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Dynamical evolution of asteroid pairs on close orbits

Eduard D. Kuznetsov†, Dmitrij V. Glamazda, Galina T. Kaiser, Vadim V. Krushinsky, Aleksandr A. Popov, Viktoriya S. Safronova, Andrej A. Shagabutdinov, Pavel V. Skripnichenko and Yuliya S. Vibe

Kourovka Astronomical Observatory, Ural Federal University,
Lenina Avenue, 51, Yekaterinburg, Russia 620000
email: eduard.kuznetsov@urfu.ru

Abstract. We apply Kholshevnikov metrics defined in the space of Keplerian orbits to search for asteroids in close orbits. We showed that the Yarkovsky effect was required to take into account accurately to carry out precise simulation of dynamical evolution of the asteroid pairs. Determination of physical and rotational parameters of asteroids is needed to solve this problem.

We apply natural metrics (Kholshevnikov metrics) defined in the space of Keplerian orbits to search for asteroids in close orbits. We use as a metric ϱ_2 the distance between two orbits in the five-dimensional space of Keplerian orbits.

We have used 582 120 orbits of asteroids (using both numbered and multi-opposition objects – 22.06.2018 release) from the Asteroids Dynamic Site – AstDyS. There are 105 asteroid pairs that have $\varrho_2 < 0.002$ (au)$^{1/2}$ ($\varrho_2^2 < 600$ km). Of these, 33 asteroid pairs were identified within known families of asteroids using AstDyS:

16 pairs are members of fragmentation asteroid families: (158) Koronis, (434) Hungaria;

10 pairs are members of cratering asteroid families: (4) Vesta, (15) Eunomia, (20) Massalia;

2 pairs are members of young asteroid families: (396) Aeolia, (1547) Nele;

1 pair is member of one-sided asteroid family: (93) Minerva;

4 pairs are members of unclassified asteroid families: (135) Hertha, (298) Baptistina, (1338) Duponta.

There are 72 asteroid pairs that are not identified with known families of asteroids.

We consider orbital evolution of two the tightest pairs: (63440) 2001 MD30 and (331933) 2004 TV14, and (355258) 2007 LY4 and (404118) 2013 AF40. To carry out a high accuracy numerical simulation it is necessary to take the Yarkovsky effect into account. In total, we used 7 test orbits for each of the two paired orbits that were assigned different values of the secular semimajor axis drift rate da/dt. The test values were chosen as $da/dt = 0$, $\pm 10^{-5}$, $\pm 10^{-4}$, $\pm 10^{-3}$ au/Myr. We numerically integrated the orbits of these pairs backward in time (a time span of 20 kyr) with the code known as Orbit9.

We showed that the Yarkovsky effect was required to accurately carry out precise simulations of dynamical evolution of the asteroid pairs. Determination of physical and rotational parameters of asteroids is needed to solve this problem.

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