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A SIMPLIFIED MODEL FOR MOTIONS AROUND THE COLLINEAR LIBRATION POINTS IN THE EARTH-MOON SYSTEM

Abstract

Due to the perturbations from the Moon's orbit eccentricity and the Sun, the dynamics of the collinear libration points in the real Earth-Moon system are different from those of the Circular Restricted Three-Body Problem (CRTBP). Generally, special quasi-periodic orbits exist around them, replacing the geometrical collinear libration points as time-varying equilibrium points. These orbits are called dynamical substitutes. Similar to the CRTBP case, Lissajous orbits and Halo orbits exist around these dynamical substitutes. Considering all the perturbations from the Moon's orbit eccentricity and the Sun's perturbations, high order analytical solutions for these orbits can be constructed. However, these literal solutions suffer from their complicated forms. Besides, for large amplitude motions, these literal solutions also suffer from the problem of divergence due to the well-known small denominator problem.

Using the Elliptic Restricted Three-Body Problem (ERTBP) with the Earth-Moon mass ratio, literal expansions of the Lissajous orbit and the Halo orbit around the collinear libration point are first constructed. Using the mean orbital elements of the Moon's orbit, we find the initial conditions given by these literal solutions do not diverge fast in the real Earth-Moon system. By adding the lowest order perturbation from the Sun, these literal solutions can be further improved. In some cases, these solutions perform better than the ones given by considering all the perturbations, even though the model is simpler than the true Earth-Moon system. This is a very interesting phenomenon. In this paper, the details to deduce the simplified model and some numerical simulations will be given.