Bridging the gap between particulate systems and continuum theory

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1 Background

Project description

Particle simulations can now correctly predict grains behavior in a wide range of circumstances, but are mainly limited to spherical geometries, or/and to a low number of particles. Moreover, several continuum equations that describe granular flows have been proposed, but fail to accurately predict the behavior for a wide range of densities and geometries. This project focuses on establishing a connection between both approaches by carefully studying a particular system and its phase transitions, with the goal comparing micro and macro dynamics.

Two main aspects motivate this research: the development and comparison of a set of simulation tools, both microscopic (molecular dynamics), and macroscopic (granular-hydrodynamics equations solver), in order to see the limits and advantages of each approach in different scenarios; and the study of the vertically vibrated shallow granular system from a physical point of view, in order to further understand the complex behaviors present in driven granular systems.

2 Ongoing efforts

Characterization of low-frequency oscillations

Our model makes several assumptions in order to obtain the simplest possible estimate for the frequency of oscillations. The full equations have now been solved and are being compared to the numerical simulations. Furthermore, the stability of the numerical solution of the hydrodynamic equations in the Leidenfrost state is being checked, against perturbations that would yield low-frequency oscillations.

Experimental observation of low-frequency oscillations

New experiments were realized in order to improve the phase-space characterization. The new data is currently now being analyzed. Moreover, experiments by a new group are being supervised, already with positive results. The new experimental setup allows the visual observation of the oscillations, which provides some new possibilities.

Segregation and phase coexistence on mass binary systems

The disagreement of experiments and simulations is being studied. Simulation of wider systems have lead to a better understanding of the natural scales of each state in the coexisting scenarios.

Particle size scaling and hydrodynamic limit convergence

We are currently working on generalizing the size scalings to the full hydrodynamic equations. The analysis has already yielded important insights into the influence of the particles' size in continuum descriptions of granular matter. Predictions have been tested against experiments.

Granular hydrodynamics solution

The hydrodynamic equations in steady state have been solved. Currently work is being done in generalizing the solution to two dimensions, and introducing time dependence. Results for the steady state are being compared with simulations, with excelent agreement.

3 Publications 2014

1. *Influence of Initial Conditions on Granular Dynamics near the Jamming Transition.* C.R.K. Windows-Yule, N. Rivas, A.D. Rosato, and D.J. Parker. New Journal of Physics, 2014, Accepted.

2. *Structure characterization of hard sphere packings in amorphous and crystalline states.* Vitaliy Ogarko, Nicolas Rivas, and Stefan Luding. Journal of Chemical Physics, 050421JCP, 2014.