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Successful first flight of the DLR Mapheus research rocket

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Three minutes of weightlessness for materials physics experiments

On Friday 22 May 2009 at 12:32, the Mapheus research rocket of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) lifted off from the Esrange launch facility near Kiruna in northern Sweden. Mapheus is an acronym for Materialphysikalische Experimente unter Schwerelosigkeit – Materials Physics Experiments under Weightlessness. Scientists from the DLR Institute for Materials Physics in Space, located in Cologne, used this flight to investigate how liquids behave in conditions of weightlessness. The focus was on the characteristics of liquids – particularly solidification and separation. Under conditions of weightlessness, the absence of perturbing forces allows for precise measurements under controlled and defined experimental conditions – in contrast to experiments on Earth.



DLR scientists working on Mapheus

The scientists and engineers from the Mobile Rocket Base (MORABA) of DLR Space Operations in Oberpfaffenhofen developed and built the Mapheus rocket for this purpose. The project is managed by the DLR Institute of Space Systems in Bremen. The 113 kilogram scientific payload on the maiden flight of Mapheus consisted of three experiment modules and a battery module, developed and built at DLR in Cologne. There was also a measurement platform from Aachen University of Applied Sciences – Department of Aerospace Technology and the DLR Microgravity User Support Center, Cologne.

The heart of the rocket is the service module, which takes care of data transmission and the timing of the scientific experiments and contains all the sensors required for measuring acceleration, yaw rate and position – needed to guide the rocket. Using compressed gas and jet systems, the rate control system (RCS module) is able to minimise all rotational movement during the ballistic (coasting) flight phase above the dense atmosphere and thus create ideal conditions for microgravity, a state of minimal gravity.



Mapheus being prepared

Three minutes for experiments under conditions of weightlessness – with 20-fold gravitational acceleration into space

The Mapheus experiments were transported to a height of 140 kilometres by a two-stage solid-fuel rocket motor. The first stage took the rocket to a speed of 1940 kilometres per hour. The second stage fired about nine seconds after lift-off. Following the separation of the second rocket stage, a device known as a 'mechanical Yo-Yo system' reduced the spin around the longitudinal axis of the rocket to low levels at a height of 70 kilometres. Ice skaters use a similar principle when they extend their arms during a pirouette to slow down their spin. The normal spin around the longitudinal axis during rocket launches and flights stabilises the trajectory of the rocket during its ascent but for these experiments it had to be neutralised to achieve weightlessness.



The inside of the ATLAS-M experiment module

Then, at a height of more than 100 kilometres, the experiment phase of about three minutes – the key stage for the scientists – began. Once that was completed, the rocket section with the experiments re-entered Earth's atmosphere. The stabilising parachute of the recovery system opened at a height of about five kilometres. Finally, the payload with the experiments landed safely in an uninhabited area in northern Sweden with a rate of descent of about eight metres per second (about 29 kilometres per hour).

The Mobile Rocket Base of DLR Space Operations in Oberpfaffenhofen was responsible for preparing the flight and executing it. The Mapheus research rocket is financed by the DLR's 'Weltraum' (Space) research and development programme. Following Mapheus' successful maiden flight, the aim is to launch it in a regular annual program to enable a systematic study of materials physics.

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