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EFFECT OF EARTH-MOON PERTURBATION ON THE DEFLECTION OF TETHERED ASTEROID SYSTEMS

Abstract

In recent years, several celestial bodies with different shapes and sizes have been detected as they approach dangerously the Earth's orbit. The threat of an impact with our planet has encouraged many studies of Potentially Hazardous Asteroids (PHA). In the literature, one can find several techniques for the deflection of PHAs according to the available time to plan and execute the mission. In 2022, for example, NASA's DART mission plans to perform the first kinetic impact experiment of a spacecraft on the moon of a double asteroid system.

In this work, a previously studied deflection method is considered, which consists of a PHA connected to a smaller asteroid with a tether. The physical principle of the chosen technique is the displacement of the center of mass of the system. The dynamics of all bodies involved are assumed to be on the plane of the PHA, therefore asteroids Bennu and Itokawa were adopted for having low inclination orbit. The tethered system rotates with the angular velocity of the main body due to the constraint imposed by connecting the two bodies with a tether (rigid and negligible mass).

The focus of the present work is to analyze the influence of the Earth-Moon perturbation on the dynamics of the PHA-tether-asteroid system. It is expected that this effect becomes more evident in regions of orbital interaction between the planet and these rocky bodies. The effects of the gravitational perturbation caused by the interaction between the binary asteroid system and the Earth-Moon system is quantified as the difference between the perturbed and unperturbed positions of the PHA after a certain time, and also its minimum distance from the Earth.

The tether technique was adopted as a solution to avoid fragmentation debris that can be generated by the impact method, allowing to deflect the whole body without causing unpredictable consequences. In addition, another application would be to transfer these bodies closer to the Earth's orbit to explore them scientifically as well as commercially. In this regard, the ongoing Osiris-Rex mission plans to collect a small sample of asteroid Bennu, which can possibly provide important information about the origin of the Solar System.