PHYSICS DEPARTMENT COLLOQUIUM

"FREEZING AND MELTING IN GRANULAR MATERIALS"

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From bowls of nuts to eroding soil, granular materials are all around us. It is tempting to think of such materials as collections of supersized molecules, particularly since their behavior can be classified into phases corresponding to ordinary solids, liquids, and gases. However, they also exhibit a wide range of phenomena which fall outside such common experience: networks of force chains carry loads, and flow takes place in localized bands. In spite of the fact that granular materials are both dissipative and athermal, adaptations to statistical mechanics are allowing considerable insight into their behavior. I will present results on novel experiments on granular materials in which particles are vibrated from below and sheared from above within an annular channel. The vibrations have the remarkable effect of crystallizing the material, rather than melting it as temperature would an ordinary material. This freezing/melting transition is hysteretic, with the critical line corresponding to equal kinetic energies for vibration and shear. Another remarkable property is the increase of pressure with volume over a continuum of partially and/or intermittently melted states, in contrast to standard thermodynamic behavior. Such discoveries are important steps in developing a statistical mechanics of granular systems.

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