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Required deflection impulses as a function of time before impact for Earth-impacting asteroids

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ABSTRACT

The Large Synoptic Survey Telescope (LSST) will increase the number of known near-Earth asteroids (NEAs) by more than an order of magnitude (Ivezic et al., 2008, Jones et al., 2018). These ~100,000 newly discovered NEAs will include those on potentially Earth-impacting orbits. For any asteroid on an impact trajectory, the amount of time prior to impact a deflection can be implemented can drastically change the amount of deflection impulse required.

In this study we use the precision cloud-based asteroid orbit propagation and targeting capability of the B612 Asteroid Institute's Asteroid Decision and Analysis Mapping platform (ADAM) to investigate the distribution of deflection delta-v required to divert asteroids on Earth impact trajectories as a function of time prior to impact for 10,000 virtual impacting asteroids. We calculate the distribution of deflection delta-v required if applied 10, 20, 30, 40, and 50 years prior to impact.

In initial studies, we found a fraction of impacting asteroids are significantly easier to deflect than the mean, with >10 times less velocity impulse required; the fraction increases as the time before impact rises. A portion of these easily-deflected asteroids are found to have intervening close approaches with a planet prior to Earth impact, which substantially reduces the delta-v deflection requirement. While these represent a small fraction of asteroid impact cases, we expect them to be over-represented among the difficult deflection decision cases because they are also the asteroids that are observationally most difficult to rule out as impact threats.

The initial study, which used desktop software to calculate the deflection delta-v for all 10,000 asteroids, took several months to complete. ADAM, which operates using Google Compute Engine, allows us to get targeting results for all 10,000 asteroids in <24 hours. This allows us to both perform the calculations much faster and to study the required deflection delta-v as a function of time prior to impact. The tools developed in ADAM will eventually be open to the public for precision studies of asteroid deflection scenarios.

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