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PROBING A LABORATORY ASTEROID MODEL: MECHANICAL CHARACTERIZATION UNDER LOADING-UNLOADING CYCLES

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This study examines the mechanical properties of asteroids on a laboratory scale, focusing on their relevance in space mission design, Earth collision hazard assessment, and understanding collisional processes. Following the NASA-DART mission, the effectiveness of deflection relies on factors like cratering events, momentum distribution in ejecta, and the propagation of impact-induced seismic waves within asteroids.

Our comprehensive laboratory-scale characterization of granular media in dynamic regimes offers a cost-effective alternative to in-situ measurements. Scaling experiments by approximately 300-fold simulates a Dimorphos-sized asteroid, revealing particle sizes of 5 to 50 cm as observed on the mission. Micro-gravity conditions on asteroids yield unique mechanical properties challenging to replicate on Earth. While non-realistic, our experiments aid in understanding seismic wave propagation's role in material expulsion within asteroids, contributing to the comprehension of active asteroids and enhancing our knowledge of asteroid interiors and boulder distribution.

We observe pressure waves with frequencies ranging from 200 to 500 Hz. Independently of the granular media, glass beads (artificial, spherical), sand (natural, irregular), and gravel (natural, irregular), the wavespeed follows a power-law relationship $v \propto p^{1/2}$, and indicates that the speed of seismic body waves is independent of the origin mechanism, suggesting safer wave-generating methods for low-gravity experiments instead of risky impact devices.

The equivalence between wave propagation from impacts and shaker-born perturbations is valuable for non-impacted testing to assess granular material properties in low-gravity conditions. With the upcoming Hera mission to the Didymos-Dimorphos system in 2027, aiming to study internal asteroid structure, our research lays a foundation for a deeper understanding of asteroid interiors and boulder distribution.