MAR09-2008-002243

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

A statistical mechanics framework for static granular matter[1]

SILKE HENKES, Lorentz Institute

It is still an open question if the formalism of equilibrium statistical mechanics can be extended to athermal granular media. A number of authors have used a maximum entropy approach with a flat measure in configuration space to derive the equivalent of the canonical ensemble for the total volume or for the boundary forces as conserved quantities. We have generalized the force-based ensemble to the full force-moment tensor, and allow for the effects of a measure that is not flat. At the isostatic point, this formalism allows us to compute the force distribution exactly, and we obtain an exponential if we choose a flat measure. We use this result as a baseline to investigate the effects of the measure, and we also study the link to a recently proposed ensemble which incorporates an additional stress-based conserved quantity. At a coarse-grained level, the jamming transition can be studied within this framework by postulating a field-theoretical model for the density of states. We construct a minimal model based on symmetry arguments and a positivity constraint for the pressure, which incorporates force and torque balance through the Airy stress function. Unlike in continuum elasticity, the material constants crucially depend on the imposed boundary stresses. The model predicts that the jamming transition is characterized by a vanishing phase space available to the system as the pressure goes to zero. We are able to calculate correlation functions for the components of the stress tensor and compare them to simulation results.

[1]This work was supported by NSF-DMR 0549762