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AN INVESTIGATION OF 3D PERIODIC ORBITS IN THE VICINITY OF ASTEROIDS WITH POLYHEDRAL MODEL

Abstract

3D periodic orbits in the vicinity of asteroids with established polyhedral models are searched and investigated in this paper. This study is conducted under the following assumptions: (1) the density of each asteroid is uniform; (2) each asteroid rotates around its principal axis of the largest moment of inertia; (3) the motion of a spacecraft is affected only by the gravitation of the asteroid and solar perturbation. A variety of 3D periodic orbit families in the vicinity of 4 Vesta, 216 Kleopatra, 243 Ida, 433 Eros, 951 Gaspra, 1620 Geographos, 2063 Bacchus, 2867 Steins, 4769 Castalia, 6489 Golevka, (8567) 1996 HW1, 25143 Itokawa, (52760) 1998 ML14, and 101955 Bennu are calculated with the hierarchical grid searching method. Topology and stability of these orbit families are studied according to their local manifolds. The patterns of topology continuous variation, which is ubiquitous in most of the cases, are also summarized in this paper. The conclusion, according to the basic study on 216 Kleopatra and 433 Eros in IAC 2014, states that solar gravitation is not strong enough to increase or decrease the families of periodic orbits, nor is it able to change the stabilities of periodic orbits. This conclusion still holds after this extensive investigation about asteroids with sizes from hundreds of kilometers to a few kilometers. Based on suggestions from the last IAC presentation, perturbation from solar radiation is also considered in numerical simulation and will be discussed in this paper. Although most of the periodic orbit families are not stable, numerical simulation indicates that a lot of families have periodic characteristics that can hold for a few periods without any control. In addition, chaotic trajectories of which subastral points cover most of the asteroid also exist in some cases. This phenomenon suggests that even unstable orbits around asteroids may be useful during future deep space mission.