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Momentum enhancement for the DART projectile impact

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We study kinetic impacts of a spacecraft as an option to deflect sub kilometer sized potentially hazardous asteroids that may collide with Earth. Near-Earth asteroids of this size – diameters in the order of 100 m – are difficult to observe and at the same time are believed to be very common and to consist of a wide variety of materials with varying bulk densities. The momentum delivered by such an impact of a spacecraft may alter the asteroid's orbit and henceforth avoid an impact with our home world. In addition to a direct transfer of momentum from the projectile to the target, a kinetic impact will also involve post-impact effects caused by material ejected from the impact site. This will result in a momentum transfer efficiency beta > 1 which is only weakly constrained. Thriving for constraining this beta factor, we investigate the impact of a spacecraft onto an asteroid similar in size to the secondary body of the binary near-Earth asteroid (65803) Didymos. The configuration is chosen to resemble NASA's Double Asteroid Redirection Test (DART) and ESA's Hera mission concepts. We present results from simulations with our own 3D smooth particle hydrodynamics (SPH) hypervelocity impact code assuming a rocky target of 160 m diameter and varying porosity between 0% and 75% which is hit at angles of 0 deg (head-on) and 45 deg. The assumed projectile mass and velocity are 500 kg and 6 km/s, respectively. Depending on the impact angle and assumed target porosity, we find beta factors between 1.15 and 1.93, which is compatible with results obtained by others using various methods.