

MAPHEUS-4: X-rays in microgravity

15 July 2013

DLR launches sounding rocket with materials physics experiments

Close to four minutes of microgravity prevailed in the sounding rocket MAPHEUS-4, which was launched on 15 July 2013 at 07:53 local time, from the Esrange Space Center in northern Sweden. The German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) had two materials physics experiments on board the rocket. For the first time, the diffusion of aluminium and nickel was recorded under space conditions using X-ray analysis. The scientists at the DLR Institute of Materials Physics in Space examined the behaviour of granular gases in microgravity. The launch was conducted by the team of DLR's Mobile Rocket Base (MORABA).

The right conditions for the experiments were reached just 83 seconds after launch – the experiments MIDAS (Measuring Interdiffusion in Alloys and Semiconductors) and MEGrMA (Magnetically Excited Granular Matter) could thus be initiated without the disturbing influence of gravity. The rocket reached an altitude of about 154 kilometres.

Experiments in weightlessness

Before the launch, a small furnace containing the six samples containing various proportions of aluminium and nickel was preheated to 900 degrees Celsius. The furnace had already had its premiere in November 2012, when the scientists tested it on board the sounding rocket MAPHEUS-3. During microgravity, the different metal samples were moved into contact with each other inside the furnace, and thus diffuse the molten aluminium-nickel samples. The compact X-ray system, which is fully shielded to prevent the egress of radiation, was able to acquire one image per second in real time. "At present, the diffusion of liquefied metals is not completely understood," says Florian Kargl, Project Leader for the MAPHEUS-4 mission. The data acquired during microgravity is compared with model calculations and data from the terrestrial laboratory. The results can then contribute, among other things, to optimising industrial casting processes such as those used to produce turbine blades.

To better understand the behaviour of granular gases, researchers from the Institute subjected small metal balls to microgravity conditions. During the flight, four magnets placed the balls in motion and two high-speed cameras, which acquired up to 500 high-resolution images per second, recorded the particles as they pushed against each other and determined the velocity distribution. With the results, the researchers can analyse how granular gases – for example bulk goods like pills – can be packed more densely and in a more stable way. "The microgravity flight of the sounding rocket allows us to study these processes, without the particles being influenced by gravity."

Rescue by helicopter

After the 10-minute flight, the container that carried the experiments landed about 60 miles from the launch site and was retrieved by a helicopter. The DLR Mobile Rocket Base department was responsible for the design of the single-stage launcher and mission operations. Following the success of the previous flights, MAPHEUS-1 to MAPHEUS-3, they adapted the Brazilian-German S30 rocket motor for MAPHEUS-4 to significantly increase the payload capacity and flight altitude. "With a total payload mass of 272 kilograms, MAPHEUS-4 reached an altitude of 154 kilometres," said Frank Scheuerpflug, responsible for the MAPHEUS mission at MORABA, after the flight.

The scientists and engineers of the MAPHEUS teams can now look back on the results and experiences of four fruitful flights. "MAPHEUS is an excellent example of the most up-to-date

material research under microgravity conditions, benefiting from the efficiency and flexibility of rockets," said project leader Martin Siegl from the DLR Institute of Space Systems. The MAPHEUS programme will continue next year.

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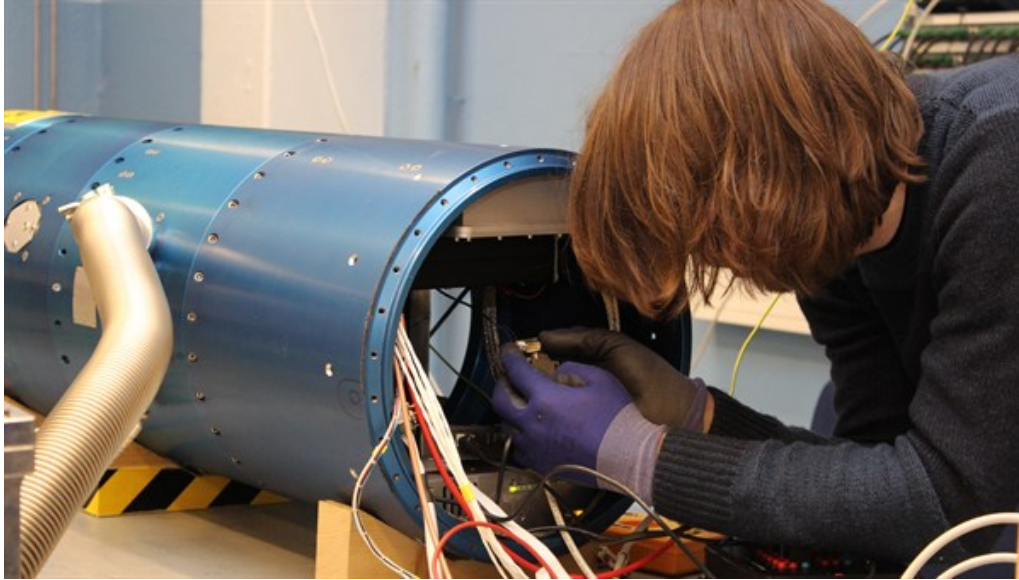
Launch of the MAPHEUS-4 sounding rocket



Close to four minutes of microgravity prevailed in the sounding rocket MAPHEUS-4, which was launched on 15 July 2013 at 07:53 local time, from the Esrange Space Center in northern Sweden. During the four minutes of microgravity, researchers from the DLR Institute of Materials Physics conducted various experiments.

Credit: DLR (CC-BY 3.0).

Experiments on board the sounding rocket



The DLR Institute of Materials Physics had two experiments on board the MAPHEUS-4 sounding rocket – MIDAS, to study the diffusion of aluminium and nickel, and MEGraMA, to learn about the behaviour of granular gases.

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