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# NEOSHIELD: THE FATE OF EJECTA FROM A KINETIC IMPACTOR STRIKE ON A NEAR-EARTH OBJECT

**Stephen R. Schwartz**(1)**, Yang Yu**(2)**, Patrick Michel**(3)**, Martin Jutzi**(4)**, and Derek C. Richardson**(5)

(1)(2)(3) *Laboratoire Lagrange, University of Nice Sophia Antipolis, CNRS, Observatoire de la Côte d'Azur, C.S. 34229, 06304 Nice Cedex 4, France, +33 04 92 00 31 56,*

(4) *University of Bern, Bern, Switzerland, +41 31 631 85 49,*

(5) *Department of Astronomy, University of Maryland, College Park, MD 20742-2421, United States, +1-301-405-8786,*

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## ABSTRACT

NEOShield is a European-funded project to address near-Earth object (NEO) impact hazard mitigation issues. Its work plan consists of scientific investigations into the nature of the impact hazard and the physical properties of NEOs, as well as technical and engineering studies of practical approaches to deflect NEOs. Along similar lines, AIDA is a joint NASA-ESA mission in Phase A/B1 study comprising the NASA Double Asteroid Redirection Test (DART) mission, which is to act as a test of our ability to deflect an asteroid using a kinetic impactor, and the ESA Asteroid Impact Monitor (AIM) rendezvous mission, an oberver spacecraft that would characterize the target and the impact outcome. In light of the potential observational and mechanical effects of lingering dust and debris, information about the ejecta produced by such an impact is particularly important for the mission profile of an observer satellite, such as AIM.

We thus define a set of procedures to assess numerically ejecta fates in the framework of hypervelocity kinetic impactors. The numerical approaches we explore are varied, allowing for comparisons between our methodologies. We use the *N*-Body code `pkdgrav` (Stadel, 2001, *Ph.D. thesis*, U. of Washington; Richardson et al.,

2000, *Icarus* 143, 45) outfitted with a soft-sphere collisional routine (Schwartz et al., 2012, *Granul. Matter* 14, 363) to perform the bulk of the numerical work. Ultimately, we will construct a database outlining the effects of different impact conditions and gravitational environments on the ejecta outcome. These results may be used in space mission studies to examine the fate of certain-sized ejected grain fragments and regolith based on impact conditions in order to assess the risks posed to the spacecraft and the expected momentum transfer efficiency to the asteroid target.

In order to generate an ejecta field, the late-stages of the impact phase must be solved; we do so in three different ways and compare the results: by using a hydrocode to compute the impact outcome (Jutzi & Michel, 2014, *Icarus* 229, 247), solving for the initial ejecta positions and velocities using known scaling laws (Housen & Holsapple, 2011, *Icarus* 211, 856; Fig. 1), and by using an *N*-Body approach to compute the impact (Schwartz et al., 2014, *Planet. Space Sci.* 103, 174) as well as the resulting ejecta field. Each approach has its own unique strengths and limitations, which will be addressed.

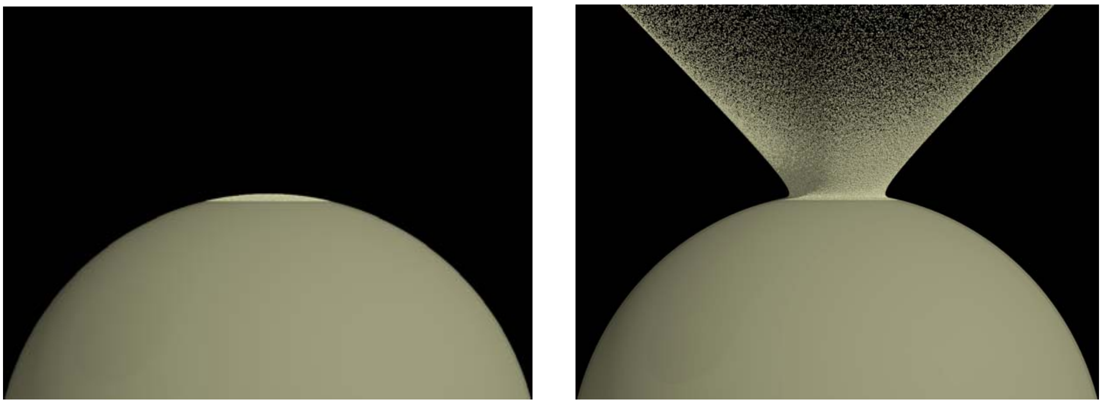

Fig. 1. The start (left frame) of an *N*-body simulation using ejecta particle velocities solved for with scaling laws from Housen & Holsapple (2011): a bowl of 641,586 particles representing a portion of the surface of an asteroid that suffers a kinetic impactor strike is embedded into the surface of a sphere that represents the entire asteroid; the particles are then ejected (right frame).

Between the European Commission-funded NEOShield consortium (EC-FP7, #282703) and the AIDA concept study, approved by both ESA and NASA, there exists great international interest in performing a deflection study. Results will be shown in the context of an impact into the secondary of a binary system (AIDA), and in the context of an impact into a single asteroid (NEOShield).

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