Kinetic energy spectra in a vibrated 2D granular medium with magnetic dipolar interactions.

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Using a 2D out-of-equilibrium system of magnetized and vibrated granular particles, a transition from a granular gas towards a hexagonal crystal has been reported, when magnetic field is increased at constant agitation [1]. By extracting the longitudinal and transverse current correlations in dynamical regime, the spectrum of excitations can be measured in the Fourier space to characterize how kinetic energy is distributed through the scales. In the granular phase, we show that energy transfers between particles are mediated by compression longitudinal waves. In contrast, in the hexagonal solid phase, energy transfers occur by the macroscopic equivalent of phonons, whose dispersion relations for longitudinal and transverse waves can be analytically computed. Moreover, for the granular gas phase, we quantify the out-of-equilibrium character. The fluctuating hydrodynamic theory [2] explains indeed well the deviation from energy equipartition due to dissipative collisions. A moderate increase of magnetic field, induces a repulsion between particles. The rate of collision is thus reduced and the distance to thermal equilibrium is decreased.

[1] S. Merminod, M. Berhanu & E. Falcon, Transition from a dissipative to a quasi-elastic system of particles with tunable repulsive interactions, *EPL*, **106** 44005 (2014).
[2] A. Puglisi, A. Gnoli, G. Gradenigo, A. Sarracino & D. Villamaina, Structure factors in granular experiments with homogeneous fluidization, *J. of Chem. Phys.*, **136** 014704 (2012).

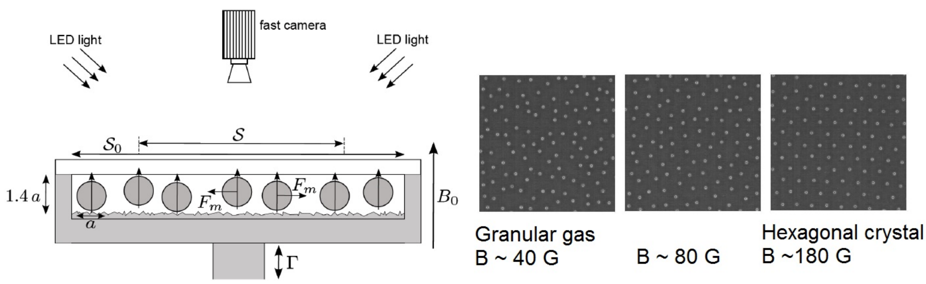

Figure 1: Left, Experimental setup. 2000 soft magnetic spheres =of diameter $a = 1\,\mathrm{mm}$ are confined in a square cell ($9 \times 9\,\mathrm{cm}$). Right, Snapshots of the experiment for various values of imposed magnetic field B for a constant agitation.