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MOVING TO AND FROM THE LUNAR GATEWAY WITH ELECTRIC PROPULSION

Abstract

In the last decade a strong interest has grown in the future Lunar Orbital Platform-Gateway (LOP-G, formerly Deep Space Gateway, DSG) as a base for future space missions. This orbiting platform may have some similar uses compared to the ISS, but at the same time, it could greatly simplify some deep space operations, produce a more practical handling of lunar resources and would also serve as supply point for spacecrafts to distant destinations, as assumed for the Deep Space Transport. Recently, NASA has published on NAIF a reference trajectory, in the full ephemeris model, for a 15-year-long positioning of the LOP-G (NASA, White Paper: Gateway Destination Orbit Model: A continuous 15 Year NRHO Reference Trajectory, 2019).

The reference orbit is a Southern L2 Near Rectilinear Halo Orbit (NRHO) with 9:2 Lunar Synodic Resonance, average orbital period of 6.5 days, and perilune and apolune average radii equal to 3300 km and 70000 km, respectively. This trajectory allows to minimize the station keeping and, almost completely, eliminate eclipses. The orbit of the LOP-G could be identified as a point of departure or arrival of numerous space missions. It is vital, therefore, to validate the most interesting mission scenarios that could not only increase even more the scientific interest towards the LOP-G framework, but also allow the discovery of innovative orbital solutions at low cost.

The proposed paper aims to evaluate the many possible mission scenarios and opportunities that may arise from the use of this new platform for an electric propulsion (EP) spacecraft. An indirect method to determine optimal EP trajectories both for the missions towards the NRHO (from Low Earth Orbit, LEO, or Low Lunar Orbit, LLO, for example) and from the NRHO (interplanetary escape to Mars, for example) with the use of EP is developed. High accuracy of the results is sought. The dynamic model considers 4-body gravitation (spacecraft subject to Earth, Moon, and Sun gravity), JPL' ephemeris for the position of the bodies and may take spherical harmonic models for Earth and Moon into account; solar radiation pressure is also considered.