Experimental measurements of granular friction

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Probing the rheological properties of granular matter by shearing a layer of grains is a classical method, which has been widely studied either experimentally [1,2,3,4], numerically [5,6] or analytically [7,8,9]. The system typically consists of a mass pulled by a spring, this latter being translated at constant velocity V. For small or moderated velocity V, the slider exhibits a periodic motion, referred to as *stick-slip* motion : it remains still as long as the tangential force F is smaller than a threshold force F_s (*'stick'*) ; it then exhibits a sliding dissipative motion (*'slip'*) during which the dynamic friction force F_d is roughly constant. From this motion, one can infer the static and dynamic friction coefficient, μ_s and μ_d, respectively. Another classical experiment consists of measuring the grains avalanches in a rotating drum. In theory, the static and dynamic friction coefficients should be directly related to the starting angle of the avalanche, θ_s, and to the dynamic angle of the avalanching grains, θ_d, with the relationship $\tan\theta = \mu$. However, to our knowledge, these two experiments have never been compared directly.

We report the experimental study of granular friction based on the two experiments previously described. In the first experiment, a slider with a monolayer of grains stuck on its lower surface to ensure grain-grain friction is pulled over a granular bed of the same grains via a cantilever spring. In the second experiment, we measure the avalanche angle of a granular assembly in a rotating cylindrical drum. The study compares the friction coefficients obtained with both experiments. Several grain samples of different characteristic size and type of material (glass beads, ceramics) were analyzed. The effects of humidity and of bidisperse grain mixtures were also quantified. Our preliminary results show that the friction coefficients computed from both experiments exhibit a roughly linear trend, but with small shifts. These discrepancies are apparently independent of the humidity (below a given limit), but are dependent on the grains size and material.

Références

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