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CHARACTERIZATION OF LOW-ENERGY ORBITS FOR THE EXPLORATION OF PLANETARY SYSTEMS

Abstract

The moons of the giant planets are getting into the focus of the next exploration missions to the outer solar system. The reason for this interest resides in their dynamical role within their respective systems (e.g., Enceladus with respect to the E-ring of Saturn) and the signs of habitability suggested in some cases by surface and subsurface features (e.g., the liquid oceans below the crust of Europa and Enceladus). Flyby missions offer valid and well-established exploration scenarios, and have been extensively exploited. On the other hand, the dynamical structures of the circular restricted three-body problem open the way to different observational opportunities. In particular, libration point orbits (LPOs) around the two collinear equilibrium points L_1 and L_2 of a planet-moon-spacecraft system are characterized by low speeds relative to the moon and periodic behaviour. Heteroclinics and homoclinics allow further close-up views of these bodies. These objects have been the focus of previous investigations concerning the design of spacecraft transfers between moons on consecutive orbits as part of a lunar cycler mission. The present contribution addresses the kinematical and observational characteristics of LPOs, of their hyperbolic stable and unstable invariant manifolds, of heteroclinic and homoclinic connections. The study is parametric and aims at providing a complete picture of these low-energy orbits for observational purposes. Lunar surface coverage, repeat patterns, lunar distance ranges, speed profiles, transfer maneuver magnitudes are derived and discussed for all the systems of interest. Some example applications are included.