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The Effect of Surface Ejecta due to Ion Beam Impingement for an Asteroid Redirection Mission

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ABSTRACT

Ion beam deflection (IBD) is a conceptual method for redirection of asteroids which may be on a collision course with Earth. In this method, a solar-electric powered (SEP) plasma thruster is pointed at the asteroid surface and operated for up to thousands of hours, eventually imparting enough momentum such that the asteroid orbit is altered in a way that it no longer presents a threat to Earth. Previous studies of this concept have identified that the spacecraft must be at some minimum stand-off distance such that the thrust imparted to the asteroid is far greater than the gravitational attraction imparted on the spacecraft. However, a complication for this method could occur if particles ejected from the surface of the asteroid impinge upon the spacecraft. If particles do indeed stream back toward the spacecraft, they may build up on the solar arrays which the spacecraft relies on to operate the plasma thrusters. This would result in degradation of the solar electric power, and ultimately could lead to failure of the mission to achieve the desired consequences. Therefore, this study aims to understand whether ion beam induced asteroid ejecta could deposit sufficient material on the spacecraft solar arrays to diminish or altogether eliminate the ability of the spacecraft to accomplish the objective of asteroid redirection.

To accomplish this analysis, we use SPHERAL, a smoothed-particle hydrodynamics code, to estimate backflow from a simplified surface with a particle size distribution representative of a theoretical asteroid environment. We account for the spacecraft solar arrays by assuming an area necessary to power an IBD mission architecture. Then, we track all particles which impinge upon the solar arrays during a time scale typical particles streaming from the asteroid surface. By extrapolating this over a period of years, we then estimate the amount of asteroid material which contaminates the solar arrays, and the effect that this has on the spacecraft operating power.

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