What do we learn from microbiological space experiments?

Dr. Ralf Möller

German Aerospace Center (DLR e.V.), Institute of Aerospace Medicine, Radiation Biology Department, Space Microbiology Research Group, Linder Höhe, D-51147 Cologne (Köln), Germany, Phone 49(2203) 601-3145, Fax 49(2203) 61790, E-mail: ralf.moeller@dlr.de

The vast, cold, and radiation-filled conditions of outer space present an environmental challenge for any form of life. The majority of experiments on microorganisms in space were performed using Earth orbiting robotic spacecraft, or human-tended spacecraft, and space stations, e.g. the International Space Station (ISS). The responses of microorganisms (viruses, bacterial cells, bacterial and fungal spores, and lichens) to selected factors of space (microgravity, galactic cosmic radiation, solar UV radiation, and space vacuum) were determined in space and laboratory simulation experiments. In a variety of space experiments, spores of *Bacillus subtilis* have been used as valuable biological test organisms. Spores of the gram-positive bacterium *B. subtilis* are highly resistant to inactivation by environmental stresses, such as biocidal agents and toxic chemicals, desiccation, pressure and temperature extremes, and high fluences of UV radiation and are a powerful biodosimetric system for terrestrial environmental monitoring and astrobiological studies. Onboard several spacecraft, e.g. Apollo 16, Spacelab 1, LDEF, D2, FOTON, spores of *B. subtilis* were exposed to selected parameters of space, such as space vacuum and different spectral ranges of solar UV-radiation and cosmic rays, applied separately or in combination (Horneck et al. [2010]). Bacterial endospores have since been recognized as the hardiest known form of life on Earth, and considerable effort has been invested in understanding the molecular mechanisms responsible for the almost unbelievable resistance of spores to environments which exist at (and beyond) the physical extremes which can support terrestrial life (Nicholson [2009]). Endospores (or spores for convenience) of *Bacillus* sp. are ubiquitous and can be isolated in almost every niche in nature and they are relocated spatially via wind, water, living hosts, etc., to environments potentially favorable for germination and resumption of vegetative growth. As a result, *Bacillus* species and their spores can be found in environmental samples obtained from all parts of the Earth, both above (bacterial spores were collected at high altitudes up to 77 km) and below (spores of *Bacillus infernus* were isolated from ca. 2700 m below the land surface) the surface, and as such represent a highly successful strategy for the survival and widespread dispersal of microbial life. Dormant spores exhibit incredible longevity, reliable reports exist of the recovery and revival of spores from environmental samples (i.e. lake sediments) as old as 100 000 years or even elder. Because of their high resistance to environmental extremes and their reported longevity bacterial spores have also been suggested as ideal test system for studying the "*Lithopanspermia*" theory, the hypothetical transfer of (microbial) life between the planets of our Solar System via meteorites (Mileikowsky et al. [2000]). In this seminar talk, I will present data and information on the survival, molecular mechanisms and potential transport of bacterial spores in space (from one planet to another) in support of the "*Lithopanspermia*" theory and give an outlook of the ongoing and future space microbiology/astrobiology activities of the DLR.

References:

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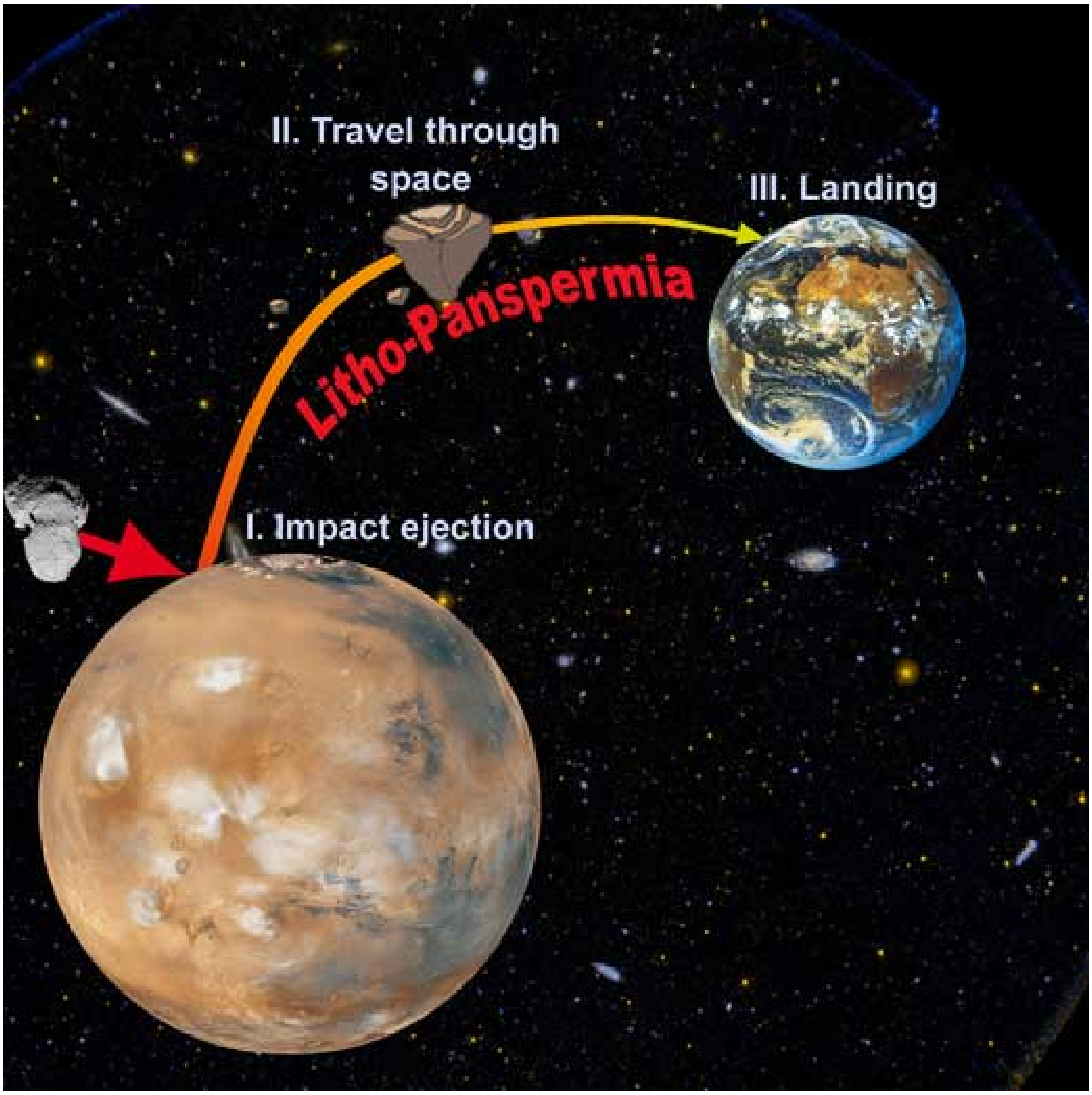
II. Travel through space
III. Landing
Litho-Panspermia
I. Impact ejection