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DEFLECTION OF A BINARY ASTEROID SYSTEM USING TETHERS

Abstract

In the solar system there are millions of asteroids. The large majority are located between the orbits of Mars and Jupiter, but there are many asteroids close to the Earth. The Near- Earth Objects (NEOs), are objects with perihelion below 1.3AU, including comets and asteroids. The NEOs are considered to have orbits passing close to the Earth's orbit and, in the case of asteroids, are called Near-Earth Asteroids (NEAs). Among the NEAs there are bodies that are considered potentially hazardous asteroids (PHAs), whose minimum orbit intersection distance with the Earth is 0.05AU and absolute magnitude (H) of 22, which would mean an asteroid of at least 110-240 meters, depending on its albedo. There have been many proposals to deflect the path of the PHAs so as to prevent them from colliding with the Earth. One of the potential methods is to connect a tether and ballast mass to the PHA. It has been shown in the literature that by a judicious choice of the length of the tether and ballast mass, sufficient deflection of the path of the PHA can be obtained. It has also been shown that this deflection can be increased by cutting the tether at an appropriate time. The current paper examines a novel modification of the concept of tether-assisted asteroid diversion. Rather than carrying a ballast mass from the Earth, this paper proposes to use another asteroid, a smaller one, as the ballast mass. The smaller asteroid will be brought closer to the PHA and will then be connected to it by a tether. The PHA's path can then be diverted. This method may have certain advantages, such as lower overall fuel consumption, compared to the usual tether-assisted asteroid diversion.

The paper develops a mathematical model for the dynamics of a binary asteroid system connected by a tether. The model is then used to study the motion of the larger asteroid (PHA). One of the major characteristics of the asteroids is their irregular shape. The gravitational field of a rotating irregular body is very different from that of a spherical body. This complexity of the gravitational field is taken into account in the dynamical model. As a starting point, motion only in the plane of the orbit of the PHA around the Sun is considered in the paper. The equations of motion are integrated numerically. Simulation results show that the concept has some practical merit.