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Direct observation of impact propagation and absorption in dense colloidal monolayers

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Dense colloidal suspensions can propagate and absorb large mechanical stresses, including impacts and shocks. The wave transport stems from the delicate interplay between the spatial arrangement of the structural units and solvent-mediated effects. For dynamic microscopic systems, elastic deformations of the colloids are usually disregarded due to the damping imposed by the surrounding fluid. Here, we study the propagation of localized mechanical pulses in aqueous monolayers of micron-sized particles of controlled microstructure. We generate extreme localized deformation rates by exciting a target particle via pulsed-laser ablation and we track the displacements of all the particles using a high speed camera. In crystalline monolayers, stress propagation fronts take place, where fast-moving particles (V approximately a few meters per second) are aligned along the symmetry axes of the lattice. Conversely, more viscous solvents and disordered structures lead to faster and isotropic energy absorption. Our results demonstrate the accessibility of a regime where elastic collisions also become relevant for suspensions of microscopic particles, behaving as "billiard balls" in a liquid, in analogy with regular packings of macroscopic spheres. We furthermore quantify the scattering of an impact as a function of the local structural disorder.