EXOcube – Exposure of Organisms/Organics cube: A New Cubesat Based Life Sciences Exposure Platform for the International Space Station with In-situ Analytical Capabilities. A. Elsaesser[1], A. Perfumo[2], A.L. Mattioda[3], A.J. Ricco[3], C. Danelon[4], D. Wagner[2], F. Salama[3], F. Canganella[5], H.-G. Löhmannsröben[6], H. Linnartz[1], P. Ehrenfreund[1], R.C. Quinn[7], V. Parro[8], W. L. Nicholson[9], Z. Martins[10]
[1]Leiden University, NL (email: a.elsaesser@umail.leidenuniv.nl), [2]GFZ Potsdam, DE, [3]NASA Ames Research Center, US, [4]TU Delft, NL, [5]University of Tuscia, IT, [6]University of Potsdam, DE, [7]SETI Insitute, US, [8]CAB-INTA, ES, [9]University of Florida, US, [10]Imperial College London, UK

Introduction: How does life at different stages of complexity respond to, and evolve in, space and planetary conditions and what biomolecular mechanisms come into play at the interface between biology and physics? EXOcube is aiming to address these questions with far reaching implications for the interpretation of the results of past and upcoming planetary exploration missions.

EXOcube represents a new generation of space exposure platforms based on cubesat mini-space laboratories equipped with in-situ analytical instrumentation. EXOcube will combine the capability of in-situ online monitoring of organism responses to the spaceflight environment in real time, coupled with detailed post-flight sample analyses on the ground (see Figure 1). The immediate goals are to investigate (i) the response of life at different stages of complexity to space conditions and (ii) the role of membranes and membrane components as the interface between life and the physical environment.

Implementation: We plan to expose organisms, with different structural complexity from protocells to eukaryotic cells, to radiation levels in low Earth orbit and microgravity and to measure in-situ their biological response via reporter dyes. This, together with further sophisticated ground based post-flight analysis will allow us to study in detail the bio-molecular pathways triggered by radiation events and microgravity and will help to identify key molecules and membrane components, which are involved in the adaptation of these organisms to space conditions.

While leveraging existing astrobiology and astrochemistry proven in-situ technology from the O/OREOS satellite and the OREOcube experiment on the ISS, EXOcube will have an advanced concept such as additional UV transmitting windows to expose organisms to a wider spectral range of radiation and a planned development for a miniaturized IR spectrometer, which will allow to investigate changes of relevant molecules.

Impact: Outcomes from the EXOcube project will support current and upcoming ESA/NASA planetary and space exploration missions (e.g. ExoMars, Mars2020, JUICE) by:

- Providing valuable data for open issues concerning the survival of organisms to space conditions.
- Investigating photochemical processes of important biomolecules with relevance for the adaptation of life forms to space conditions and the origin of life.
- Investigating the stability of primitive cell membrane constituents under space conditions.
- Supporting planetary exploration by studying organisms used for life support systems and organic components with a potential for radiation shielding technology.

EXOcube is selected by the European Space Agency (ESA) for the definition phase for installation on the ISS in the 2017-2020 period.

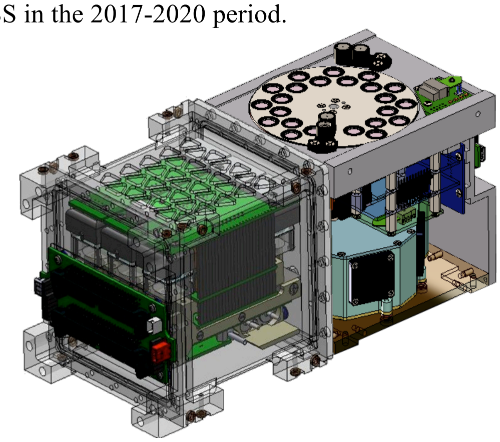

Fig.1: EXOcube payload: EXOcube-Bio and EXOcube-Chem, both investigating the effect of space radiation on membranes, either of live organisms or as chemical thin films.