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State variables in dense granular materials

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Granular materials are integral to many parts of our daily lives, from the coffee beans that fuel our mornings to the coal that fuels our power plants. Two related aspects of their dynamics are particularly striking: their ability to exhibit both solid-like and liquid-like behavior, and the presence of highly heterogeneous force chains in which the magnitude of the local stress varies widely over short distances. These distinctive behaviors are connected to the fact that granular materials are always out of equilibrium: first, because they are typically both driven and dissipative, but also because they remain in metastable states even when they aren't being driven. I will present recent results from several experiments ranging from the theoretically-motivated (the equilibration of state variables within a non-equilibrium system) to the practical (particle-segregation by size). The results of these experiments elucidate the complex behaviors which underlay granular dynamics, and provide a reason to hope that statistical physics might hold the keys to explaining the observed phenomena.