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ON THE RELATIONSHIP BETWEEN THE EARTH'S WEAK STABILITY BOUNDARY REGION AND THE LOW-ENERGY TRANSFERS TO THE MOON

Abstract

The term Weak Stability Boundary (WSB) indicates a region of stable motion around the small primary of a circular restricted three-body problem (CR3BP). Previous work on this subject has shown that at a given energy level the boundaries of such region are provided by the stable manifolds of the central objects of the L1 and L2 libration points, i.e., the two planar Lyapunov orbits. This offers a natural dynamical channel between the Earth's vicinity and the Sun-Earth libration points L1 and L2. Furthermore, it has been shown (and successfully employed to design low-cost spacecraft lunar transfers) that the Sun-Earth L2 unstable manifolds can be linked, through an heteroclinic connection, to the stable manifolds of the L2 point in the Earth-Moon three-body problem. In the present work, an extensive and systematic exploration of the heteroclinic trajectories between planar Lyapunov orbits corresponding to all the possible combinations of two libration points in the Sun-Earth CR3TP and the Earth-Moon one, seen as two coupled CR3BP's, has been made. The results of such exploration give us a deeper and more complete understanding of the dynamics and properties of such connections, and ultimately explain the existence of natural dynamical channels from the Earth (through its WSB region) to the Moon that can be exploited for designing spacecraft trajectories. The investigation on the connections between the Sun-Earth and Earth-Moon libration point orbits, has been extended to the coherent bicircular four-body problem, which constitutes a more natural framework for the problem under consideration and also a more realistic dynamical model of motion.