*Track 1: *

We are interested in dense, slow granular flows. In this flow regime, the grains maintain substantial long-term contacts, but the system still flows and its properties fluctuate. The fluctuations in velocities, stresses, contact networks, and other important quantities can be quite large on both laboratory and practical scales. These fluctuations can occur intermittently and over a wide range of lengthscales. Also, fluctuations can strongly influence the mechanical and flow properties of these systems. Our current inability to make quantitative predictions about fluctuations in this flow regime is an important unsolved problem that hampers the design and performance of a host of granular materials handling and processing devices.

The dissipative and athermal character of granular interactions makes it difficult to develop theoretical descriptions of these systems. For example, it is becoming increasingly clear that dense granular flows may not be adequately modeled using kinetic theories that describe energy fluctuations solely in terms of velocity fluctuations or the granular kinetic temperature. In contrast, such kinetic theories are on firmer footing and describe experimental data reasonably well in the dilute flow regime.

In this posting, we want to suggest a different approach that might provide a better understanding of fluctuations in dense granular flows. This idea is borrowed from statistical descriptions of equilibrium systems (i.e. systems without dissipation, friction, and flow). In equilibrium systems, the size of fluctuations is proportional to the linear response of the system to a small perturbation. For example, pressure fluctuations in a gas are proportional to its response to a change in density (i.e. its compressibility). This relation between the response of the system and its fluctuations has been extended to some nonequilibrium situations, but the extension to a realistic granular system has not been worked out. Therefore, we have been designing situations in which we can measure by experiment and by simulation response functions in granular materials. Much can be learned from the response functions themselves and in addition we can attempt to relate the response to fluctuations with the hope of predicting the magnitude of the fluctuations. There have been several preliminary studies in this direction [1,2], but much more work needs to be done.

[1] N. Xu and C. S. O'Hern, Effective temperature in athermal systems sheared at fixed normal load, PRL 94 (2005) 055701

[2] K. Feitosa, Menon, N., A fluidized granular medium as an instance of the fluctuation theorem, Phys. Rev. Lett. 92, 164301 (2004)

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