IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

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PREDICTING THE SCIENTIFIC OUTCOME OF LUMIO LUNAR CUBESAT

Abstract

The Lunar Meteoroid Impacts Observer (LUMIO) is a CubeSat mission to observe, quantify, and characterise the meteoroid impacts by detecting their flashes on the lunar far-side. This complements the knowledge gathered by Earth-based observations of the lunar nearside, thus synthesising a global information on the lunar meteoroid environment. LUMIO envisages a 12U CubeSat form-factor placed in a halo orbit at Earth-Moon L2 to characterise the lunar meteoroid flux by detecting the impact flashes produced on the far-side of the Moon. The mission employs the LUMIO-Cam, an optical instrument capable of detecting light flashes in the visible spectrum.

LUMIO is one of the two winners of ESA's LUCE (Lunar CubeSat for Exploration) SysNova competition, and as such it is being considered for implementation in the near future. The Phase-A deign has been conducted in 2020 under ESA GSTP contract, after a successful, independent mission assessment performed by ESA's CDF team.

In this work, we present the methodology developed to predict LUMIO's scientific contribution to refine the current meteoroid flux models in the solar system. Our approach relies on a combined modelling and simulation of LUMIO's Payload, Orbit, and Environment (POE). The LUMIO-POE tool has been developed in order to conduct preliminary parametric analyses, which feed back the design of both the payload and the mission operative orbit. LUMIO-POE has an inner engine and several modules. Worth to mention is the Meteoroid Gun (MeGun), which models numerous known meteoroid shower as well as sporadic impacts with the lunar surface.

Statistical analyses have been performed via Monte Carlo simulations. Our results indicate that the present-day LUMIO mission has the potential to detect 10e4 total meteoroid impacts (10e2 in the range of impact kinetic energy at Earth [10e-4,10e-1] kton TNT and 10e4 in the range [10e-6,10e-4] kTon TNT). It is expected that 10 different meteoroid showers (with more than 10e2 detections per shower) as well as more than 10 sporadic impacts per 24-hour observation period will be observed. Overall, LUMIO can fill a current gap in meteoroid impact data and refine the cumulative number of impacts within part of the already characterised impact kinetic ranges.