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The ringed planet reveals its secrets: Cassini in the Saturn system for three years

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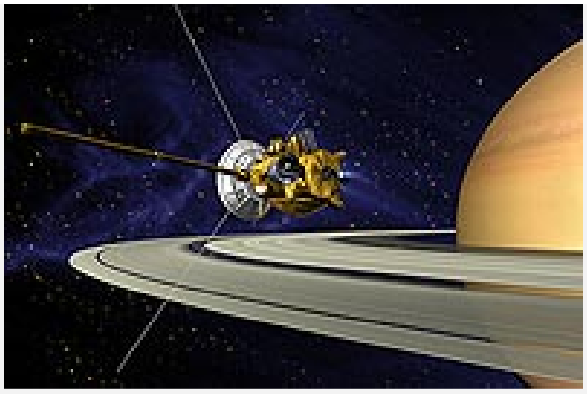
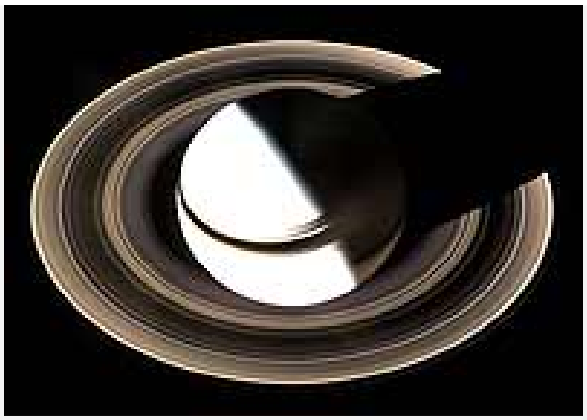


Arrival of the Cassini probe at Saturn

It is surely one of the most exciting space travel adventures of our day: the exploration of the Saturn system by the space probe Cassini. On 1 July 2004 at 5:54 CEST, the space probe - the size of a bus and weighing over two tons - swung into orbit around the ringed planet after a journey of almost seven years. On 14 January 2005 the European lander Huygens, which was traveling with Cassini, touched down on Saturn's moon Titan.

For the past three years on a weekly basis, Cassini has been transmitting to Earth data that is of invaluable scientific value. Worldwide around 250 scientists and their research teams are taking part in this project - the largest research mission ever to a planet in the outer Solar System. Scientists from the German Aerospace Center (DLR) are also taking part in the planning of and the carrying out of experiments with Cassini and also in the processing of data. Using the results, researchers are helping to paint a new and significantly different picture of the second-largest planet in the Solar System together with its rings and its numerous icy moons.



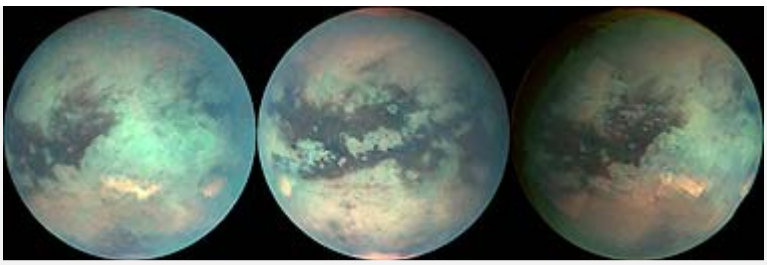
Majestic - Saturn and its ring system

"Every time we fly by one of Saturn's moons there are surprises, and new questions are arising all the time - we can often do nothing more than simply stare!", commented Professor Ralf Jaumann from the DLR Institute for Planetary Research. "But the best is still to come: the mission has been extended until 2010 by NASA. This will provide us with numerous excellent opportunities to observe the very individual ice moons at close range - we will be able to intimately study the ice volcanism on Enceladus and perhaps also find out whether it is actually methane that rains out of Titan's clouds and then flows over the icy surface in rivers and finally into lakes. Cassini is a fantastically multi-faceted mission that is marvelous for the field of planetary research".

DLR studies Saturn's icy moons

The focus of the Cassini research work at the DLR Institute for Planetary Research in Berlin-Adlershof is the analysis of data from the 'ice moons'. Among these are data collected by one of the three optical spectrometers onboard Cassini. In addition, DLR planet researchers are determining the topography of ground structures on some of the Saturnian moons using stereo picture data from the camera system.

The height of a mountain range on the moon Iapetus has been measured in this way. This range may turn out to encircle the entire moon and is up to 20 kilometers high. As regards the Cassini camera system, DLR (in cooperation with the Free University of Berlin) is also responsible for the detailed photographic planning for the close-range fly bys of the moons Iapetus, Rhea, Dione and Phoebe.



Unveiling the secrets of Titan

The Berlin researchers used DLR expertise in the field of photogrammetry - a measuring and assessment method for remote sensing - to create global and high-precision pictorial maps of Saturn's satellites. In addition, the Institute of Planetary Research has produced the first complete pictorial atlas of the moon Enceladus. Also located on the Cassini orbiter is the Cosmic Dust Analyzer (CDA), an instrument that was jointly developed and built at DLR in Berlin-Adlershof. The experiment is being led by the Max Planck Institute for Plasma Physics in Heidelberg.

Ice vulcanism on Enceladus

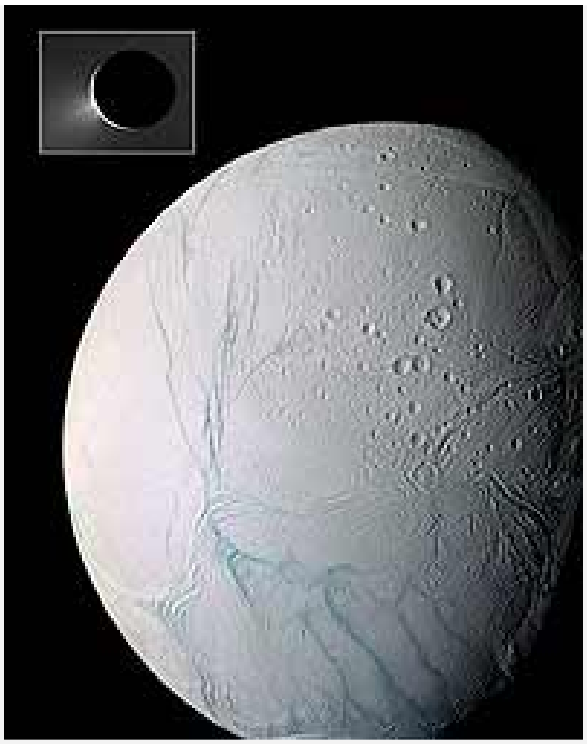
The icy desert of Titan

Next to the successful landing of the Huygens craft on Titan, the discovery of ice volcanism on Enceladus attracted the greatest interest - and not only in the scientific world.

With a diameter of only 500 kilometres this satellite is actually too small too allow enough warmth to be created from the decay of radioactive elements in its interior to melt any part of its mantle of water ice. On the surface of Enceladus - at a distance of almost one and a half billion kilometres from the Sun - the temperatures are around minus 180 degrees Celsius. However, the researchers noticed that a large area at the southern pole of Enceladus has no craters.

This suggests that this region has not been exposed to the environmental effects of cosmic bombardment for a long time and therefore must be "young" in a geological sense. The southern pole area is also covered with unusual ridges that are hundreds of kilometres long. The first measurements using Cassini's CIRS experiment (Composite Infrared Spectrometer) also showed that the surface temperature along these ridges - called 'tiger stripes' by the researchers - is higher than the surrounding levels by 15 to 20 degrees Celsius.

The Cassini magnetometer also measured increased values in Saturn's magnetic field, implying that an "obstacle" exists along the lines of force in the vicinity of Enceladus - small particles must therefore be present in the space around the moon. Then photographs of the unusual southern pole region were taken backlit by the Sun using the Imaging Science Subsystem (ISS), the camera on board Cassini. This provided evidence that ice particles were hurled from there into space for many hundreds of kilometres. This implies that Enceladus is the first known ice moon in the Solar System that is not completely frozen but instead has water in a reservoir under its ice crust. As a result of excess pressure under the crust, is sprayed across the surface and into space, similar to a geyser. This form of ice fountain is known as "cryovulcanism".



Ice volcanoes on Saturn's moon Enceladus

The water particles freeze immediately upon emission. They land on the surface of Enceladus and can also add ice particles to the outer rings of Saturn - this has been debated for a fairly long time and has now been confirmed. "Using the spectrometer VIMS we were able to capture data from this area during three fly bys of Enceladus that confirm that the cryovolcanoes along the tiger stripes shoot fine ice particles into the atmosphere and snow down onto Enceladus. As a result the surface there is being continuously renewed", explains Professor Jaumann, who is a member of the VIMS (Visual and Infrared Mapping Spectrometer) team. The heat source that causes the ice in the interior of the moon to melt has also now been found. The gravitational force of the giant planet Saturn causes tidal forces to affect Enceladus, generating enough warmth to cause ice to thaw at a depth of several kilometres.

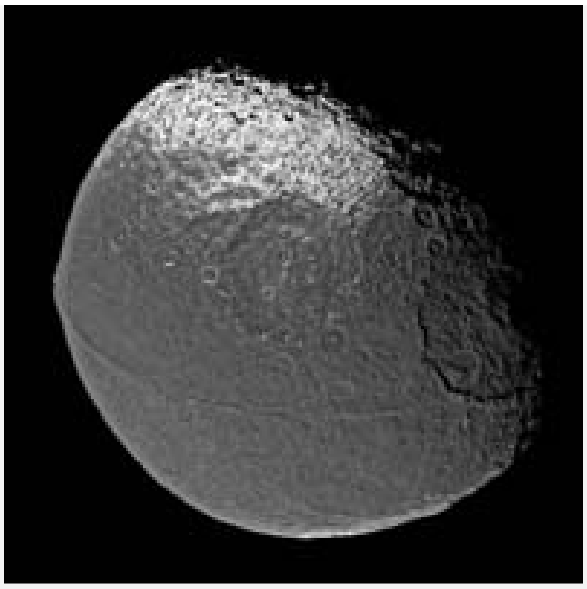
Methane rain from Titan's clouds?

As well as investigating Saturn and its rings and ice moons, the known number of which has now grown to over fifty, Titan is the main focus of the Cassini mission.

With a diameter of 5150 kilometres, Titan is the largest of Saturn's moons and the second-largest satellite of all of the planets after Jupiter's Ganymede. Titan is the only moon in the Solar System that is surrounded by a dense atmosphere. This has also meant, however, that prior to the Cassini mission, almost nothing was known about the moon's surface. The potent atmosphere, consisting of 95 per cent nitrogen and around 5 per cent methane, has not allowed ordinary camera systems a view of the surface of the moon. The existence of gases such as methane, ethane and complex hydrocarbon molecules does however mean that even the atmosphere is a highly interesting subject for planet research.

Due to the low surface temperatures of minus 180 degrees Celsius this "original" atmosphere changes much more slowly over the course of billions of years than in the warmer inner Solar System, allowing conclusions to be made about atmospheric processes that took place at the dawn of the Solar System. It is possible that molecular building-blocks of life could also have developed on Titan. There are also signs of (cryo) vulcanism on the moon which suggests that also under the ice crust there are sufficiently large amounts of energy being created that can enable more chemical reactions between the molecules and elements present than would be the case if the body were completely frozen.

After three years of research of Titan by Cassini and Huygens it has emerged that Titan is a very dynamic moon with a surface that is subject to constant change as the result of numerous processes. "Using the spectrometer VIMS it is possible at certain infra-red wavelengths to discern the structures on Titan's surface", explains Professor Jaumann about one of the focuses of his work. "The branching valley systems that Huygens photographed when descending through the atmosphere can also be seen in other areas of Titan with the spectrometer.



Mysterious Iapetus: Light and dark at the same time

It could be that there is precipitation either intermittently or even over longer periods of time in the form of methane or ethane rain from the dense clouds. This rain collects in streams and rivers and significantly changes the surface when it runs off.

Cassini's radar discovered smooth plains which could be vast 'methane/ethane lake plateaus'. This makes Titan, together with Earth, bodies in the Solar System with surfaces that are changing with lasting effect due to liquids, in this case due to methane.

Mission extended until 2010

On Friday, 29 June 2007, during the 47th orbit of Saturn, the 33rd close-range fly by of Saturn's largest moon, Titan, will take place. Originally the Cassini mission was only supposed to be conducted until the end of 2008. Now, over the next three years there will be an additional 35 targeted fly bys of Titan and journeys to numerous other ice moons.

The highlights will certainly include seven targeted observations of Enceladus. In the process Cassini will come within a 23 kilometer range of the volcanic moon in 2008 and within a 20 kilometre range in 2010.

Cassini-Huygens is a joint project of NASA, the European Space Agency (ESA) and the Italian space agency (ASI). German participation has been and will be partially sponsored by DLR's space agency.

Contact

Elke Heinemann
German Aerospace Center (DLR)
Corporate Communications, Online Communication - DLR Web Portal
Tel: +49 2203 601-2867
Fax: +49 2203 601-3249
E-Mail: elke.heinemann@dlr.de

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

Ulrich Köhler
Institute of Planetary Research
Tel: +49 30 67055-215
Mobile: +49 175 1641737
Fax: +49 30 67055-402
E-Mail: ulrich.koehler@dlr.de

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