Particle diffusion in the bulk of slow granular flows

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Granular flows have been successfully modeled by the inertial number theory [1]. This mean field model provides insight into which timescale sets the flow dynamics for granular flows. However, there are several shortcomings to this model; for example, it fails at describing slow granular flows. Indeed, there is as yet very little insight in the microscopics of slow granular flows.

Here we report on direct measurements of microscopic particle dynamics in the bulk of a slow, dense granular flow. To image the bulk of the granular flow, we use an index matched scanning technique [2]. We measure the trajectories and diffusion of all particles for a wide range of strain rates in a split bottom cell. This setup has been shown to provide smooth and continuous shear bands [3, 4]. Crucially, we can probe the dependence of the particle diffusion on the local pressure. With dimensional analysis, we explicit the family of timescales associated with particle dynamics. We show that in order to capture the diffusive particle behavior within the bulk, one needs the local inertial number, but also a new dimensionless number that we call the layer number [5].

References

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