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The Distribution of Required Deflection Impulses as a Function of Time Before Impact for Earth Impacting Asteroids

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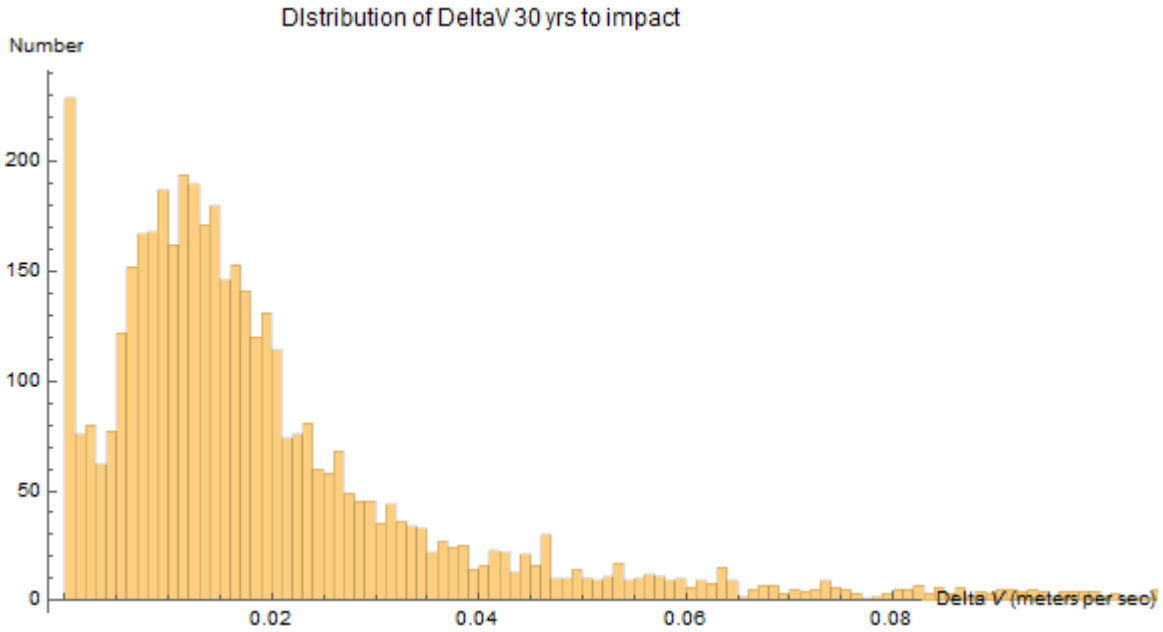
ABSTRACT

We have built a precision cloud based asteroid orbit propagation and targeting capability that enables investigations of planetary defense questions requiring large computational resources. We use this to investigate the distribution of deflection ΔV required to deflect asteroids from hitting Earth as a function of time before impact. Starting from a population of 10000 virtual impacting asteroids (from Veres et al), we calculate at various times before impact the impulsive ΔV required to cause them to miss the Earth by a distance of 10 Earth radii. We find a significant fraction of impacting asteroids are significantly easier to deflect than the mean, with more than an order of magnitude less velocity impulse required. An example distribution of required deflections at 30 years prior to impact is shown below.



At larger times before impact, the fraction of these easily deflected asteroids increases. These easily deflected asteroids are found to have intervening close approaches with a planet (usually the Earth itself) prior to Earth impact which substantially reduces the impulsive deflection requirement (the real asteroid Apophis is a good example of such a case). At 30 years prior to impact, 5% of the impactors had a close approach (within a Hill radius) of a planet prior to impact. While these represent a small fraction of asteroid impact cases, we expect them to be overrepresented among the difficult deflection decision cases because they are also the asteroids which are observationally most difficult to rule out as impact threats. Our real world asteroid impact deflection scenario decisions are likely to be dominated by such cases.

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