An itinerant oscillator model with cage inertia for an intruder in granular liquid experiments

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Recent experiments with a rotating probe immersed in weakly fuidized granular materials show a complex behavior on a wide range of timescales [1] (see fig 1). Viscous-like relaxation at high frequency is accompanied by an almost harmonic dynamical trapping at intermediate times, with possibly anomalous long time behavior in the form of super-diffusion. Inspired by the Itinerant Oscillator model for diffusion in molecular liquids, and other models with coupled thermostats acting at different timescales, here we discuss a new model able to account for fast viscous relaxation, dynamical trapping and super-diffusion at long times. The main difference with respect to liquids, is a non-negligible cage inertia for the surrounding (granular) fluid, which allows it to sustain a slow but persistent motion for long times. The computed velocity power density spectra and mean-squared displacement qualitatively reproduce the experimental findings. We also discuss the linear response to external perturbations and the tail of the distribution of persistency time, which is associated with superdiffusion, and whose cut-off is determined by cage inertia [2] .

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[2] A. Lasanta, A. Puglisi, J. Chem. Phys. **143**, 064511 (2015).