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The EXPOSE-R Experiment ROSE-3 SPORES in artificial meteorites

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Abstract

In the conducted experiment, spores of bacteria, fungi and ferns, especially adapted to survive extreme conditions, were either solely or embedded in artificial meteorites exposed to space environment in the ESA facility EXPOSE-R for 22 months (10.03.2009-21.02.2011). The experiment will provide experimental clues to the question whether meteorite material offers enough protection against the harsh environment of space for spores to survive a long-term stay in space. This question has received increased attention since the discovery of Martian meteorites has provided evidence that rocks can be transported from one planet to another in our solar

1. Introduction

The SPORES experiment as part of the EXPOSE-R Mission consisted of three parts: (1) "Snapshot" where the conditions of a hypothetical journey of spores inside a meteorite will be mimicked as closely as possible; (2) "Augmented insolation" which takes into consideration that solar UV radiation is one of the most harmful factors of space and therefore maximum insolation will be provided by use of special filters giving access to wavelengths >110 nm; (3) "Protective mechanisms" where carefully controlled parameters of space (e.g. space vacuum, defined wavebands and intensities of solar UV) will act on spores which are combined with protectants. In addition, physical instruments will provide experimental data for the UV and particle radiation distribution on top of the meteorite material and beneath. After almost 2 years in space, the viability and impairment of the spores was analyzed in the laboratory using a set of biological and biochemical assays.

2. Materials and Methods

The test samples were accommodated in the EXPOSE-R ESA facility (Rabbow et al. 2009), which was attached outside the ISS on the Svesda modul for 22 months (10.03.2009-21.02.2011). Before the space flight a profound mission preparation program with a series of ground based simulations was performed with participation of the SPORES experiment. Several verification tests (EVTs), a science verification test (SVT) before the mission and a mission parallel Mission ground reference test MGR were conducted.

3. Summary and Conclusions

From the ongoing analysis of the experiment experimental clues are expected to the question, whether meteorite material offers enough protection against the harsh environment of space for spores to survive even long-term phases in space. The data will contribute to our understanding of the chances and limits of interplanetary transfer of life, by testing experimentally one of the crucial steps a 3 years snapshot of a hypothetical journey through the solar system. In other constellations the hostile conditions were aggravated by increasing the periods of insolation reaching UV doses which would be equivalent to approximately 10 years insolation of a randomly moving meteorite. This part will identify the most resistant type of spores with respect to the most harmful parameter of space, i.e. solar UV radiation.

Extent and kind of protection (chemical or physical) against the parameters of space, applied individually or in selected combinations will be identified for selected materials, such as certain soil or rock components, thin layers of meteorites and upper layers of spores in multilayer. It will provide new data to the previous observation of increased UV sensitivity of spores of ***Bacillus subtilis*** when irradiated in space vacuum. By analyzing the molecular injuries in the DNA of the spores, produced by UV radiation and/or space vacuum, the cellular and molecular mechanisms of injury and

protection will be elucidated. It is expected that the data will contribute to the understanding of the chances and limits of interplanetary transport of spores, e.g. in rock material.

The results of the space experiment will be complemented by data obtained in the laboratory using the space simulation facilities at DLR and will contribute to our understanding of the chances and limits of interplanetary transfer of life.

Figure 1: The EXPOSE-R facility outside the ISS with accommodated SPORES samples

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