LONG-TERM EVOLUTION OF THE EARTH'S CO-ORBITAL ASTEROIDS. Paweł Wajer, Space Research Centre of Polish Academy of Sciences, Celestial Mechanics Department, Warsaw, Poland. wajer@cbk.waw.pl

Introduction: In a co-orbital region of a given planet three types of orbit can occur: tadpole, horseshoe and quasi-satellite orbits. In the planar case these families of orbits are separated, but spatial tadpole or horseshoe orbits can merge with quasi-satellite orbits or transitions between different types of orbits can appear. In recent years several these asteroids have been discovered in the Earth co-orbital region [1].

We analyzed numerically the evolution of a few known Earth's co-orbital asteroids with small and moderate values of the eccentricity and inclination of its orbits (and the arc of observations longer than one year). The objects are (85770) 1998, 2000 WN10, 2002 AA29, 2004 BO 41, (164207) 2004 GU9 and 2006 FV35. We used all known observations of these asteroids and give detailed analysis of their motion.

We applied the last results of theory of co-orbital motion developed in [2] and [3] for the analysis and identification of the co-orbital libration modes of the asteroids.

Initial conditions and method of numerical integration: The power series integration method of 26^{th} order has been applied to the integration of equations of motion of the asteroids [4]. This method allows us to determine an optimum value of integration step.

Our analysis of the asteroids was performed by means of a sample of 100 cloned orbits selected randomly from initial coordinates and velocities of nominal osculating orbit. The cloned orbits were generated by the Sitarski's orbital program package [5] that allows to create any number of the initial orbital elements, and each set of the elements fits the observations well. The planetary coordinates were taken from the JPL ephemeris DE406. Our model includes all the planets and the Moon treated as the separated body.

Results: All the analyzed objects exhibit interesting dynamics. The orbit of 2002 AA29 is very similar to that of the Earth, this object moves on horseshoe orbit and from time to time transits to the quasi-satellite state. We found that these transitions occur near 580, 2580 and 3750. After about 6400 this object probably leaves co-orbital librating regime. 2004 GU9 and 2006 FV 35 are long-term visitors in an Earth-QS orbits. They remain in this state over a thousand years. The orbital evolution of 2000 WN10, 2004 BO 41 and (85770) 1998 UP1 seems to be more complicated. In their motion transitions between different types of co-orbital motion appear.

References:

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