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MISSION CONCEPT FOR THE STUDY OF CISLUNAR SPACE WEATHER AND LUNAR OCCULTATIONS FROM STABLE EARTH-MOON L4 ORBITS

Abstract

With the growing interest from governmental and private organizations in the cislunar region, developing mission concepts that enhance our understanding of this region has become increasingly crucial. This paper presents the development of a mission concept designed to investigate key science questions in space weather by deploying a scientific platform at the Earth-Moon L_4 Lagrange point to study solar energetic particles (SEP) distribution and the solar corona. Placing a spacecraft around L_4 allows for periodic solar-eclipse observations of the corona once a month due to its strategic position relative to the Moon. The science payload under consideration consists of a natural occulter coronagraph, a high-energy particle detector to map SEP across the cislunar realm, and a magnetometer to investigate periodic magnetotail crossings throughout the mission duration. In addition, lunar occultations of stars permits the direct measurement of stellar properties such as diameter, binarity, circumstellar envelopes, and starspots. While observing the lunar limb, it is also possible to study lunar impact flashes, a phenomenon that occurs when meteors crash onto the Moon and release high-energy light. Finally, positioning a spacecraft at this location enables feasibility studies on orbital transfers to the region, lunar surveillance, and the potential establishment of a communications relay.

This work will focus on introducing the primary and secondary science objectives and their respective technical requirements. These requirements have a direct impact on payload and subsystem design. Following conventional space systems engineering, our goals to perform trade studies will be discussed with the purpose of weighing the various spacecraft configurations and determining the payload and subsystems that will best meet mission constraints and satisfy the defined science goals. First, we will

present the motivation behind this mission concept, with a thorough review of the state of the art. This will be followed by a science traceability matrix that outlines of all desired science targets and outcomes, mapped to relevant decadal survey priorities, including topics within astrophysics, heliophysics, lunar environment, and space weather. Methods to achieve these goals will be presented, namely instruments and science orbits. Finally, a discussion of the trade studies to be performed will be presented. The expected results of these will be outlined, emphasizing the impact on spacecraft subsystems.