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**Kinetic impactor technique: Benchmark and Validation Studies with iSALE and SPH**

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***Keywords:*** *DART, Hera, asteroid deflection, numerical simulations, impact cratering*

##### ABSTRACT

NASA's Double Asteroid Redirection Test (DART) will impact the secondary of the 65803 Didymos system, Dimorphos, in October 2022. The impact will cause a measurable change in the orbital period of the binary. ESA's Hera mission will arrive at the Didymos system several years after the DART impact and will characterise the binary system in detail, particularly the small moon and the crater produced by DART on its surface.

The aim of this work, which was generated in the context of the NEO-MAPP project, is to model the collision of the DART kinetic impactor with Dimorphos and to provide quantitative and reliable predictions regarding the outcome of the impact with respect to parameters that are measurable by spaceborne and in-situ instrumentation provided by the Hera mission. Here we present a series of systematic benchmark studies and validation tests against laboratory experiments purposely designed to detect, assess and remove deviations between two different numerical schemes, iSALE (in 2D and 3D) and Bern SPH.

iSALE-2D/-3D [1, 2] is a grid-based arbitrary Eulerian and/or Lagrangian (ALE) code and is best suited to study the crater formation and the propagation of shock wave from a high velocity impact. On the other hand, Bern's grid-free Smooth Particle Hydrodynamics (SPH) [3, 4] is most appropriate to study the ejection of material and processes where the entire target body is involved.

In order to improve the reliability of results from numerical modelling, accurate validation tests against laboratory experiments are required. Here, we present first results of a new validation study that extends the range of tested target materials to glass beads and regolith simulant (i.e., smaller or larger coefficient of friction, respectively, and larger cohesion for regolith simulant), and compare against results from a recent laboratory study [5].

Despite the fact that all codes in principle solve similar forms of conservation equations and use similar constitutive models, different numerical schemes tend to produce more or less varying results. The first benchmark study focuses on the influence of target porosity on the efficiency of the momentum transfer from the DART impact, β. In iSALE the porosity compaction behaviour of the target material is modelled using the ε-α model, while SPH uses the P-α model. The second benchmark study focuses on the influence of the impact angle on β.

Our joint modelling and experimental approach to study the efficiency of a kinetic impactor to deflect an asteroid shows that there is generally a good agreement between different numerical approaches and experimental work on estimating crater size and ejection parameters. The benchmark studies show that the grid based iSALE (-2D/-3D) and the meshless SPH produce similar results when similar impact conditions are considered. In a next step, we will investigate in depth small deviations between different modelling schemes and, in particular, effects of internal heterogeneities, and global consequences on the entire impacted asteroid.

**Acknowledgements:** This work has received funding from the European Union’s Horizon 2020 research and innovation programme, NEO-MAPP, grant agreement No. 870377.

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