German Aerospace Center

Back from space: bacteria's survival skills tested on the International Space Station

04 April 2011

Resistant spores of *bacillus subtilis* have spent 22 months in the 'EXPOSE-R' test container outside the International Space Station (ISS). For the first time during a long-duration mission, they were mixed with artificial meteorite dust and exposed to the harsh conditions of outer space. Scientists at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) are now determining precisely how many of these spores have survived their stay in space. If it turns out that the meteorite dust was able to shield the spores from the hostile space environment, microorganisms may be capable of surviving in meteorites for long periods of time and travelling from one planet to another.

Over the next few months, Gerda Horneck, director of the Spores in artificial meteorites (SPORES) experiment, and her colleagues from the DLR Institute of Aerospace Medicine will examine almost 300 samples containing these microorganisms. Since this experiment began back in March 2009, the samples have been subjected to harsh conditions. They have been exposed to ultraviolet and ionising radiation, vacuum and temperature variations from minus 20 to plus 40 degrees Celsius in the ESA EXPOSE-R facility, as well as microgravity and a complete absence of any type of nutrients. The spores of bacillus subtilis have proven to be true survivors, employing an effective strategy; they enter a kind of hibernation, waiting for conditions to become more favourable, and then germinate again and restart their metabolism. The scientists now want to trigger this reaction themselves. "First, we try to bring the spores back to life by feeding them nutrients," explains astrobiologist Corinna Panitz, one of the scientists involved in SPORES. "By doing this we can examine how many spores have survived their extended stay in space, the extent of damage to their DNA and the precise nature of that damage."

Resistant to vacuum, radiation and temperature extremes

Bacillus subtilis is a thoroughly researched microorganism that is widespread in land, water and air. Its ability to withstand vacuum, radiation and temperature extremes makes it a good candidate for potential travel through space in a meteorite. Researchers have been testing its ability to survive under a wide range of conditions in the EXPOSE-R test facility. "Using optical filters and various artificial meteorite materials, we have created different environments for these microorganisms," states Panitz.

In the experiment carriers, some of the samples were exposed to an inert gas atmosphere, while others were exposed to vacuum conditions. Some of the carriers, each of which contained ten million spores, were exposed to ultraviolet radiation through eight-millimetre-thick highly ultraviolet-transparent glass. Other samples received a reduced radiation dose through optical filter wheels. The microorganisms placed on the lower two of the three stacked trays remained completely protected from extraterrestrial UV radiation. "The spores have been subjected to various radiation environments; those that were exposed to the entire spectrum of radiation will probably have died because their cells are unable to repair the damage incurred," explains the astrobiologist. "At lower doses, more of the microorganisms will probably have survived." The researchers also simulated different scenarios with the meterorite dust – some microorganisms were covered with it, while others were mixed together with it.

Protection for a journey through space

The same experiment that was being carried out on the ISS was also being conducted on the ground by DLR researchers at the Planetary and Space Simulation Facility. In the vacuum test facilities at Cologne, 300 samples of *bacillus subtilis* in meteorite dust were exposed to virtually the same conditions as the microorganisms in space. The temperature,vacuum and radiation parameters were reported by the ISS, and the conditions were then simulated in the laboratory to create a similar environment for the samples. "We have a set of comparison samples here on Earth," states Corinna Panitz. "But we can't replicate ionising radiation and zero gravity as they only really exist on this scale in space."

In addition to the DLR scientists' 300 samples, an additional 800 from EXPOSE-R returned to Earth on board Discovery. Gerda Horneck is the coordinator of the Response of Organisms to Space Environment (ROSE) consortium; this is why the DLR team not only prepared the entire test facility at the start of this mission, but is also in charge of assigning and physically sending the samples to the other scientists involved from around the world. This is when the real work starts; DLR researchers estimate that it will take about one year to investigate and evaluate all of these samples. "During the evaluation stage of this experiment, we analyse precisely how much protection the meteorite material is able to offer the microorganisms." The answer to this question could shed light on whether or not organisms in a meteorite might be able to travel to a nearby planet. "These samples from the ISS will help us to better understand the origin, development and possible dissemination of life in the Universe. An unprotected cell would never be able to survive the conditions of a long journey in space – but it may be able to do so when it is inside a meteorite."

Contacts

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

Dr. Gerda Horneck
German Aerospace Center (DLR)
Institute of Aerospace Medicine, Radiation Biology
Fax: +49 2203 619-70

Dr.rer.nat. Elke Rabbow
German Aerospace Center (DLR)
Institute of Aerospace Medicine, Radiation Biology
Tel.: +49 2203 601-3146
Fax: +49 2203 619-70

EXPOSE-R with microorganisms outside the ISS

Resistant spores of bacillus subtilis have spent 22 months in the 'EXPOSE-R' test container outside the International Space Station (ISS). For the first time during a long-duration mission, they were mixed with artificial meteorite dust and exposed to the harsh conditions of outer space. Scientists at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) are now determining precisely how many of these spores have survived their stay in space. If it turns out that the meteorite dust was able to shield the spores from the harsh space environment, it could mean that microorganisms are capable of surviving in meteorites for long periods of time and travelling from one planet to another.

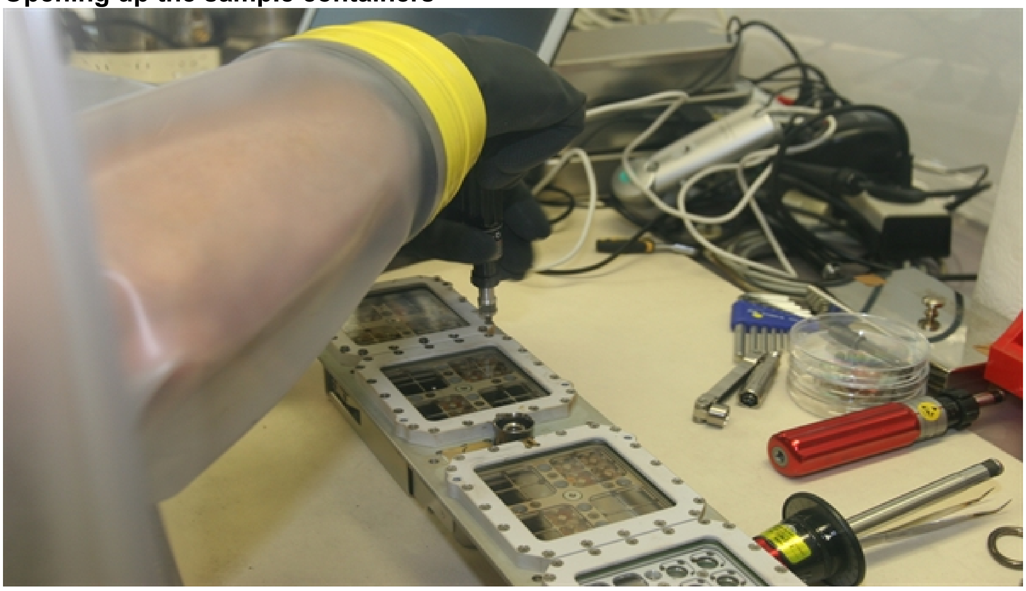
Credit: NASA.

After disassembly – EXPOSE-R on board the space station

After the EXPOSE-R test facility was dismantled and removed from the outside wall of the ISS on 21 January 2011, astronaut Dmitri Kondratyev opened up the unit and removed the samples. These returned to Earth on board the Space Shuttle Discovery.

Credit: NASA.

Opening up the sample containers



In the experiment carriers, some of the samples were exposed to an inert gas atmosphere, while others were exposed to vacuum conditions. Some of the carriers, each of which contained ten million spores, were exposed to ultraviolet radiation through eight-millimetre-thick highly ultraviolet-transparent glass. Other samples received a reduced radiation dose through optical filter wheels. The microorganisms placed on the lower two of the three stacked trays remained completely protected from extraterrestrial UV radiation. The researchers also simulated different scenarios with the meterorite dust – some microorganisms were covered with it, while others were mixed together with it.

Credit: DLR (CC-BY 3.0).
