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ASTEROID RESOURCE EXPLOITATION ON THE LUNAR DISTANT RETROGRADE ORBIT

Abstract

The French multidisciplinary project, titled *ECOCEL*, *Exploitation des Ressources des Corps Célestes*, is aimed at studying different aspects of the exploration and commercial exploitation of asteroids.

This work is focused on examination of feasibility and advantages to transport raw materials from an asteroid to the vicinity of Earth in the lunar Distant Retrograde Orbit (DRO). Due to its high long-term stability, this parking orbit offers the opportunity to develop in-situ resource examination and processing, such as production of propellant, life-support or space construction using water and other extracted materials. These activities can be of interest to provide autonomous provisioning for robotic and crewed missions for the Lunar Orbital Platform-Gateway (LOP-G), proposed as a staging station for future lunar and deep-space missions.

Our study is focused on design of rendez-vous trajectory between DRO and the baseline candidate orbit for the LOP-G: Near Rectilinear Halo Orbit (NRHO) about Lagrange L2 point of the Earth-Moon system. The two families of orbits have very different geometries: DROs are planar solutions of the the Circular Restricted Three-Body Problem (CRTBP), while NRHOs are quasi-perpendicular to the lunar orbit plane. Moreover, unlike NRHOs, DROs don't have associated invariant manifolds, hence they are not flexible for a low-cost transfer. Rendez-vous options for transfers between various phase points in both orbits are analysed in the current work, and an assessment of the required delta-v and flight time is performed. Trajectories are computed using SEMPy open source python package in the framework of the CRTBP, and then validated in a high-fidelity dynamical model using GMAT software.