Granular convection of horizontally shaked granular layers: Simulation

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Granular convection is a controversial topic due to the variety of mechanisms proposed to justify the experimental observations. To bring some light to this problem, we study a setup which shakes a single layer of spherical beads horizontally. We found that global collective movements can be induced if break the symmetry of the applied excitation signal. Nevertheless, advective transport can also be observed even if symmetric perturbations are used. Although the origin of both dynamics seems to be the same, the role of the boundary condition effects and the external forcing can be isolated.

When a sinusoidal signal is applied, four rolls can be distinguished. In order to understand the role of the lateral walls on the resulting patterns, we simulate the experimental conditions but tunning the friction coefficient of the lateral wall.

The present contribution is devoted to a numerical study of the effects of the friction and the asymmetry of the input signal on the resulting dynamic of a spheric particles monolayer in a cylindrical oscillating base. The asymmetrical input signals are piecewise functions with a period T, which are composed of two sinusoidal functions with different periods T_1 and T_2. We carry out numerical simulations using the discrete particle modeling code MercuryDPM [1, 2].

We have found that global collective movements can be observed in a horizontally shaken granular monolayer. When a non-symmetric signal is applied, the symmetry breaking induces a momentum gradient along the excitation direction that produces the displacement of the particles from the less energetic (less dense) zone to the densest (more dissipative) region. This observation is opposed to the mechanism of the natural convection where most energized areas are advected to the *cold* zones. To understand the origin of the observed collective motions, the wall friction must be discussed, as we show simulating a comparable situation but considering frictionless lateral wall.

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[2] T. Weinhart, A. R. Thornton, S. Luding, and O. Bokhove, From discrete particles to continuum fields near a boundary, Granul. Matter **14**, 289-294 (2012).