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DLR simulates Mars' atmosphere in Göttingen

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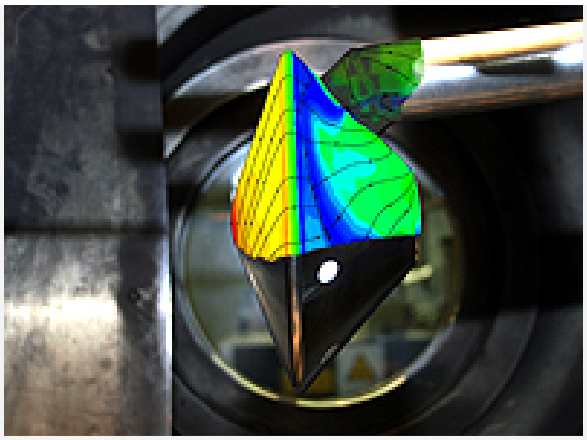

ExoMars capsule in the wind tunnel

Is the Earth the only place in our Solar System on which living organisms exist? Is there, for example, life on Mars? The goal of the European space mission ExoMars is to resolve this question. To this end, the atmosphere on Mars is being simulated at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) in Göttingen.

An alien atmosphere

The researchers in Göttingen are examining the impact the exotic atmosphere of the red planet has on a landing capsule that flies through it. "Mars' atmosphere is completely different from Earth's air", says Dr Klaus Hannemann, Head of the Spacecraft Department at DLR's Institute of Aerodynamics and Flow Technology (Institut für Aerodynamik und Strömungstechnik; IAS). It is made up of 95 percent carbon dioxide and it is very thin. If a landing capsule is to fly through the Martian atmosphere at several times the speed of sound, effects will arise that must be studied in detail. At the extremely high temperatures that occur in situations like this, chemical reactions that change the properties of the gas are initiated: the carbon dioxide breaks apart into its individual components. "This can influence the distribution of pressure on the capsule and thus affect the aerodynamic behaviour", explains Dr Hannemann. A further important aspect of the studies is determining the extremely high thermal loads on the capsule's heat shield.

Hotter than the Sun

Scientists at the wind tunnel

The experiments, which are being performed on behalf of the European Space Agency (ESA), are being carried out using the high-enthalpy tunnel in Göttingen, one of the most important large-scale European plants for researching the hypersonic re-entry of spacecraft. In the 62-metre long wind tunnel, a piston first compresses a propellant gas, like in a giant air pump. After a steel membrane bursts, a strong impulse wave compresses and heats the carbon dioxide before it is accelerated into a wind tunnel jet at 4.4 kilometres per second. This corresponds to almost 16,000 kilometres per hour. Then, the gas flows around a model of the landing capsule. This scenario simulates the flight situation of the capsule in Mars' atmosphere at a height of 40 kilometres above the planet's surface. In the process, temperatures of 6000 degrees Celsius are generated in the test system – hotter than the surface of the Sun.

"When observing the experiment, we use a phenomenon that everyone knows: the flickering of the air over a hot street in summer", explains Dr Jan Martinez Schramm, who is leading the experiment. As a result of this heating, the density of the gas changes – and so too does the way in which light is refracted. The scientists in Göttingen can draw conclusions about the variations in density, known as schlieren, from the 'flickering' of the gas in the wind tunnel. They have defined one especially critical point on the Mars capsule: the rear. "This is the point where stalling and very high thermal loads can occur", says Dr Hannemann.

Mars Rover

Two-pronged mission

For further tests, a model of the Mars landing capsule will be hung in the wind tunnel by thin threads, in order to determine the forces acting upon it. When they are touched by the hot gas the threads burn and the model floats in free flight for a split second. A longer period of time is not required as it only takes one millisecond (one one-thousandth of a second) to make a measurement in the high enthalpy tunnel.

ESA's ExoMars mission has recently been updated. According to the current plan, in 2016 ESA wants to land on the surface of Mars with a landing capsule and carry out scientific experiments in an independent mission. At the same time, an orbiter will circle Mars to ensure communication with Earth. The orbiter will also be used by NASA. Under NASA's lead, a European rover with a drill will then land on Mars to examine the planetary surface in 2018.

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