

Evolution of the Aphophis orbit and possible its using

Joseph J. Smulsky¹, Yaroslav J. Smulsky²

¹ Institute of Earth's Cryosphere of SB RAS (Tyumen)

² Institute of Thermophysics of SB PAS (Novosibirsk)

In a number of works, for example [1] etc., is shown, that asteroid Aphophis on April 13, 2029 will pass on distance of 38000 km from the centre of the Earth and because of essential change of the orbit the further prediction of its movement becomes impossible. However there is some probability of collision of it with the Earth in 2036. We have analyzed the publications and have established, that of uncertainty in the Aphophis trajectory are caused by imperfection of methods of its computing. By a new numerical method [2] we have integrated the differential equations of movement of Aphophis, planets, the Moon and the Sun and investigated evolution of its orbit. At April 13, 2029 the Aphophis will pass on distance $R_{min} = 38907$ km from the Earth centre and during 1000 year it will not passage so close.

The change of parameters of an orbit Aphophis was investigated on an interval -100 years \div +100 years from epoch of November 30.0, 2008. As it is visible from fig. 1, the eccentricity e of the Aphophis orbit changes non-uniformly. There are jumps or breaks of eccentricity. One of significant breaks is observed at the time $T_A = 20.369$ years from 30.11.08, i.e. in April 13, 2029, when Aphophis approaches with the Earth on smallest distance R_{min} . The second essential jump of eccentricity occurs at approach to the Earth at the time $T_B = 58.368$ years from 30.11.08 on distance of 622231 km.

The longitude Ω of ascending node is less subject to breaks. Other elements of an orbit i_e , ω_e and a have significant break at the time (T_A) of the closest passage of Aphophis at the Earth.

In Fig. 1 the dash line gives the orbit elements on the data JPL (USA). They coincide with orbit elements at time $T = 0$, received at integrating of the equations. It testifies the reliability of the executed calculations.

The moment of approach of Aphophis with the Earth of April 13, 2029 at 21 hours 45 '47' times on Greenwich and distance R_{min} , computed by us, coincides with results received in other works (see for example [1]).

Since such approach of Aphophis to the Earth will not be any more, therefore it is a happy case to transform asteroid Aphophis in the satellite of the Earth. It can be used for many targets, namely: as permanent orbital station, as the basis for the space lift, as "shuttle" for delivery of cargoes to the Moon and on the contrary.

We executed research on transformation of Aphophis in the satellite. It is necessary to reduce Aphophis velocity on 0.0008 km/c prior on 0.443 years to its ap-

proach to Earth, and at approach to the Earth it is necessary to diminish velocity by 3.5 km/c.

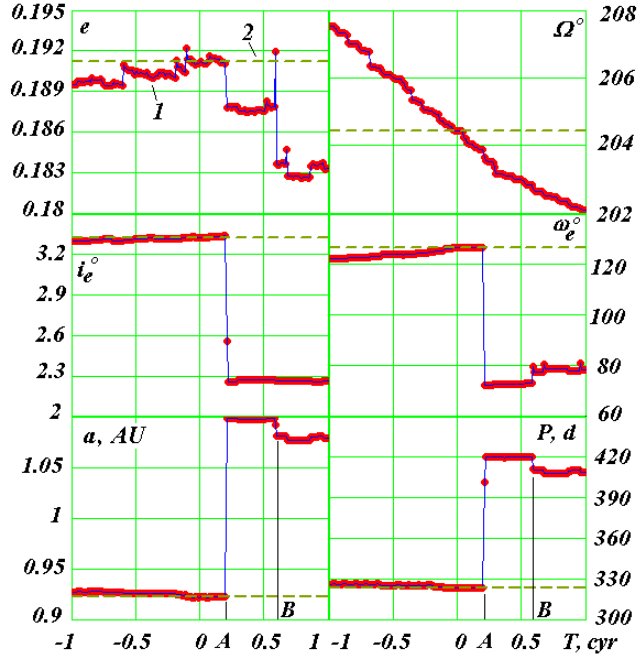


Fig. 1. Evolution of the Apophis orbit elements under influence of planets, Moon and Sun: 1 – by integrating of the movement equations; 2 – initial values. Angular parameters: Ω , i_e , ω_e are given in degrees, large semi-axes a – in A.U., and cycle time P – in days. T , cyr is time in sidereal centuries; A and B are the moments of time.

The diminishing of body velocity, which mass is 30 millions tones, by 3.5 km/c now represents a serious scientific and technical problem. But the experience of creation of the first artificial satellite of the Earth's testifies that if the society set itself enormous aim, it can be successfully realized within few decades.

List of references

1. *Georgini J.D., Benner L.A.M., Ostro S.I., Nolan H.C., Busch M.W.* Predicting the Earth encounters of (99942) Apophis // *Icarus*. 2008. V.193, P. 1 – 19.
2. *Smulsky J.J.* Optimization of Passive Orbit with the Use of Gravity Maneuver // *Cosmic Research*, 2008, Vol. 46, No. 5, pp. 456–464.
<http://www.ikz.ru/~smulski/Papers/COSR456.PDF>.