct path

Researchers refer to this Mars fly-by as a Mars Gravity Assist (MGA). It allows the gravitational force of Mars to be used to slightly increase the flight speed of the spacecraft and to expand the radius of Dawn's spiral flight path around the Sun such that, in the coming months, the spacecraft will gradually travel in the direction of the main asteroid belt between Mars and Jupiter. Vesta is approximately 2.5 times further from the Sun than is the Earth (150 million kilometres).

A further important goal of the MGA manoeuvre is to alter the angle of Dawn's orbital plane around the Sun. Compared to the ecliptic, the plane of the Earth's orbit around the Sun, Vesta's orbit is tilted at an angle of more than seven degrees - as a result of the Mars fly-by, Dawn will be steered into the orbital plane of the asteroid.

Unusual manoeuvre by the European spacecraft Mars Express

In order to be able to photograph the same area that Dawn is photographing in a several hundred kilometre-wide strip between the volcanoes of Tharsis and Olympus Mons, the highest volcano on Mars, Mars Express will be pitched approximately 28 degrees to the east in a manoeuvre that, to date, has only rarely been carried out. ESA's Mars Express spacecraft has been in orbit around the red planet for more than five years. One of seven experiments on board is the stereo camera HRSC operated by DLR, which has photographed a good two thirds of Mars at high resolution, in colour and in 3D. In addition to the pictures taken by the cameras on both Dawn and Mars Express, the spectrometers on both spacecraft will also acquire data. The Mars researchers will then also be able to compare this data. After the fly-by, Dawn's camera will continue to take photographs of Mars from increasing distances for around one week.

Logo of NASA's Dawn discovery mission

The destination: two asteroids - Vesta in August 2011 and Ceres in February 2015

Conducted by NASA, Dawn is a 'discovery' mission to the asteroids Vesta and Ceres, which are located on orbital paths around the Sun in the asteroid belt. These two bodies have hardly changed at all since their formation, and by studying them in detail scientists hope to gain important insights into the earliest period of our almost 4.6 billion year old Solar System.

Camera systems from Germany on board the spacecraft

In addition to a spectrometer from the Italian Space Agency (Agenzia Spaziale Italiana; ASI), which will be used to map the mineralogical composition of the surfaces of the asteroids, and a gamma ray neutron spectrometer (GRaND - Gamma Ray and Neutron Detector) from the Los Alamos National Laboratories (New Mexico, USA), there are also two photographic systems aboard Dawn: the framing cameras. The name 'framing camera' is derived from the built-in, light-sensitive surface sensor that creates a square picture ('frame') of the area being photographed. The framing cameras are the German contribution to the Dawn mission and were built under the auspices of the Max Planck Institute for Solar System Research (MPS) in Katlenburg-Lindau, in collaboration with DLR's Institute of Planetary Research (Institut für Planetenforschung). Dr. Holger Sierks from MPS is responsible for the photographic planning and the operation of the framing cameras. The two cameras are identical in construction. In the event that one should fail during the mission the other is able to completely fulfil its functions. The light-sensitive sensor and the electronic system connected to it that is used to read out the signals and relay them to the instrument computer (DPU - Digital Processing Unit) were developed at DLR, where some of the camera parts were also calibrated.

The German framing camera on NASA’s Dawn mission

Powered by an ion engine, Dawn will reach the asteroid in August 2011 after having travelled 2.8 billion kilometres. The spacecraft will pivot in an orbit around the asteroid that, with a diameter of about 500 kilometres, is the third largest (but second heaviest) in the main asteroid belt between Mars and Jupiter. After completing the experiments in April 2012, Dawn will fly a further 1.6 billion kilometres to Ceres that, with a diameter of almost one thousand kilometres, is the largest asteroid and, like Pluto, is classified as a dwarf planet. Dawn will be the first mission in the history of space travel to swing by two different bodies in one orbit.

DLR funds German participation via its space agency

The total cost for the Dawn mission, including launch and operating costs, is approximately Euro 320 million; the German contribution amounts to 3% of this sum. The two cameras were funded by the federal government’s national spaceflight programme via DLR’s space agency and DLR’s basic funding programme for research and development, and also by the Max Planck Society, which provided the majority of the funds. In addition, NASA’s Jet Propulsion Laboratory provided funding for the German cameras. The Technical University of Braunschweig’s Institute of Computer and Network Engineering assisted with the construction of the cameras.

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