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CubeSats as innovative but low-cost science platforms for planetary exploration

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The new concept of a CubeSats as “planetary hitchhiker” consists of a payload system or a complete nanosatellite, which is carried along on a mission to a planet, a moon, or other solar system bodies, with science or technology goals that are separate and independent from the primary mission. A hitchhiker payload may simply perform measurements while in transit in a beyond-low-Earth-orbit environment (e.g., cosmic radiation effects on living organisms or engineering materials) and/or a hitchhiker may be deployed as a self-sufficient small satellite while in transit or upon arrival at a destination orbit. The goal is delivery to a variety of orbital destinations (e.g., LEO, L1, L2, lunar orbit) and ultimately to supply miniaturized payloads for surface missions (platforms, landers, rovers) that e.g. operate on the surface of the Moon, including sample return missions (Ehrenfreund, Elsaesser et al. 2013).

To prepare for human exploration or habitation of the Moon, other planets or deep space, risk mitigation strategies need to be developed. The GeneSat-1, PharmaSat, and O/OREOS payload systems developed by NASA Ames Research Center supported and characterized living model microorganisms (E. coli, S. cerevisiae, B. subtilis) that share many fundamental characteristics with mammalian cells. By monitoring, for example, DNA damage and repair consequent to high-energy particle radiation in appropriate model organisms or cell cultures, a better understanding of the extent of damage in higher animals exposed to radiation in deep space, lunar, or planetary environments is anticipated. The O/OREOS satellite launched in a high-inclination (72°) also investigated the photostability of biomarkers in 650-km Earth orbit and has proven a stable performance for several years (Mattioda, Cook et al. 2012). O/OREOS technology is currently being modified for a "hitchhiker mission" on the International Space Station (ISS). This spin-off experiment is called OREOCube (Elsaesser, Quinn et al. 2014) and is currently under development as an external science instrument for the ISS. OREOcube will monitor, in-situ, the photostability of biomarkers important for the search for life on other planets. Samples will consist of organic thin films in contact inorganic substrates of catalysts and minerals with relevance to Mars. Further developments for planetary, lunar and deep space missions (LuBiC: Lunar Biosentinel Cube, RASIR: Reactivity Analyzer for Soil, Ices, and Regolith) are in development.

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