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# EFFICIENT TWO-BODY APPROXIMATIONS OF IMPULSIVE TRANSFERS BETWEEN HALO ORBITS

**Abstract**

This contribution presents an efficient method to compute direct transfers between Halo orbits of two coupled circular restricted three-body problems. Given the growing interest in the robotic exploration of the Jovian system, which has resulted in numerous studies and mission proposals, the envisaged application is the design of low-energy spacecraft trajectories between consecutive moons in a planetary system, as part of a lunar tour. The basis of the method were set in a previous work in which planar Lyapunov orbits of two such moons were connected by approximating their stable and unstable invariant manifolds through two-body elliptical orbits with focus at Jupiter. The propellant cost at the intersection (impulsive manoeuvre) between ellipses departing from and leading to each moon turned out to depend on the relative orbital phase between the moons, and the minimum-$\Delta$V was found to correspond to the orbital configuration in which the ellipses were mutually tangent. The identification of such configuration was entirely analytical and, hence, computationally very fast. Here, we extend the method to the more interesting and scientifically useful case of Halo orbits because these orbits offer a 3D view of the moons. The two-body approximation of their stable and unstable invariant manifolds again consists in sets of ellipses, but their intersection must be determined in 3D, and its existence and associated manoeuvre cost depends on the difference in the right ascension of the ascending nodes of the two conic sections (a reflection of the relative orbital phase between the moons). The method adopted to compute the intersections and identify the minimum-cost solution will be illustrated. In order to assess the accuracy of the approach, the two-body transfers will be verified against a numerical integration of the invariant manifold trajectories. Finally, the benefits of this methodology when applied to the design of a 3D lunar tour will be discussed.