The dynamical evolution and the force model for asteroid (196256) 2003 EH1

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The dynamical research has shown that the asteroid 2003 EH1 is associated with one of the main annual meteor showers – the Quadrantids [1–3]. In this work we analyze influence of various perturbing factors on the asteroid motion, such as gravitational perturbations from all major planets, Pluto, the Moon, Ceres, Pallas, Vesta; the Earth, the Sun and Jupiter oblateness, the solar radiation pressure and the relativistic effects of the Sun. The perturbation's estimation was done by five different methods [4] based on the nominal orbit evolution and the size of the initial confidence region.

As an example, we describe briefly one of the methods. The orbital elements is improved using the full model *F* and model *F** without estimated perturbation. The comparison of the models *F* and *F** is made by means of the indicator

$$\varepsilon = \left|\hat{\mathbf{q}}^* - \hat{\mathbf{q}}\right| / \left|\bar{\mathbf{q}} - \hat{\mathbf{q}}\right| .$$

Here $\hat{\mathbf{q}}$ is the vector of the asteroid orbital parameters $\boldsymbol{q} = (q_1, ..., q_K)$, obtained by the least square method for the model *F*, and $\hat{\mathbf{q}}^*$ is the same, but for one of the *F**-models; $\bar{\mathbf{q}}$ is a point, which lies in the parametric space along direction ($\hat{\mathbf{q}}^* - \hat{\mathbf{q}}$) on the boundary surface of the asteroid's motion probability domain Φ_F (Fig. 1). Here perturbations can be classified in dependence of ε as strong ($\varepsilon > 1$), medium ($0.1 < \varepsilon < 1$) and weak ones ($\varepsilon < 0.1$).

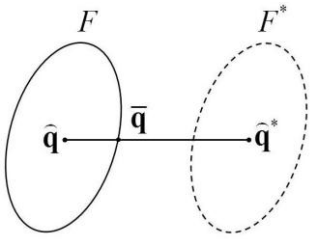

Fig 1 Confidence regions for complete (*F*) and incomplete (*F) force models.**

We calculated the mean exponential growth of nearby orbits *MEGNO* [5] and found that $MEGNO < 2$ only in the interval 1700–2300 (Fig. 2). This indicates that the orbit may be considered as regular on the time interval of ± 300 years from now, and as chaotic outside this interval.

Conclusions

We found that the period of the asteroid's motion predictability is about ± 300 years from now. The reason, as we suppose, is frequent close approaches of the asteroid with Jupiter (Fig. 2).

Now we continue the study and plan to classify perturbations according their strengths and research the chaos confidence regions by clones' integration.

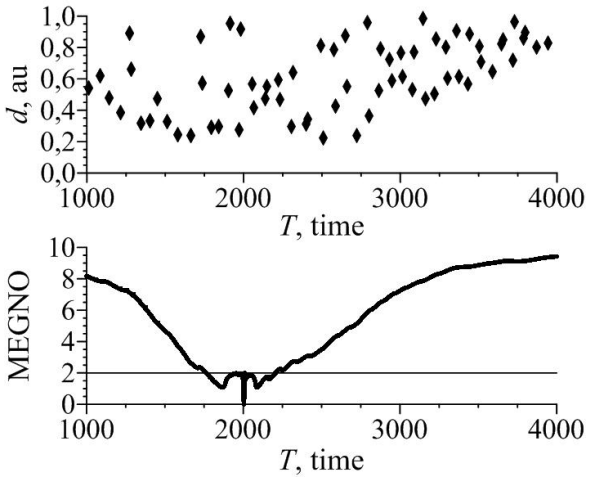

Fig 2 Close approach of asteroid 2003EH1 with Jupiter, d – distance between an object and Jupiter (top). Evolution of the parameter MEGNO for the nominal orbit (bottom).

Acknowledgments

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References

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