German Aerospace Center
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News-Archiv

Venus' atmosphere observed – SCIAMACHY on Envisat looks elsewhere

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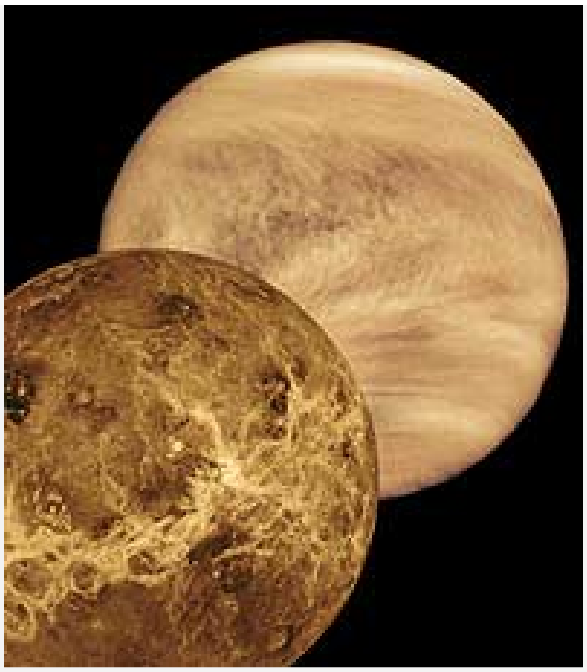


Pioneer-Venus visible-light image, and Magellan radar view of Venus

Scientists at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) and the Netherlands Institute for Space Research (SRON) have found a new area of deployment for the SCIAMACHY (**SC**anning **I**maging **A**bsorption Spectro**M**eter for **A**tmospheric **CH**artograph**Y**) atmospheric instrument on the European environmental satellite Envisat. In March and June 2009, the spectrometer, in a research activity initiated by the DLR Remote Sensing Technology Institute and SRON, looked away from its normal target, Earth, towards our neighbouring inner planet Venus and investigated its radiation at visible light and near-infrared wavelengths.

"Carrying out these observations was a great challenge, as SCIAMACHY was not actually designed for such measurements," Dr. Manfred Gottwald, responsible for SCIAMACHY at the DLR Remote Sensing Technology Institute (Institut für Methodik der Fernerkundung; IMF), said. "We were surprised how excellently everything worked despite that," his colleague at the institute, Dr. Sander Slijkhuis, the specialist responsible for calibrating the instrument, added.

SCIAMACHY on Envisat, Venus Express and COROT complement one another

The Venus observations by SCIAMACHY are useful in two respects. On the one hand, they support the in-situ measurements by the Venus Express space probe of the European Space Agency (ESA), which has been orbiting our neighbouring planet since 2006. Venus Express is studying the dense atmosphere of Venus with great precision using the SPICAV and VIRTIS spectrometers. SCIAMACHY and Venus Express are observing Venus under different viewing geometries and lighting conditions, so that their results complement one another well. In addition, SCIAMACHY's Venus observations are a further test of the way that an Earth-like planet presents itself spectrally when observed from a great distance.

Since the first extra-solar planets – that is, planets orbiting stars other than our Sun – were discovered in the mid-1990s, the search for Earth-like companions of stars similar to the Sun, in other words a 'second Earth', has been one of the great challenges in astronomy. Currently, however, most of the so-called exoplanets that have been found are giant gas planets rather like Jupiter. In 2008, researchers succeeded for the first time in discovering a possible Earth-like exoplanet using the CoRoT (**Co**nvection, **Ro**tation and Planetary **T**ransits) space telescope, a project in which the DLR is also involved (see article CoRoT discovers extrasolar rocky planets in the right column). But in the near future, small Earth-like planets could also come within reach using improved telescopes. However, they will always appear as small dots due to the enormous distances involved. The spectral analysis of the central star's light when scattered by the exoplanets and their own thermal radiation emissions could provide information as to whether they might be suitable for harbouring life. Hence, observations of the known planets in our solar system provide an excellent experimental environment for gaining experience with regard to the interpretation of spectral signatures of Earth-like bodies.

Earth observation satellite ENVISAT

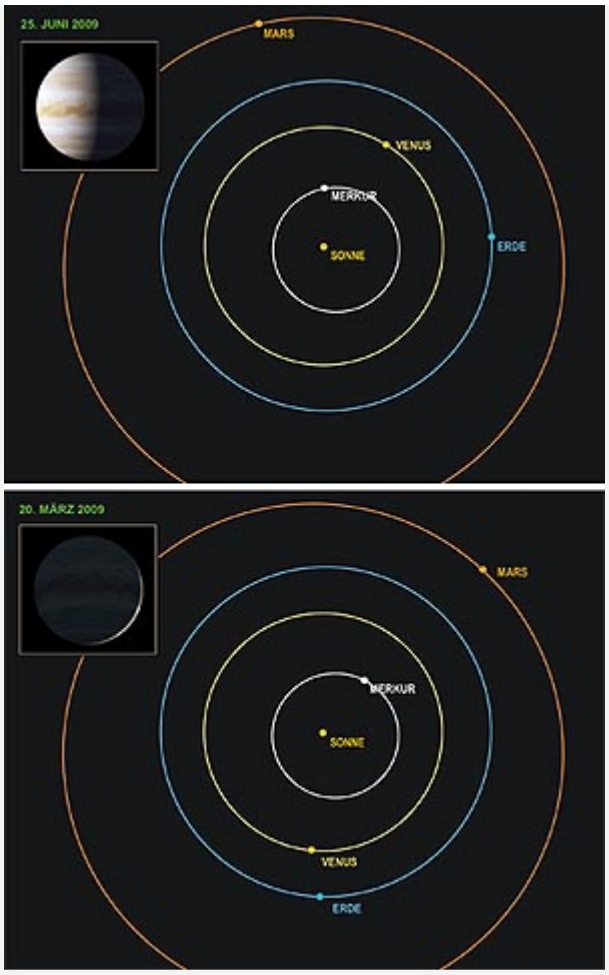
DLR planetary researchers pleased about interdisciplinary approach

The observations of Venus, with its hot and hostile environment – surrounded by a dense carbon dioxide atmosphere – can provide outstanding comparative data in our immediate cosmic neighbourhood for the analysis of the atmosphere of exoplanets. "As planetary researchers, we are of course very pleased about these additional measurements from a mission whose aim is actually Earth observation," Prof. Tilman Spohn, Director of the DLR Institute of Planetary Research (Institut für Planetenforschung) in Berlin-Adlershof, says. He adds: "It is excellent that these data from SCIAMACHY were picked up. They help us to evaluate the data supplied by our experiments on the planetary missions."

"We are very impressed by the SCIAMACHY observations," Prof. Heike Rauer, also from the DLR Institute of Planetary Research and the leader of the project through which DLR is involved in the search for exoplanets with CoRoT, said happily. "The new results illustrate excellently what atmospheric signatures would be expected if a Venus-like exoplanet were discovered." Future satellites could then search for signs of a biosphere, the zone where organisms can live, on such planets. Scientists from the DLR Remote Sensing Technology Institute in Oberpfaffenhofen have been working with the researchers from the DLR Institute of Planetary Research in Berlin-Adlershof for some time in the search for what are known as 'biomarkers' – components in the atmosphere or on the surface of planets that have been created through the metabolic activity of life forms.

The intention is to make further use of the SCIAMACHY measurements in the 'Planetary Evolution and Life' Helmholtz Alliance. This international research network is investigating the question, among other things, as to what conditions must prevail on a planet in order for life to develop. Here, the data offer a realistic background for modelling the radiation transport in the atmospheres of Earth-like planets.

Additional measurements of spectra in various phases of Venus are planned with SCIAMACHY. In addition, studies are underway as to how the other bright planets of our solar system, Mars, Jupiter and Saturn, can also be used as extraterrestrial objects of investigation.



Relative positions of Earth and Venus, March and June 2009

Venus – bright, small and "difficult to measure"

Venus, with its 12 100-kilometre diameter, is almost as large as our home planet. Seen from Earth, it appears as the brightest celestial body after the Sun and Moon – but with a subtended angle of less than one minute of arc (one sixtieth of a degree) it looks relatively small. As a consequence, in order to keep this small 'Venusian disc' in SCIAMACHY's field of view long enough to perform the observations, the instrument configuration had to be changed substantially. Due to the arrangement of SCIAMACHY's observation windows, Venus only appears above Earth's horizon briefly after rising – a process which is repeated 14 to 15 times per day as a result of Envisat's orbit of the Earth. Precise planning as well as chronologically exact measurements finally enabled the derivation of Venus spectra on the basis of the solar radiation reflected and scattered by the planet's atmosphere. Both in March and in June 2009 SCIAMACHY recorded Venus spectra during several orbits of Earth (see PDF download 'SCIAMACHY spectra of Venus' in the right column).

As an inner planet, Venus moves faster around the Sun than Earth. Therefore, the relative positions of Earth, Venus and Sun changed significantly between March and June 2009 (see image). In March 2009, Venus was close to what is known as its 'inferior conjunction', directly between Earth and the Sun. Seen from Earth, it presented mainly its dark side and only a thin crescent of the sunlit planetary disc was visible. At this time, the distance of Venus from Earth was only 43 million kilometres. In June 2009, by contrast, the Sun, Venus and Earth formed an almost right-angled triangle. Although the distance between Venus and Earth had grown to 127 million kilometres, more than 50 percent of Venus' disc now lay in sunlight when seen from Earth.

SCIAMACHY on Envisat

ESA's Envisat Earth observation satellite has been orbiting Earth since 2002 and supplies valuable information about the state of Earth. The SCIAMACHY atmospheric instrument on board Envisat, designed under the lead management of DLR together with Dutch and Belgian partners, measures the solar radiation scattered back from Earth's surface and atmosphere from the ultraviolet to the near-infrared parts of the spectrum. These measurements can be used to determine the atmospheric concentration of many different trace gases, which are important with regard to air quality, the greenhouse effect and ozone chemistry. SCIAMACHY is the first and currently the only satellite

instrument in the world to carry out measurements of such complexity. The project is managed by DLR and the Netherlands Space Office (NSO). The Institute of Remote Sensing and Environmental Physics (IFE/IUP) of the University of Bremen is responsible for the scientific management the project.

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