# Study of wave propagation in aqueous close-packed colloidal monolayers using laser based excitation

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Wave propagation in 2D granular crystals composed of macroscopic elastically interacting spheres has been extensively studied in recent years. The rich 2D crystal configuration space provides numerous possibilities to engineer promising applications, including sound absorption, energy transfer control and redirection [1-2].

In this work, we investigate the wave propagation in 2D colloidal systems composed of micro-scale particles. Colloidal particles, i.e., micro- and nanoparticles with a size between a few nm and a few µm, are successfully used as “big atoms” to mimic the behaviour of complex atomic and molecular materials [3]. In contrast to atomic systems structures composed of microparticles show large deformations under moderate stresses and can be directly observed by means of standard optical microscopy.

Using laser-based non-contact excitation, we study the wave and stress propagation through 2D-colloidal monolayers immersed in a fluid as a function of the excitation energy, liquid viscosity, packing structure and inter-particle potential.

The laser excitation system is based on the technique of pulsed laser ablation [4]. A high energy laser pulse is shined onto the surface of metal-coated microparticles (7.38 µm diameter) to induce micro-explosions and propel the particles forward with velocities of the order of few m/s. A small number of coated particles are then placed inside an aqueous colloidal monolayer of close-packed uncoated micro-beads and act as strikers. The collisions of the striker particles with the surrounding monolayer lead to the propagation of localized waves. Tuning the energy of the excitation laser pulses allows for control on the momentum transfer to the striker particles. We vary the structure of the monolayer (from crystalline to fully disordered) and the inter-particle potential (from Herzian contact to attractive interactions) to study the effects on the propagation and branching of the force chains. We also address the role of the surrounding liquid using aqueous solutions with increasing viscosity. The response of the system is monitored with a high-speed microphotography system at 300 kfps and results are compared with computer simulations.

Our observations reveal that stress waves travel mostly throughout crystallographic directions; defects and local disordered structures annihilate the wave propagation within very short distances. Ultimately, we find that the properties of the dispersion medium, i.e., the surrounding liquid, play a key role in the momentum transfer.

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