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LONG-TERM ASTEROID MITIGATION VIA THE YARKOVSKY EFFECT

Abstract

For some potentially hazardous Near Earth Asteroids, it might be desirable to implement a "slow push" mitigation technique that is capable of altering the NEA orbit continuously and permanently. This possibility was suggested in earlier work that outlined an archetypal exploration/mitigation mission to the NEA 99942 Apophis. In this scheme, long term mitigation is achieved using a novel albedo change approach. This paper describes the details of the albedo modification technique and apparatus. To continually alter the orbit of Apophis (or similar NEAs) over an extended period, and eventually eliminate the threat of impact altogether, we propose to alter the NEA albedo to either diminish or enhance the Yarkovsky effect. Detailed calculations show that within reasonable bounds for the absorptivity and mass, and depending upon the spin state, a 5At present, the albedo change mechanism that appears the simplest and most effective involves a device that dispenses, in a controlled fashion, ionized powder onto Apophis' surface – which is itself ionized by ultraviolet radiation. Electrostatic attraction provides the dominant force that will distribute and bind the powder to the surface. The albedo change dispenser described here is based upon triboelectric powder dispensing technology and contains two supply canisters containing either very high or very low albedo powders. Either one or the other will be used, depending on the albedo/thermal emission data and the tracking/orbit prediction data collected during the exploration phase of the mission. We describe the design details and the constraints on particle size (to prevent electrostatic levitation and escape) and dispensing speed (to achieve the desired coverage zone and prevent particles from orbiting or escaping). A LEO flight test is planned to validate the tribodispensor technology on orbit. Besides analysis of the dispenser operation, we present ground-based experiments and detailed simulations of a possible asteroid deflection scenario.