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ANALYSIS AND CONCEPTS DEVELOPMENT FOR AN ASTROBIOLOGY-FOCUSED EXPLORATION OF THE JOVIAN MOON EUROPA

Abstract

With the emerging field of Astrobiology, novel targets for the exploration of our Solar System are being unveiled. One is the Jovian moon Europa, which is not only geologically of particular interest due to its earth-like internal structure, but also from the astrobiological point of view of special importance. An icy outer layer of several kilometres thickness has been proven by the Galileo mission to exist on Europa. This ice-layer is not only very young and geologically active, but moreover, the finding of an induced magnetic field has led to the discovery of a possible underlying ocean, which is kept liquid by the heating of Europa's interior due to tidal flexing. The existence of such a liquid water ocean, together with the present source of energy, and a suggested suite of organic materials, indicates a potential to harbor extraterrestrial life, which leads to a particular interest to further investigate Europa. Sending an orbiter is essential, hence NASA and ESA currently perform detailed studies therefore, but a long-term exploration strategy should necessarily be completed with a dedicated in-situ exploration mission for the ice layer and the underlying ocean.

To access the subsurface of Europa, several different concepts for suitable vehicles have been proposed so far in literature. Within the research presented here, we have performed a deep investigation of design-driving environmental conditions on the journey to and on Europa itself. Resulting essential requirements for technologies have thereupon been used to suggest concepts to overcome the most demanding difficulties. Therefore, trade-off studies on important subsystems, e.g. the propulsion system using either propellers, buoyancy control or a more advanced concept with wheels, have been performed.

Five standardized operation scenarios have been established, one of which is the search for signs of life within the cracks at the ice-water interface. In applying these operation scenarios, we have simulated and evaluated the operation of the systems and subsystems under the respective close-to-reality conditions. Hereupon, the concepts weak points have been identified.

The aim of our research was to investigate potential fields of improvement and to derive enabling technologies. Since most of the time, which is spent for the realization of space exploration missions is used to develop enabling technologies, the knowledge that will be derived by the research presented here, could be used for an enhanced technology development, and therefore allow a more determined and more rapid realization of a future in-situ mission to Europa.