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ON A HAZARD MITIGATION PROBLEM FOR APOPHIS-EARTH POSSIBLE COLLISION IN 2036

Abstract

Forthcoming approaching of asteroid Apophis to Earth in 2029, which can lead to the Apophis-Earth collision with Earth in 2036 with a high enough impact energy, not only confirms the reality of the asteroid-comet hazard problem but also requires to perform scientific and technology analysis of the problem and to take some arrangements in mitigation of this hazard. Asteroid trajectory correction to deflect it from Earth and prevent this collision is studied in the Paper. Apophis' orbit is determined here by integration of the asteroid motion equations with taking into account the correcting effect.

Some impulsive correction strategies are studied. One-impulsive correction and two-impulsive one are analyzed. A correction that deflects the asteroid from Earth and directs it to Moon is considered, too. This impulsive correction could be implemented, e.g., by kinetic-impulse effect or nuclear one. Their characteristics are evaluated. These effects are convenient because of their quickness in realization and energy efficiency. But these methods do not make it possibly now to perform this correction exactly enough because of indefiniteness in some their factors.

In this respect, weak effects with slow change of asteroid's orbit are more convenient although they require a large enough duration for the correction. The Paper analyses characteristics of a weak gravity effect by a special spacecraft. In this method, the spacecraft is kept by a controlled jet thrust in a special space position near asteroid and gives a gravity perturbation to asteroid. This leads to a slow change of asteroid's orbit and deflecting the asteroid from Earth in 2036. The change of the perigee distance for Apophis' orbit in 2036 as well as the fuel consumption for controlled keeping the spacecraft relative to the asteroid are studied depending on the duration of the gravity effect, the spacecraft initial mass, its distance to asteroid, initial correction time, exhaust velocity of the spacecraft engines. The main attention is paid to a case of a small spacecraft with initial mass of about one thousand kg. Again, this correction before the Apophis-Earth approach in 2029 is essentially more effective than a correction after this approach. It is shown that this gravity effect, in principle, can be used to deflect asteroid from Earth using a small enough spacecraft if Apophis' updated orbit results in the collision with Earth in 2036.

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