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The Ceres and Vesta effect on some young asteroid families

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Abstract

Large asteroids (Ceres, Vesta) can a very significant perturb of orbits of very young compact asteroid families, in some cases principally change the stability of motion. The effect of most massive asteroids on dynamics of young compact asteroids clusters is different for different clusters. Moreover, it may be different for the members of the same cluster. In particular, we note Ceres+Vesta+Asteroid resonance in Lucascavin family.

1. Introduction

An asteroid family is a group of asteroids with similar orbits and spectra that was produced by a collisional breakup of a large parent body. The ages of asteroid families are in wide range from hundred of thousands up to few Gyrs. The research of young minor planets clusters is easier, because many factors have no sufficient time to operate.

In this paper we consider the effect of Ceres and Vesta on young families dynamics. The role of large asteroids on dynamics of main belt is significant and multivariate. A secular resonance between the dwarf planet Ceres and other asteroids first studied by Novakovic et al **[4, 5, 6]**. Galad studied the effect of main belt perturbers on asteroid pair age estimation **[2]**. Christou put forward the idea about Ceres and Vesta Trojans existence and had given some examples **[1]**.

The main goal of present paper is to study effect of Ceres and Vesta perturbation on some very young and compact asteroid families (age<1Myr). We have shown that the influence of Ceres and Vesta is complex and not bounded only secular resonances and close encounters.

2. Method

To study the dynamical evolution of these compact asteroid clusters, the equations of the motion of the systems were numerically integrated 800 kyrs into the past, using the N-body integrator Mercury and the Everhart integration method. On base of previous age estimation, we expect that this time interval is sufficient. We made four series of integration. In the first we use only large planets perturbations. In the second we add Ceres only and only Vesta in the third. Finally, we add perturbations of both Ceres and Vesta. We have not taken into account any non-gravitational forces, because they poorly known and have no time to sufficient change of orbital elements in considered pairs.

3. Results

The Lucascavin family was discovered by Nesvorny & Vokrouhlicky **[3].** They estimate the age of this family 50-250 kyrs old. The problem of Lucascavin family age estimation is still difficult, more difficult than in case, for example, Emilkowalski family. The possible reason of this is resonance related chaos in semimajor axis of 180255 2003 VM9 due to joint Ceres and Vesta perturbations.

There are few high order mean motion resonances in vicinity of orbit of family: Jupiter 31:9 resonance at 2.2811701 au, Mars 6:11 resonance at 2.2824255 au, Ceres 4:3 resonance at 2.2841907 au, Vesta 19:20 resonance at 2.282122 au. In addition, secular perturbations by Ceres and Vesta may be important [6].

But semimajor axis of Ceres and Vesta are dependent on time. By this reason, resonance conditions are changed. Around to epoch -300 kyrs, orbits of Ceres and Vesta become close to the mutual 4:5 resonance and to the 3-body resonance with asteroids of Lucascavin cluster type: 5V:4C :6A. It explain the behavior of 180255 2003 VM9 semimajor axis in

figure 2. Other members of cluster have smaller perturbations maybe due to phase protection.

Ceres and Vesta perturbations contribute significant effect on Kap'bos young asteroid cluster. But in this case is it not so easy to explain it. We can only state significant chaotic variation of semimajor axis of all members of Kap'bos family. As in case Lucascavin family, it is strongly complicate the estimation of age of cluster. In contrary, in cases Emilkowalski and Brugmansia (1992YC2) family, perturbations of Ceres and Vesta have not significant effect on angular elements convergence and age estimation.

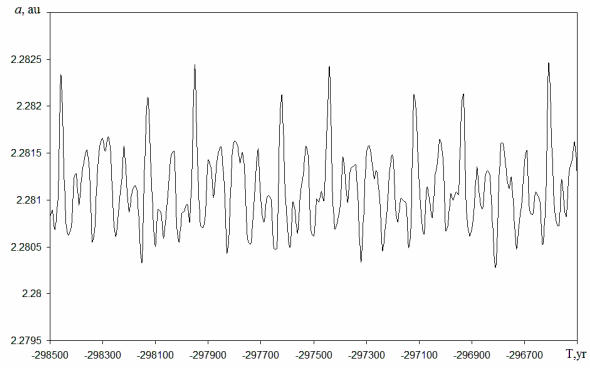

Figure 1: Perturbations in semimajor axis 180255 2003 VM9. Only Ceres effect have taken into account.

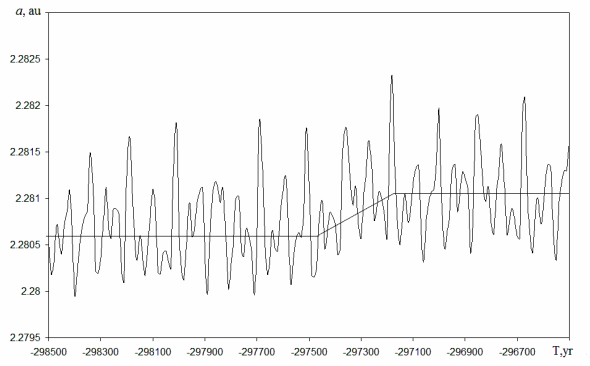

Figure 2: Perturbations in semimajor axis 180255 2003 VM9. Both Ceres and Vesta effect have taken into account

4. Conclusions

Finally, we can say following. Large asteroids (Ceres, Vesta) can produce a very significant perturbations of orbits of very young compact asteroid families, in some cases principally change the stability of motion. The effect of most massive asteroids on dynamics of young compact asteroids clusters is different for different clusters. Moreover, it may be different for the members of the same cluster!
Influenced by Ceres and Vesta, resonant changes in semimajor axis in Lucascavin cluster are comparable with differences between members of cluster, the problem of age determination becomes very complex, much more complex, than for Emilkowalski and Brugmansia cases. Similar situation of strong chaos, induced by Ceres and Vesta, we have in Kap'bos family.

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