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ESCAPE TRAJECTORIES FROM THE LUNAR GATEWAY WITH ELECTRICAL PROPULSION

Abstract

The future Lunar Orbital Platform-Gateway is foreseen to be placed close to the Earth-Moon L2 point in a Southern Near Rectilinear Halo Orbit with 9:2 Lunar Synodic Resonance. Such operational orbit minimizes the station-keeping needs and almost completely eliminates eclipses.

Future interplanetary missions could be performed with departure from this orbital platform. For this reason, an indirect method to determine optimal low-thrust trajectories for the escape from Earth's sphere of influence from such NRHO is developed. Both direct and indirect escapes are considered. Direct escapes show single-burn or two-burn solutions depending on the lunisolar perturbation during the escape to exploit its favorable effects and reduce propellant requirements. On the other hand, indirect escapes perform an Earth Gravity Assist (EGA) or a Lunar Gravity Assist (LGA) to achieve higher characteristic energies C_3 at Earth's SOI.

The highly chaotic and non-linear dynamic of motion close to Lagrangian points challenges the indirect method's remarkable precision: different approaches and improvements, such as multifield and multishooting methods, are implemented to handle these numerical problems. The dynamic model considers 4-body gravitation (spacecraft subject to Earth, Moon, and Sun gravity), JPL ephemeris for the bodies' positions, and may include spherical harmonic models for Earth and Moon; solar radiation pressure is also considered.

Results show that escape with relatively low values of C_3 can be obtained with ΔVs ranging from few tens to few hundreds m/s. All the considered escapes from the design NRHO, both direct (single-burn and two-burn) and indirect (with EGA or LGA), are substantially influenced on performances by the relative positions of Sun and Moon.