

MAPHEUS-3 - spherules, metals and microgravity

23 November 2011

DLR scientists launch sounding rocket with material physics experiments

First, it is launched into space at 5400 kilometres per hour, then come three and a half minutes of weightlessness, and finally it lands using a parachute. Researchers at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) are sending four experiments to high altitude on the MAPHEUS-3 (Materialphysikalische Experimente unter Schwerelosigkeit – Material Physics Experiments Under Microgravity) sounding rocket to investigate the properties of metals and granular gases. The rocket is scheduled to launch from Esrange, near Kiruna in Sweden, on 25 November 2011, weather conditions permitting. The experiments include a video system designed to record how a granulate consisting of tiny spherules behaves in microgravity after being set in motion in a controlled manner.

The DLR scientists have been in Kiruna in northern Sweden for days, preparing their experiments and getting them ready for flight. Eighty seconds after launch, as soon as the MAPHEUS-3 sounding rocket propulsion engine has exhausted its propellant and there is no further propulsion, the vital minutes during which Earth's gravity no longer has any effect begin. "All the tests are designed to provide us with important results during the short three-and-a-half minute window," says Andreas Meyer of the Institute of Material Physics in Space. The Cologne-based DLR institute designed and constructed all four experiments. "The processes we want to observe all occur relatively quickly." Shortly before launch, small ovens in some of the experiment boxes heat the various metal samples, melting them at temperatures of up to 1500 degrees Celsius so they are in a liquid state when weightlessness begins. Upon atmospheric re-entry, air resistance slows down the rocket and payload, and a parachute opens to bring the experiments back to the ground. The researchers can follow the vehicle's path during flight via an onboard video system. There is also continuous radio contact, so that a recovery helicopter can be despatched to collect the experiments after MAPHEUS-3 has landed.

Avoiding unwanted effects

Also on board is a transparent container filled with a granulate composed of spherules, which the scientists will use to investigate the impact behaviour of the spherules during microgravity. With a diameter of less than a millimetre, the particles are surrounded by four magnets that accelerate them in a controlled manner during the flight. Meanwhile, a video camera records how the spherules lose energy by colliding with one another and with the inner wall of the container. The results of the MEGraMa-M (Magnetically Excited Granular Matter on MAPHEUS) experiment will provide information important for modelling granular media and, in particular, granular gases, Meyer explains.

What all four experiments on the MAPHEUS-3 high-altitude research rocket have in common is that, to understand the properties of the materials, effects that might alter the results in laboratories on Earth have to be minimised. "By carrying out experiments in microgravity with the MAPHEUS-3 sounding rocket, we can study the materials without the disruptive influence of gravity," explains Meyer. Some of the tests are not being carried out for the first time – they have already been on two previous Mapheus research rocket flights. But to precisely investigate the properties of the various materials – copper and cobalt, for example – the scientists are changing both the mixing proportions of the metals and the temperature profile in the ovens in their experiments. As the DLR MAPHEUS experiments take place once per year, the material physicists can implement the tests they have designed quickly and react to current research results in short order, according to project leader Martin Siegl of the DLR Institute of Space Systems in Bremen.

A yo-yo system to achieve microgravity

To enable the experiments to be carried out in microgravity, a few tricks are needed as well. For example, the MORABA (MOBilen RAKeten Basis – Mobile Rocket Base) team from DLR space flight operations has implemented a yo-yo system that reduces the spin of the rocket at an altitude of 70 kilometres. Inhibiting the spin that stabilises the rocket in flight and reducing any rotation induced by the exhaust nozzle helps to achieve microgravity. "In the weightlessness of the Mapheus rocket, a ball would take over 500 seconds to fall to the ground from a height of one metre," explains space engineer Josef Ettl, whose team's responsibilities include the launch of the high-altitude rocket and the recovery system.

Following a successful flight in microgravity, the scientists will begin to assess the recovered experiments. The solidified metal samples will be investigated in the laboratory and the MEGraMa-M experiment video will be analysed. "If we want to develop materials on a computer, we need to obtain the basic physical data," says institute director Andreas Meyer.

Contacts

Manuela Braun
German Aerospace Center (DLR)
Media Relations, Space Research
Tel.: +49 2203 601-3882
Fax: +49 2203 601-3249
Manuela.Braun@dlr.de

Martin Siegl
German Aerospace Center (DLR)
DLR Institute of Space Systems, Project manager MAPHEUS
Tel.: +49 421 244201-124
Fax: +49 421 244201-120
Martin.Siegl@dlr.de

Prof. Dr. Andreas Meyer
German Aerospace Center (DLR)
Institute of Material Physics in Space, Head of Institute
Tel.: +49 2203 601-2667
Andreas.Meyer@DLR.de

Josef Ettl
German Aerospace Center (DLR)
Mobile Raketen Basis (MORABA)
Tel.: +49 8153 28-2715
Fax: +49 8153 28-1344
Josef.Ettl@DLR.de

Preparations for the MEGraMa-M experiment



MAPHEUS-3-engineer Jörg Drescher performs final preparation work on the MEGraMa-M experiment.

Credit: DLR / Franz Bischof.

Granulate gases in the MEGraMa-M experiment



The granulate gases in the MEGraMa-M experiment: When subjected to conditions of microgravity, the spherules float in the brightly lit sample container. The circular electromagnets on the four sides of the container caused the particles to move.

Credit: DLR / Franz Bischof.

Assembling MAPHEUS-3



Microgravity will last for three and a half minutes in the MAPHEUS-3 rocket. The experiments were designed and built at the DLR Institute of Materials Physics in Space.

Credit: DLR / Franz Bischof.

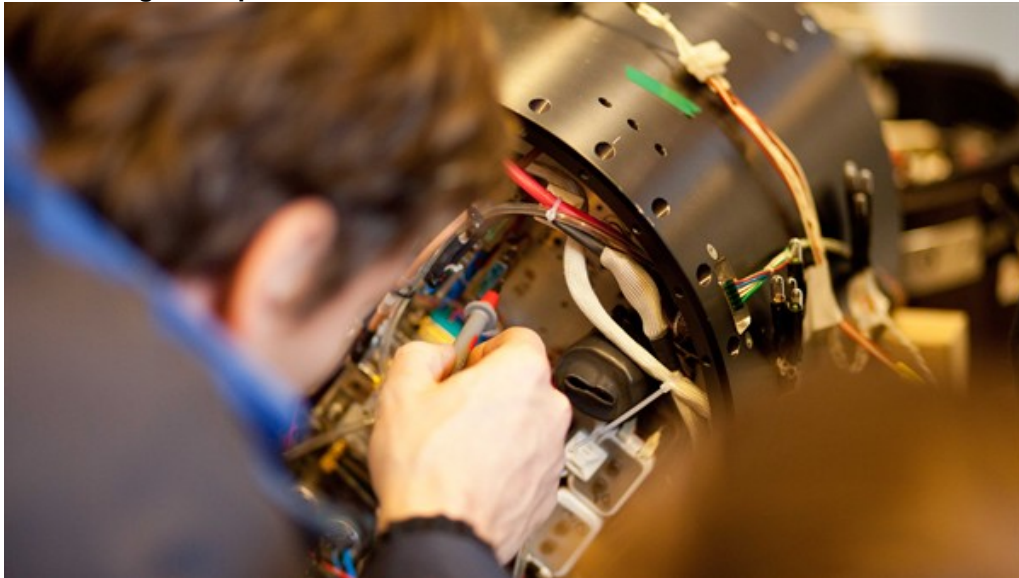
Preparing the sounding rocket



The four experiments on MAPHEUS-3 require not only microgravity but also hard vacuum conditions. The corresponding system is prepared for its use.

Credit: DLR / Franz Bischof.

Assembling the experiments



Some days before the start of the experiments, the researchers prepare for the microgravity flight.

Credit: DLR / Franz Bischof.

Contact details for image and video enquiries as well as information regarding DLR's terms of use can be found on the DLR portal imprint.