Lift-off – mini-ecosystem and mini-satellites en route to space

19 April 2013

German experiments fly on board Russian BION-M1 research satellite

It is a premiere eagerly awaited by scientists and technicians; on 19 April 2013, a Soyuz launcher successfully carried the successor to the long-standing BION series of Russian research satellites into space. BION-M1 was launched at 12:00 CEST (16:00 local time) from the Russian Baikonur Cosmodrome, and is expected to orbit Earth at an altitude of 575 kilometres until 19 May. Thanks to its solar panels, which recharge the internal batteries, the satellite, which is specifically designed for biological experiments in microgravity, can now remain in orbit for longer, and at a higher altitude than its BION predecessors, which were used as research platforms in space from 1973 to 1996.

Algae, tilapia, snails and shrimp under one roof

The scientific payload on BION-M1 includes two experiments funded by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR); biologists and zoologists from the Universities of Erlangen and Hohenheim have developed a two-chamber aquarium for 'Omegahab'. This is a mini-ecosystem designed to function as a bioregenerative life support system in microgravity, with its own nutrient and gas exchange. No larger or heavier than a case of wine, the experimental container will be home to an illustrious community with a shared destiny: the single-celled algae, Euglena gracilis, also known simply as Euglena; the aquatic plant hornwort (Ceratophyllum demersum), 40 Tilapia larvae (Oreochromis mossambicus), Mexican freshwater shrimp (Hyalella azteca) and some ramshorn snails (Biomphalaria glabrata). "The algae and hornwort will produce oxygen for the fish, shrimp and snails," explains Markus Braun, Omegahab project leader at the DLR Space Administration. The plants will then use the carbon dioxide released by the animals for photosynthesis.

Each 'roommate' has their own job

Video: Omegahab test in Moscow

The scientists have installed a filter between the two chambers; here, bacteria that break down the fish excrement are active, thus producing fertiliser for the hornwort and algae. In addition to this, the snails also work as ‘cleaners’; their task is to remove the excrement and clean up the panes so that the movements of the fish larvae in microgravity can be filmed more easily using a special camera. "With Omegahab, we are sending a complex, self-contained, fully automated ecosystem into space for the first time," says Braun. Furthermore, the German scientists are working in close collaboration with Russian researchers, and with the support of DLR; at the IBMP (Institute of Biomedical Problems) in Moscow, the two Omegahab flight models – one that is on board BION-M1 in space, the other on the ground as a reference – have been tested, filled and flown to Baikonur by the Russian Academy of Sciences. The fish larvae come from the government-owned Russian Federal Research Institute of Fisheries and Oceanography (VNIRO). Four working groups from Moscow and Saint Petersburg will be analysing the results after the flight. In Germany, the Universities of Munich, Konstanz and Magdeburg will also receive some of the on board samples.

How do cells and organs respond to microgravity?

The scientists want to use Omegahab to find out exactly how cells, organs and entire organisms respond to microgravity. With the fish, they are investigating bones, muscle structure, the nervous system, spleen and vestibular organs. This is similar to the inner ear in humans. With the algae, reproduction, photosynthesis and light-oriented movement will be studied. The biologists are particularly curious to find out how microgravity and radiation affect the complex interactions of the organisms in an enclosed ecosystem. "The results are important for our understanding of biological systems on Earth, and will help us develop resource-saving, bioregenerative life support and energy systems," explains Braun. These might be used, for example, in extreme environments such as Antarctica, or on long duration manned and unmanned space missions.

Students put picosatellites through their paces

Another payload being funded by the DLR Space Administration, and flying on BION-M1 consists of three picosatellites developed at German universities. "This is an excellent opportunity for the students and engineers taking part to make their studies more practical and test new technologies under real conditions in space," reports Christian Nitzschke, head of the university picosatellite programme at the DLR Space Administration. The **B**erlin **E**xperimental and **E**ducational **S**atellites BeeSat-2 and BeeSat-3 come from students at the Technical University of Berlin; SOMP-1 (**S**tudents' **O**xygen **M**easurement **P**roject) is a project from the Technical University of Dresden. The cube picosatellites have a length of 10 centimetres and weigh around one kilogram. They were separated from BION-M1 two days after the research

satellite was launched, at intervals of 16 seconds. All three projects include the development, construction and post-launch operation of the picosatellites.

OMP-1 is designed to test a sensor that can measure atomic oxygen and thin film solar cells under space conditions. Its intended service life is one year. BeeSat-3 is designed to spend a year in a circular orbit at an altitude of 575 kilometres, verifying the newly developed HiSPiCO S-Band Transmitter (Highly Integrated S-Band transmitter for PICO- and NANO-satellites), which is designed for microsatellites. Some 50 students have developed the picosatellite. BeeSat-2 is a technical and scientific mission to verify an active attitude control system using miniaturised reaction wheels. "If the test is successful, an active attitude control system for pico- and nanosatellites will be available for the first time," explains Nitzschke.

Contacts

Elisabeth Mittelbach
German Aerospace Center (DLR)
Communications, Space Administration
Tel.: +49 228 447-385
Fax: +49 228 447-386
Elisabeth.Mittelbach@dlr.de

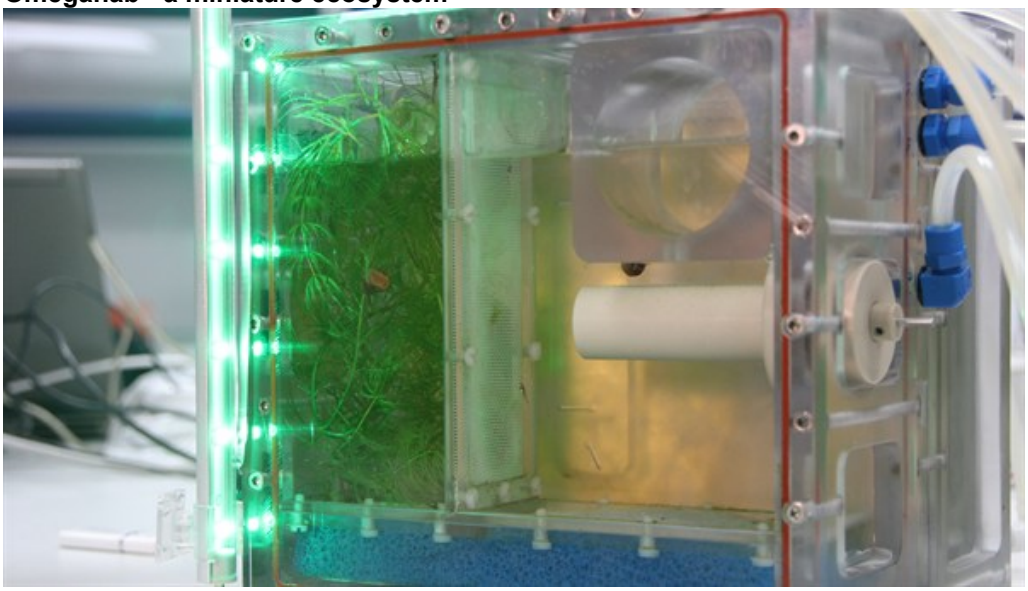
Dr. Markus Braun
German Aerospace Center
Space Administration, Microgravity Research and Life Sciences
Tel.: +49 228 447-374
Fax: +49 228 447-735
markus.braun@dlr.de

Christian Nitzschke
German Aerospace Center (DLR)
DLR Space Administration, General Technologies and Robotics
Tel.: +49 228 447-366
Fax: +49 228 447-718
Christian.Nitzschke@dlr.de

Launch of BION-M1 on Soyuz

On 19 April 2013, a Soyuz launcher successfully carried the successor to the long-standing BION series of Russian research satellites into space. BION-M1 was launched at 12:00 CEST (16:00 local time) from the Russian Cosmodrome at Baikonur.

Omegahab - a miniature ecosystem



Biologists and zoologists from the Universities of Erlangen and Hohenheim have developed a two-chamber aquarium for Omegahab, which is funded by the DLR Space Administration. It is designed to function as a bioregenerative life support system in microgravity, with its own nutrient and gas exchange. The hornwort can be seen on the left, and under the filter and to the right is a snail in the fish section. The fish eggs are in the circular section at upper right – the automatic food dispenser for the resulting larvae and for the fish is below.

Credit: DLR (CC-BY 3.0).

Omegahab in the experiment container

Omegahab is located right at the bottom of its experiment container. The entire module is filled with electronics for the bioregenerative life support system.

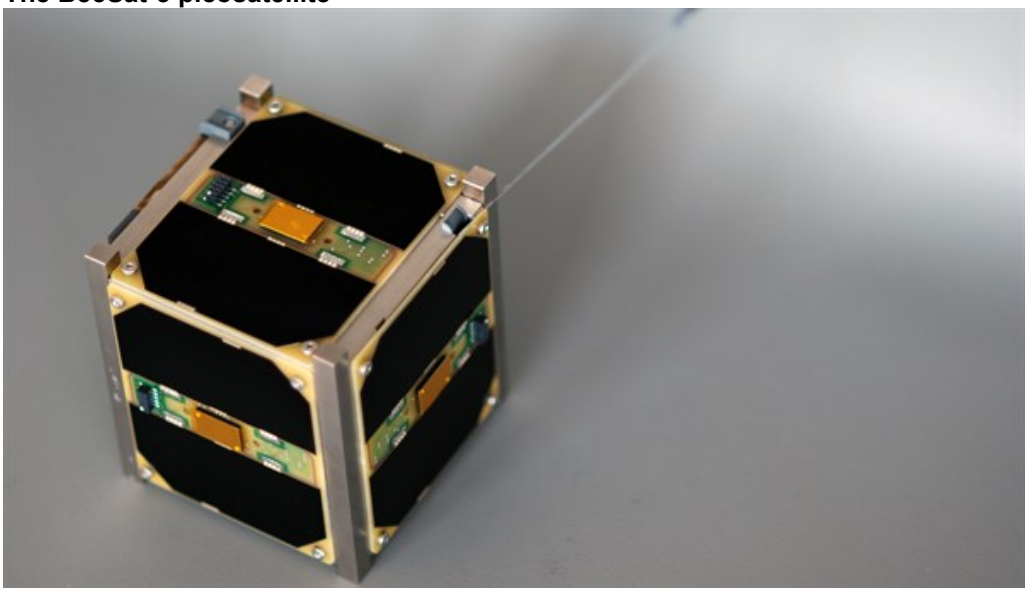
Credit: FAU/Sebastian M. Strauch.

Bion

The German Omegahab experiment being integrated into the research satellite at Baikonur Cosmodrome in Kazakhstan a few days before the launch of BION-M1. On the right in this picture is DLR Omegahab project leader Markus Braun and one of the German scientists.

Credit: DLR (CC-BY 3.0).

The BeeSat-3 picosatellite



The BeeSat-3 (Berlin Experimental and Educational Satellites) picosatellite, developed by students at the Technische Universität Berlin, is also part of the payload on BION-M1. The microsatellite, which weights one kilogram and is 10 by 10 by 10 centimetres in size is designed to spend a year in a circular orbit at an altitude of 575 kilometres, verifying the newly developed HiSPiCO S-Band Transmitter (Highly Integrated S-Band transmitter for PICO- and NANO-satellites) designed for microsatellites.

Credit: TU Berlin.

Soyuz launcher on its way to the pad

A Type 2.1A Soyuz launcher carrying the BION-M1 research satellite with its German experiments is moved to Launchpad 31 at the Baikonur Cosmodrome on 17 April 2013.

Credit: DLR (CC-BY 3.0).

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.