IAF SPACE EXPLORATION SYMPOSIUM (A3)
Solar System Exploration including Ocean Worlds (5)

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MERCURY SAMPLE RETURN MISSION DESIGN UTILIZING INNOVATIVE SYSTEMS AND TECHNOLOGIES

Abstract

Mercury is one of four terrestrial planets and the smallest planet in the solar system, known to have a significant metallic core and a high metal to silicate ratio. However, the reason for the planet's specific composition and formation is yet to be explained. While many theories attempt to justify these facts, none can be confirmed without further investigation, such as one provided by a sample return mission. The science collected from this mission will allow for validation of theories about the formation of Mercury and possibly the Solar System. By investigating theories about Mercury's formation, more information will be uncovered about the Earth's Moon as there are quite a few similarities between the two bodies. These similarities will help establish a newer, more grounded theory about the origin of the Moon and its effects on Earth. Additionally, learning about Mercury could provide information on how the Earth might evolve over time.

Sending a spacecraft to Mercury has many challenges, orbital mechanics being one of the biggest. As Mercury is the closest planet to the Sun, its orbit is the most affected by the Sun's gravity, making it difficult to maneuver a spacecraft into a stable orbit. Moreover, going to Mercury is a complicated and long-duration mission requiring gravity assists and complex trajectories. Thermal control is another

challenge since the spacecraft must be protected from Mercury's extreme temperatures. In this context, this research will attempt to deal with these difficulties through innovative analyses of technologies to develop a feasible plan to perform such a mission. The study will present trades of different technologies and approaches for subsystems. Due to the previously discussed challenges imposed by Mercury, employing an innovative approach to the technologies will allow for designing a mission optimal for combatting challenges. The paper will also discuss the mission design tools and Model-Based Systems Engineering (MBSE) approaches used to validate results.

Please note that this work is submitted under the guidance of the Space Exploration Project Group (SEPG) of the Space Generation Advisory Council (SGAC) as part of the ACHIEVED Initiative, which stands for Assembly for Concepts in Human Interplanetary Exploration with Various Extraterrestrial Designations. This initiative aims to enable students and young professionals from diverse technical and cultural backgrounds to work and collaborate on a space mission design project.