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TITAN AS A POTENTIAL DEEP SPACE BASE: ENVIRONMENTAL ANALYSIS AND RESOURCES EXPLOITATION PROPOSAL

Abstract

The biggest known moon of Saturn, Titan, is rightfully recognized as one of the most interesting celestial bodies in our Solar System, thanks to its unique environmental characteristics and its similarity to icy exoplanets of our Universe. Cassini-Huygens mission data demonstrated the presence of a dense atmosphere and unveiled a layered internal structure consisting of a rocky core enclosed by distinct ice coatings. Several studies suggest that the presence of a liquid water and ammonia ocean between the icy layers is highly probable, whereas liquid methane lakes and icy rocks cover the surface.

In this framework, NASA's Dragonfly mission will study Titan's geologic and prebiotic characteristics by exploring terrain and dunes at different equatorial sites, interesting for the search of life on this natural satellite. Its importance has motivated the students of the Master's Program in Space Exploration and Development Systems (SEEDS), with the support of Thales Alenia Space, ASI and ESA, to propose a Titan exploration mission. The mission aims to complement Dragonfly's objectives through the analysis of the body's atmosphere and of its liquid surface elements.

This work follows that mission proposal by presenting a study to determine the detailed composition of atmosphere, lake and outer crust through data collection. In addition, analyses of lake morphology, hydrological cycles and weather monitoring are included as part of the investigation. Moreover, the mission paves the way for future exploitation of Titan's environment by establishing the usefulness of its resources for various applications, such as propulsion. This work suggests chemical and physical processes that may be needed to efficiently utilize the vast amounts of available resources, such as liquid hydrocarbons.

Consequently, the results of the paper propose a number of activities to be carried out during a scientific mission to Titan. The mission outcomes are expected to broaden the knowledge of Titan and show the potential of its resources utilization, stimulating the interest in future missions on the satellite. Further work can be carried out to analyze the obtained scientific data, and to study the technological adaptations and improvements needed in order to efficiently and effectively exploit Titan as a remote base for further deep space explorations.