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SUSTAINABLE MARTIAN EXPLORATION: MODULAR ROVER-LANDER SYSTEM.

**Abstract**

Mars, with its potential for harboring life-sustaining resources, has captivated the attention of scientists and space exploration enthusiasts alike. In this pursuit, the concept of a sustainable modular rover craft paired with a lander emerges as a promising approach towards extended exploration mission on the Martian surface. Drawing inspiration from successful missions such as ISRO's Chandrayaan, this study proposes a Modular Rover and a lander which is highly tailored to complement the operations of the rover, as an approach to Mars Exploration, meant to increase Mission life and efficiency.

As a part of this combination, we propose a modular rover that is designed to adapt to the challenges of Martian terrain and environmental conditions. Unlike traditional rovers, this modular design offers features like repairability and a variety of on-board apparatuses. We propose that all the required apparatuses be divided into Modules that can easily be switched out as needed, helping with weight management, optimized energy consumption, and optimization towards carrying out specific tasks. The Lander serves as the other half of this mission. It serves as a hibernation chamber, meant to provide refuge to the rover during extreme conditions, while also acting as a 'pit-stop' for the rover to facilitate efficient maintenance, Module management, and Module Swapping, enhancing the rover's adaptability and versatility in response to evolving mission objectives. With this combination, we aim to increase Mission life and overcome the unique challenges posed by Martian exploration, all the while making exploration more sustainable and reducing space debris on Mars. In contrast to problems faced by past rover missions, like the Spirit rover losing one of its wheels, and Opportunity's demise in a sandstorm, the proposed combination would be able to easily mitigate these problems. A lost wheel could be easily replaced thanks to modularity, and a sandstorm would not pose a challenge thanks to the hibernation chamber offered by the lander.

In summary, the proposed sustainable modular rover craft, in tandem with a feature-rich lander, represents a pioneering approach towards sustainably unlocking the mysteries of Mars. By enabling extended mission lifespans and facilitating dynamic adaptation to mission requirements, this research paves the way for enhanced exploration capabilities and deeper insights into the red planet's geological, atmospheric, and biological characteristics.

**Keywords:** Sustainable, Rover, Lander, Mars Exploration, Modularity, Mission life.