Impact Experiments in Support of the DART Planetary Defense Mission

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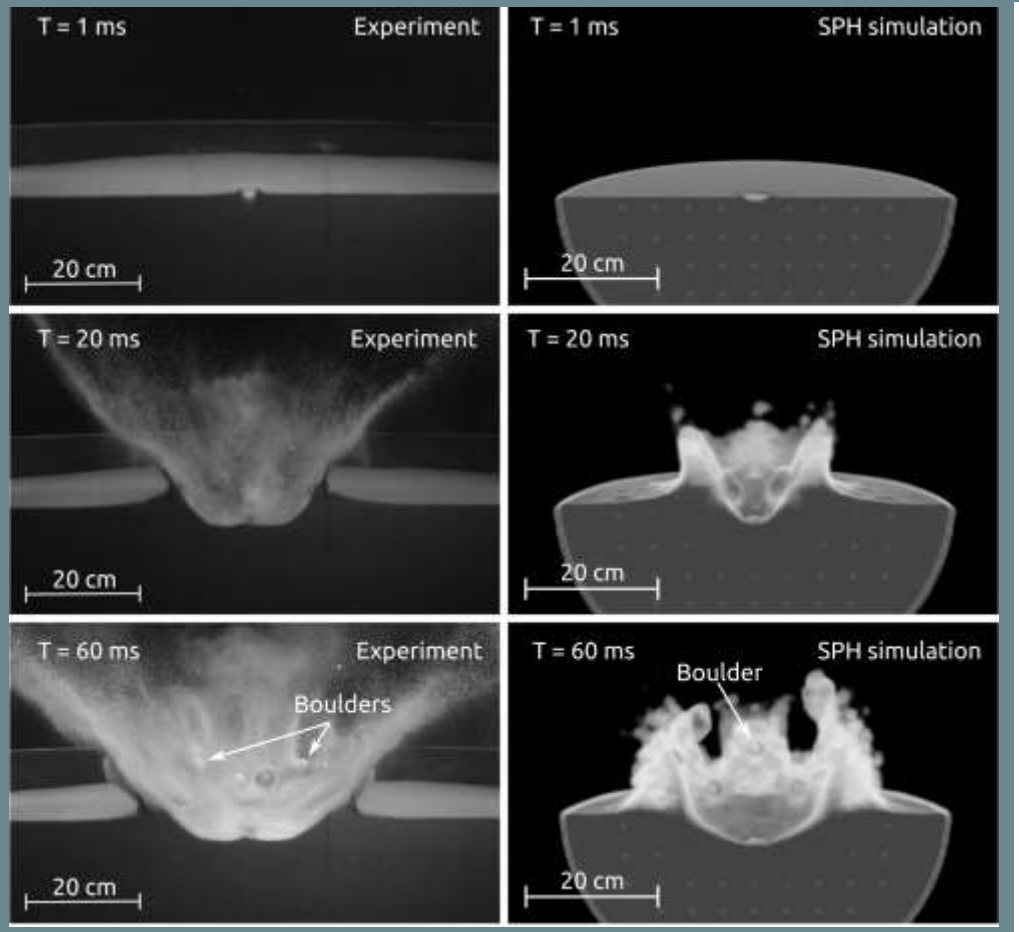

Ormö J., Raducan S.D., Jutzi M., Herreros M.I., Luther R., Collins G.S., Wünnemann K., Mora-Rueda M., Hamann C., 2022: "Boulder exhumation and segregation by impacts on rubble-pile asteroids". Earth and Planetary Science Letters, Vol. 594, Doi: 10.1016/j.epsl.2022.117713

NASA's Double Asteroid Redirection Test (DART) will impact the surface of Dimorphos (the secondary of the 65803 Didymos asteroid system) on the 26th of September 2022. It will demonstrate the controlled deflection capabilities of near-Earth asteroids by a kinetic impactor.

The kinetic impact efficiency (i.e., momentum transfer) depends strongly on the target properties and structure. The understanding thereof is imperative for a successful interpretation of the DART impact outcome. Most previous impact experiments and subsequent validation work of numerical models have focused on homogeneous targets. However, asteroids smaller than about 50 km in diameter are often considered to be rubble-pile objects, i.e. aggregates held together only by self-gravity or small cohesive forces, and have highly heterogeneous surfaces.

With the use of the Experimental Projectile Impact Chamber (EPIC) at Centro de Astrobiología CSIC-INTA and advanced 3D numerical simulation we studied impacts into granular ("rubble-pile") targets with embedded porous, spherical boulders for their effect on the cratering process, final crater morphology, boulder emplacement, and ejecta distribution. We showed that crater diameters are only slightly affected by heterogeneities as long as the energy required for crushing is small compared to impact energy. However, less mass is ejected at higher velocities from the rubble-pile target compared to homogeneous targets, which reduces the momentum enhancement. This has important implications for DART and the deflection of future Earth-threatening asteroids.