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# EFFECTS OF MOMENTUM TRANSFER DEFLECTION EFFORTS ON SMALL BODY ROTATIONAL STATE

**Abstract**

The danger of a small body collision with Earth has been described, researched and discussed in scientific and decision making forums since the beginning of the space age. Both asteroids and comets are pointed out at as members of the Near-Earth Object (NEO) population that might threaten Earth. The vast majority of this population being asteroids who's orbits are completely within the orbits of the four terrestrial planets. Many deflection techniques have been proposed and researched; including: nuclear device detonation on or near asteroid surfaces, kinetic interception with high relative velocities, gravity tractors, landers with active (thrusters) or passive (solar sails) propulsion systems, and surface ablation high energy beams. Methods that seek to slightly perturb the Potentially Hazardous Object (PHO) from its Earth collision orbit by introducing momentum into the system, either with a single event or with continuous or semi-continuous efforts. The single event, direct momentum transfer methods of nuclear detonation and kinetic interception are currently at the highest technology readiness levels. The Deep Impact mission has shown the capability of accurately hitting a small body, comet Tempel 1. And The Asteroid Impact and Deflection Assessment (AIDA) mission is planned to perform a kinetic interception demonstration of the secondary body in the (65803) Didymos system during the 2020s. The momentum transfer in these methods is intended to be linear, affecting the PHO's orbital momentum. However, an almost inevitable byproduct is the introduction of angular momentum to the PHO's rotational state. This torquing side-effect would be the result of a moment arm between the body's center of mass and surface impact area, either due to unintentional targeting discrepancies or due to operational requirements. The ejection of material off the surface would also change the body's mass distribution which would, in turn, affect its rotational state as well. This paper investigates the effects momentum transfer deflection has on a small body's rotational state. The angular momentum change applied is quantified for different deflection scenarios based on PHO shape, size, orbit, time to Earth collision, and surface impact location. The rotational state is then propagated, accounting for the expected ejecta and debris return for each deflection effort. The new rotation regime's effects on surface geopotential and surface stability is examined to account for possible destructive disruption of the PHO structure. Additionally, the long term effects on asteroid orbits due to the Yarkovsky effect are examined to promise the deflection is not nullified.