DYNAMICS OF TETHERED BYNARY ASTEROID SYSTEMS.

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Introduction: Potential impacts of near-Earth objects are one of the biggest motivations to study and detect Near Earth Asteroids. Some NEAs are also considered potentially hazardous asteroids (PHA) according to their proximity to Earth and characteristics, like size and composition. As a consequence, several deflection techniques have been suggested in the literature for short and long warning time. In this work, the use of a tether is considered to connect two asteroids, so that the motion of the secondary asteroid could change the initial trajectory of the main asteroid. The methodology aims to transfer a PHA to a new safer orbit without fragmentation. The applications for this technique are especially important for planetary defense, but could also help in the scientific exploration of these objects.

Methodology: The concept of tethers, which are spatial cables, can have several applications, for example: space elevators, tether satellite systems, for debris removal, and the use of tethers for power and propulsion. Here, tethers are used for the deflection of asteroids by altering the trajectory of a threatening asteroid, without fragmenting it. It has been studied before the case of using tethers to connect the PHA to an artificial ballast mass on a planar motion, and it was shown that depending on the configuration of the system, the deflection could be possible [1], [2].

The current work examines a modification of the concept of tether-assisted asteroid diversion considering rather than carrying a ballast mass from the Earth, using a smaller asteroid as the ballast mass. This method may have advantages, such as the possibility to reduce the fuel consumption, compared to the usual tether-assisted asteroid diversion. Also there is a possibility that a bigger mass could be necessary for a faster deflection, and might not be feasible in case it had to be brought from the Earth.

Results: The equations of motion obtained consist of four coupled equations, which include the parameters for the tethered system in relation to the Sun, the rotation of the PHA, and also the pendular motion of the secondary asteroid in relation to the PHA. This configuration is shown in Figure 1. With these set of equations it is possible to make an analysis of the deviation of the trajectory of the PHA from its original orbit.

The level of deflection depends on conditions like the mass proportion of the asteroids, tether length, spin rate of the main asteroid. Since one of the major characteristics of asteroids is their non-spherical shape, the irregularity of the body should also be investigated. Characteristics like dimension, density, precise orbit, must be known in advance and can be obtained through ground observation using radar.

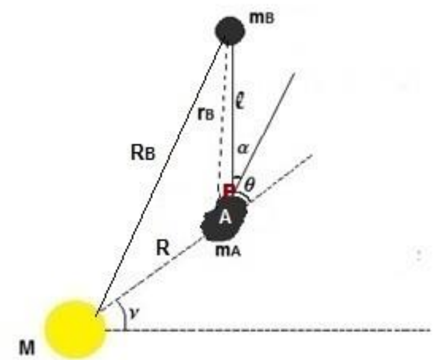

Figure 1: Configuration of two asteroids connected by a tether.

In this preliminary study a planar motion is considered, therefore only PHAs with very low inclination are studied. Another consideration is that the secondary asteroid is not spinning, and has a spherical shape. A rotating irregular shape for the secondary will be considered in further studies. The equations derived are used to obtain numerical results and analysed for different configurations for the system.

Besides the deflection of an asteroid on the collision path with Earth, the methodology could also be used to facilitate Near-Earth object accessibility in future space missions.

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