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STABLE REGIONS NEAR TRIANGULAR LIBRATION POINTS OF BINARY ASTEROID SYSTEM

Abstract

According to Liang et al. (2017), there exist two-dimensional stable/unstable manifolds of the triangular libration points in planar case as greater than Routh critical value. For simplicity, this kind of EPs is called 2+2+0 type, according to the dimension of the stable/unstable manifolds. In another paper, Jiang et al. (2014) demonstrated that as greater than Routh critical value the triangular libration points have the same topological structure with non-collinear EPs in Case 5. Numerical results show that such EPs widely exist near asteroids, such as 1996 HW1, 1620 Geographos and 4769 Castalia. According to Center Manifold Theorem, there exist no periodic orbits locally near the triangular libration points in this case. Therefore, searching for the natural stable regions near the triangular libration points, where the motions are bounded, is of great significance from both theoretical and engineering viewpoints. As greater than Routh critical value, the short and long period families of planar periodic orbits around the triangular equilibrium points do not end at the equilibrium point but along the family, the parameter ε has a strictly positive lower bound, that corresponds to the so called limiting periodic orbit (LPO). The basic idea of this paper is to construct the stable region by detecting the family of such LPO. Firstly, the family of LPO is obtained numerically by continuation method and the relationship between the stability and the energy is illustrated, where two regions of stable periodic orbits are found. Subsequently, the dynamical structure of the neighborhood of the stable periodic orbits are explored by Poincaré map, including the homoclinic tangle, KAM torus and the chaotic river, etc. Furthermore, considering the shape of the asteroid, the binary system is modelled as a combination of Ferrer's ellipsoid and a sphere. The aforementioned results are firstly extended to this improved model. Trajectories in the neighbourhood of the LPOs are classified into four species according to their patterns. To furtherly detect the long-stable motion near them, an artificial boundary is constructed outside the KAM torus, from which the orbits are generated. Characteristics including the pattern, the collision angle, time of flight and the loops around L4 or L5 and the whole system are shown for these orbit. Finally, a control strategy based on Poincaré section is developed constructing low-energy orbits serving for different missions.