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Extended Abstract

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Triggering mechanisms of granular avalanches

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Exploration of the dynamical response of an inclined granular packing brings information which may be helpful for the prediction of the occurrence of the avalanche. During inclination, small rearrangements implying only a few grains are first detected. Their size increases with the inclination angle. At some stage, large amplitude and quasi periodical events are observed . These events, called precursors, consist of collective motions of grains. Experiments showed that the precursors are bulk phenomena and allowed to interpret these events as reorganizations of the weak-contact sub network occurring in the packing. Besides optical imaging techniques which give access to grain motion and rearrangements during the tilting, acoustic methods can be experimentally used to detect precursors and to probe internal rearrangements in the bulk of the granular layer. Because part of the acoustic wave energy transports through the contact network and the elastic beads of the medium, the probing methods based on the monitoring of acoustic signatures are sensitive to changes in the elastic properties of the granular layer. The acoustic probing methods can be divided in two groups, the passive methods where acoustic sensors are used to listen to the sounds emitted by the destabilized layer itself and the active methods where an acoustic signal with desired properties is generated and detected by transducers in the medium. Systematic experiments of granular layer destabilization for various granular media and external conditions are compared and allow better understanding of the mechanisms responsible for the appearance, periodicity and intensity of precursors.

The dynamics of inclined granular packings driven towards their stability limits are studied experimentally using imaging techniques as well as acoustic methods. The former allow one to study grain rearrangements during the tilting. The implementation of both passive and active acoustic methods for probing the granular packings, with capabilities for time-resolved measurements, provides information on various elastic properties of the layers along the destabilization process, including the transient precursors. Systematic experiments of granular layer destabilization for various granular media and external conditions are compared and allow one to better understand the mechanisms responsible for the appearance, periodicity, and intensity of precursors.

The existence of the unjamming transition plays a large part in the interest in granular materials. The latter are jammed at rest and can sustain some load, but if a threshold shear stress is exceeded, part of the material starts to flow. In response to some change in external applied forces, the macroscopic activity of a granular system is related to the evolving geometry of its contact network and to the nature of the contacts. It leads to complex behaviors of great interest for industrial and natural processes. In nature, geological processes like landslides or rock avalanches involve an unjamming transition of granular media. Other natural events like earthquakes are often seen as interacting elements that discharge collectively when they reach a trigger threshold. The corresponding models are closely related to avalanches models. For free surface flows of granular systems under the action of gravity, the unjamming transition above a critical shear stress is evidenced by the existence of an angle of maximum stability of a pile: . It is the angle at which the flow starts; the angle of the pile relaxes then towards the smaller angle of repose. Many studies have been devoted to these angles, but most of them focus on the succession of avalanches in a rotating drum or on a continuously fed pile. In both cases, the heap is built by successive avalanches, giving a specific contact network geometry to the bulk. An alternative method for investigating avalanche dynamics is to incline gently an undisturbed granular bed in the gravity field.

The exploration of the dynamical response of an inclined granular packing before the avalanche starts is of the greatest interest, as it allows a study of the dynamical transition from a static packing to a flowing one and brings information that may be helpful for the prediction of the occurrence of the avalanche. Obviously, the capability of predicting the probability of occurrence is an important motivation for this area of research.

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Bottom Note: *This work is partly presented at International Conference on Physics June 27-29, 2016, New Orleans, USA*