ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (3)

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DYNAMICS OF TETHERED BINARY ASTEROID SYSTEMS

Abstract

Near-Earth asteroids (NEAs) are a population of asteroids which approach Earth. The Earth-like orbits of some NEAs make them accessible for spacecraft with a moderate amount of propellant and thus at a relatively low cost. As of 1 May 2007, 4619 NEAs have been discovered, including 712 objects with an estimated diameter of 1 km or larger. Binary asteroids make up an estimated 16 percent of NEAs larger than 0.3 km as indicated from photometric studies. Studies have also suggested that half of the fast-rotating NEAs are binaries. Another group of NEAs are the Potentially Hazardous Asteroids (PHAs), which approach Earth's orbit to within 0.05 AU and have diameters above 150 m. As of the year 2007, 869 PHAs are known. The authors have proposed a way to effectively divert asteroids and other threatening objects from impacting Earth by attaching a long tether and ballast to the incoming object. By attaching a ballast to an asteroid, the asteroid's center of mass and orbit are changed. The desired effect is to prevent an Earth-asteroid collision. Since this method of diversion requires a ballast mass, a particularly attractive target for application of the method is a binary asteroid system. Some important properties of asynchronous binary NEAs are summarized below. It is estimated from photometric surveys that 15 +/- 4 percent of NEAs larger than 0.3 km are binary systems with a secondary-to-primary mean diameter ratio Ds/Dp greater than 0.18. They found that the concentration of binaries with Ds /Dp is particularly high among NEAs smaller than 2 km in diameter, and that the abundance of such binaries decreases significantly among larger NEAs. Secondaries are said to show an upper size limit of Ds = 0.5-1 km. This paper presents a dynamic model of tethered binary asteroid systems, and examines the effectiveness of using such an approach on changing the trajectory of binary asteroid systems for the purpose of diverting them from impacting the Earth.