EP 19 Astrobiologie

Zeit: Donnerstag 14:00–16:00 Raum: B

Hauptvortrag EP 19.1 Do 14:00 B

Astrobiological experiments in Low Earth Orbit - Experiments and research facilities in space — •Petra Rettberg — DLR, Institute of Aerospace Medicine, Radiation Biology Division, Linder Höhe, 51147 Köln

Besides astrobiological laboratory experiments where one or a few combinations of physical and chemical parameters of interest can be studied in detail, it is necessary to use the space environment as a tool for astrobiogical experiments as well. ESA offers different space facilities allowing the investigation of the combined effects of microgravity, extraterrestrial solar UV radiation, galactic cosmic radiation and vacuum on biological objects. Examples are the EXPOSE facility on the ISS and the BIOPAN facility. For the study of the responses of organisms to space and to martian environment the survivability of terrestrial resistant microbial forms, spores of the bacterium Bacillus subtilis, exposed to different subsets of the extreme environmental parameters in space and on Mars was investigated in the BIOPAN facility onboard of the Russian earth-orbiting Foton M-2 satellite. This satellite was launched with a Soyuz-U rocket from Baikonur, Kazakhstan, on Mai 31, 2005. The landing took place on June 16. After exposure in space the survival as well as the mutation induction was analyzed in the laboratory together with parallel samples from the corresponding ground control experiment performed in the space simulation facilities of DLR. The results of this experiment provide new insights into the adaptation to environmental extremes on Earth or other planets which define the principal limits of life and at the same time bear the potential for the evolution and distribution of life.

Fachvortrag EP 19.2 Do 14:30 B

Deinococcus radiodurans, ein strahlenresistentes Modellsystem für extraterrestrisches Leben — •Ulrike Pogoda de la Vega[1], Petra Rettberg[1], Gerda Horneck[1], Thierry Douki[2] und Jean Cadet[2] — [1]Dt. Zentrum für Luft- und Raumfahrt e. V. (DLR), Linder Höhe, D-51147 Köln — [2]Laboratoire Lesions des Acides Nucleiques, Service de Chimie Inorganique et Biologique, Departement de Recherche Fondamentale sur la Matiere Condensee, CEA/Grenoble, France

Deinococcus radiodurans toleriert ungewöhnlich hohe Dosen ionisierender Strahlung, die auf der Erde natürlicherweise nicht vorherrschen. Ein amerikanisches Team zeigte, dass die hohe Resistenz gegenüber ionisierender Strahlung aus der Adaption an den Stressfaktor Trockenheit resultierte. Trotzdem ist es bis heute noch nicht gelungen, die zugrunde liegenden Reparaturmechanismen aufzudecken. Unser Ziel ist die Erforschung der Mechanismen, die zu einer Trocken- und UV-Strahlenresistenz von D. radiodurans führen. Anhand von Mutanten ist es uns gelungen eine photobiologische und photochemische Charakterisierung der UV-Strahlentoleranz von D. radiodurans durchzuführen. Diese Studien zeigten, dass zu längerwelliger UV-Strahlung hin, die Resistenz bei allen Stämmen zunimmt, unabhängig vom Vorhandensein eines Reparaturweges. Ferner liegt unser Anliegen in der Erforschung der limitierenden Faktoren von extraterrestrischen Extrembiotopen, wie z. B. des UV-Strahlen-Klimas auf dem Mars oder eines möglichen interplanetaren Transportes von Mikroorganismen. Ergebnisse erster Mars-Simulationsexperimente sowie der o. g. Charakterisierung werden dargelegt.

Fachvortrag EP 19.3 Do 14:45 B

Methanogene Archaea aus Sibirischem Permafrost als Modellsysteme für das Leben auf dem Mars — •Daria Morozova and Dirk Wagner — Alfred Wegener Institut für Polar- und Meeresforschung Telegrafenberg A43 14473 Potsdam

Current ESA mission Mars Express determined water on Mars and CH4 in the Martian atmosphere, which could be originated only from active volcanism or from biological sources. This finding implicates that microbial life could still exist on Mars. One possibility for survival of Martian life might be subsurface lithoautotrophic ecosystems, which are exist in permafrost regions on Earth. Within the scope of DFG Priority Program *Mars and the Terrestrial Planets* we study the resistance of methanogenic archaea to different extreme life conditions of terrestrial or extraterrestrial permafrost. The methanogenic archaea in pure cultures as well as in their natural environment of Siberian permafrost represent high survival potential under extreme conditions. Significant CH4 formation appeared by incubation with saturated salt solution (0.02 nmol CH4 h-1 g-1), radiation dose up to 5000 Jm-2 (0.8 nmol CH4 h 1 g 1), desiccation (5.24 nmol CH4 h-1 ml-1), extremely low temperatures of -80°C (5.57 nmol CH4 h-1 ml-1) and Mars simulation. The capability of these organisms to grow under lithoautotrophic anaerobic conditions, long-term survival under harsh natural environments of permafrost and high resistance to the different extreme conditions as well as to the simulated Martian environments make methanogens to the most suitable keystone organism for the investigation of possible Martian life.

Fachvortrag EP 19.4 Do 15:00 B

Could microorganisms survive an impact ejection? — •Ralf Möller[1,2], Gerda Horneck[1], Dieter Stöffler[3], Sieglinde Ott[4], Ulrich Hornemann[5], Cornelia Meyer[1,3], Jean-Pierre de Vera[4], and Jörg Fritz[3] — [1]German Aerospace Center, Institute of Aeropace Medicine, D 51170 Köln — [2]German Resource Centre for Biological Material, Braunschweig — [3]Institute of Mineralogy, Humboldt University, Invalidenstrasse 43, 10099 Berlin — [4]Institute of Botany, Heinrich Heine University, Düsseldorf — [5]Ernst Mach Institute for Short-time Dynamics, Freiburg

For testing the *lithopanspermia* - theory, i.e. the hypothetical transport of life between planets, e.g., Mars and Earth, by means of meteorites, we have performed shock wave recovery experiments with bacterial endospores and epilithic and cryptoendolithic microbial associations. It was found that survival of the microbes exponentially decreased for shock pressures from 10 to 50 GPa which is the range of pressures experienced by the known Martian meteorites. In future experiments, we will simulate the conditions of the Mars surface during impact ejection (mineral composition, temperature). The actual shock pressure of the recovered samples will be determined by refractive index measurements. The recovered microorganisms will be analyzed by molecular biological methods, SEM, and confocal laser microscopy to characterize possible effects of mechanical stress and to determine the underlying molecular mechanisms by gene expression analysis. (The project is supported by grants of the DFG to G. Horneck and D. Stoeffler).

Fachvortrag EP 19.5 Do 15:15 B

ABC-Net, ein europäisches Vorlesungsnetzwerk zur Astrobiologie — •Gerda Horneck — DLR, Institut für Luft- und Raumfahrtmedizin, Köln

Die Astrobiologie ist eine relativ junge Disziplin, deren Aufgabe es ist, das Leben und die Prozesse, die zu seiner Entstehung, Evolution und Ausbreitung führen, nicht als terrestrisches Einzelereignis anzusehen, sondern als planetares Phänomen, eingebettet in die Evolution unseres Universums. Um diese Aufgabe zu bewältigen, haben sich Astronomen, Planetenforscher, Chemiker, Biologen und Paläontologen zusammengeschlossen. Allerdings ist die Astrobiologie bisher kaum in die universitäre Lehre aufgenommen worden. Einer der Gründe hierfür mag in der multi-disziplinären Ausrichtung der Astrobiologie liegen, so dass alle betroffenen Bereiche häufig nicht an einer einzigen Universität vertreten sind. Um diese Schwierigkeit zu überwinden, haben Lektoren von 5 europäischen Universitäten (Turku, Milton Keynes, Paris, Dresden und Salzburg) mit Unterstützung des DLR und der ESA ein astrobiologisches Vorlesungsnetzwerk aufgebaut, so dass die Vorlesungen mit Hilfe der Telekommunikation gleichzeitig in allen 5 Universitäten verfolgt werden können. Weitere Information auf der ESA Webseite http://streamiss.spaceflight.esa.int/ unter Astrobiology Lecture Course Network.

Fachvortrag EP 19.6 Do 15:30 B

The experiment Lichens-Biopan 5 at Foton M-2 mission: test of survival capacity in space — •Rosa de la Torre [1], Gerda Horneck[2], and Leopoldo Garcia Sancho[3] — [1]INTA, Dpm. Earth Observation, Crta. Ajlavir, km.4, 28850-Torrejón de Ardoz, Madrid, Spain — [2]DLR, Institut für Luft- und Raumfahrtmedizin, Abteilung Strahlenbiologie, D-51170 Köln, Germany — [3]Universidad Complutense de Madrid, 28040-Madrid, Spain

Lichens are one of the most resistant organisms at Earth. They live at very extreme environments (deserts, high mountains, Antarctica, etc). Selection of two epilithic lichen species were done for the LICHENS experiment included at the ESA Biopan-facility, located at the outer shell of the satellite Foton M-2. Launching was the 31th of Mai 2005 from

Baikonur. One of this species, Rhizocarpon geographicum selected at a high mountain region, has been systematically studied in the natural environment (Sierra de Gredos, Central Spain, 2000 m altitude) as well as under simulated space conditions at the space simulation facilities of the DLR. Sensitivity of photosystem II to different environmental conditions (dryness including vacuum treatment, high temperature fluctuations, high UV intensity) was fluorometrically measured with a MINI PAM (Walz, Germany). Rhizocarpon geographicum was extremely resistant to this conditions. But surprising results were obtained after Foton M-2 flight, showing lichens a recovery of the photosynthetic activity in a 90-100%: a high survival rate to space vacuum, extreme temperatures, complete spectrum of solar UV light and cosmic radiation during 15 days was shown.

Fachvortrag EP 19.7 Do 15:45 B

Life Marker Chip development for the European ExoMars mission: biosensor technology for life detection experiments on Mars — •Jan Toporski[1], Mark Sims[2], David Cullen[3], and Andrew Steele[4] — [1]University of Kiel, Institute for Geosciences, Germany — [2]University of Leicester, Space Research Centre, UK — [3]ranfield University, Cranfield Biotechnology Centre, UK — [4]Geophysical Laboratory, Carnegie Institution of Washington, USA

Numerous microbiological, molecular, and genetic techniques are being developed for a variety of biotechnology applications. One key area is the integration of nano-technology with biotechnology, resulting in the development of robust lab-on-a-chip instrumentation, which has application in many diverse and exciting fields. Specifically DNA and protein microarray technology is currently being considered for applications in space exploration. This technology, termed Life Marker Chip (LMC), has been identified as candidate analytical instrument for life detection experiments on Mars as part of the planned ESA ExoMars mission. The LMC instrument concept presented here is being developed and tested by two collaborating teams: SMILE (specific molecular identification of life experiment, lead by Mark Sims) and MASSE (modular assays for solar system exploration, lead by Andrew Steele).

DNA microarray technology is a DNA probe-based assay using short ssDNA fragments affixed to a solid substrate to identify microorganism and is capable of *fingerprinting* multiple microorganisms in one test. The basis of protein microarrays is the binding specificity of antibodies (capture molecule) to a specific antigen (target molecule). Each antibody is a protein that recognizes and non-covalently binds a specific three-dimensional structure (epitope) of an antigen. It can thus discriminate and detect a specific antigen in a complex sample that contains multiple different antigens. Microarray technology is integrated with microfluidic sample preparation systems for a start-to-finish automated instrument. In comparison to competing technologies for the detection of organics in solar system exploration, microarray-based analyses offer advantages such as the ability to obtain complex information on samples with high sensitivity and specificity. LMC technology is designed to detect a broad variety of compounds from fossil biomarkers to biological macromolecules and can thus produce information from the surface and shallow subsurface of Mars potentially much broader and detailed than previously considered techniques. Due to its flexibility and the potential to run thousands of specific reactions in parallel (first generation devices will limit detection to tens or hundreds of molecules), analysis can test for contaminants (during Earth to Mars transfer), traces of possible Martian life (past or present), or even evidence of Earth life that may have been transferred in the past.