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Continuous and discontinuous phase transitions to an absorbing state in a vibrated quasi 2D granular setup.

Absorbing phase transitions, where a system goes from from a dynamic 'alive' state to a static 'dead' state from which there is no return, are ubiquitous in many areas of research, including epidemiology, ecology, and physics. Here, we use computer simulations to explore an absorbing phase transition in a simple model consisting of granular beads in a quasi-two-dimensional vibrating container.
The grains gain vertical momentum through the shaking of the bottom plate and roof, and transfer this energy to the horizontal plane by collisions with other beads. Additionally, the collisions of the particles with the ceiling and the plate effectively apply a drag to their motion. The competition between energy injection at collision and energy dissipation during the motion of the particles induces a phase transition. For a sufficiently dilute system, the low number of collisions means that drag dominates, and all horizontal motion eventually stops. For a dense system, particles will collide frequently enough so that the transfer of momentum from the vertical axis to the horizontal plane can sustain persistent motion of the particles.
By varying the parameters of our system such as the height of the roof or the amplitude of the shaking, we can find either a continuous or a discontinuous phase transition. The emergence of a discontinuous transition is explained by a synchronisation of the vertical motion of the particles – for a given range of parameters – which severely limits the energy transfer at collision.
To examine this more closely, we develop a coarse-grained two-dimensional hard-disk model of the complex system, and use it to better understand the transition observed in the realistic model. Both phase transitions are predicted in the framework of a kinetic theory of granular gas which plays the role of a mean field theory. Finally, we compare our results to preliminary measurements in an experimental realisation of this system.

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