97st MSS-Seminar
Wednesday, July 27th, 15:30
Nägelsbachstr. 49b

Force-based statistical mechanics in granular materials

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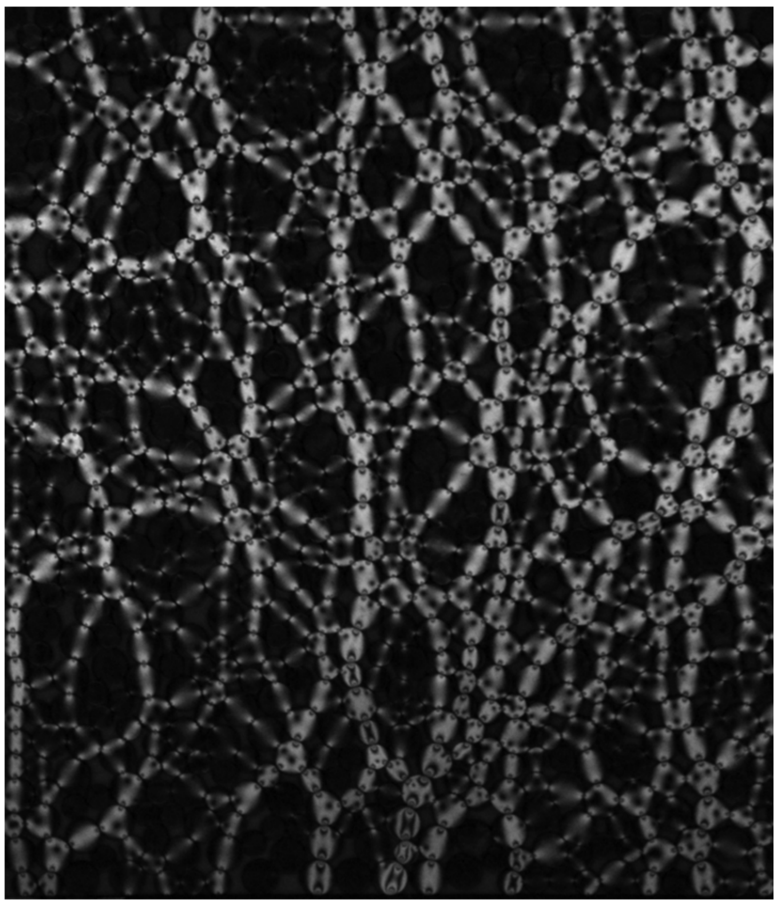

Figure 1: Two-dimensional force chains as measured by photoelasticity

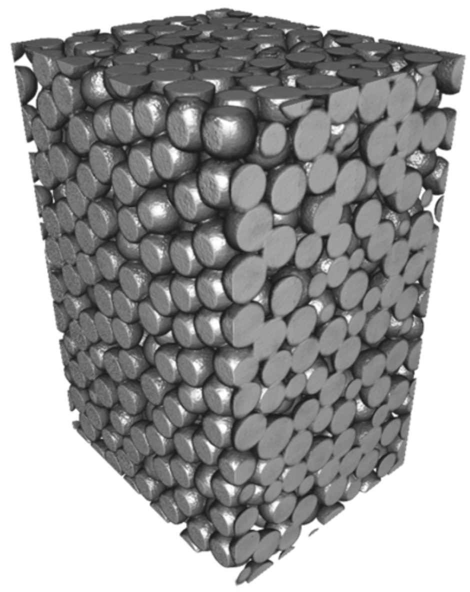

Figure 2: Sample compressed granular system seen through tomography

Recent theoretical work in the statistical mechanics of granular media emphasizes the significance of understanding the force network and structure of granular packings. Granular systems are athermal, however, and thus a complete statistical mechanics framework must be based on a set of macroscopic state variables which excludes temperature. One leading theory incorporates a stress-based ensemble, and predicts a Boltzmann-like distribution of the force-moment tensor with respect to the conjugate, temperature-like variable, angoricity. In work at North Carolina State University, we experimentally test this theory on a static, bidisperse, two-dimensional packing of discs. We simultaneously measure the contact forces acting on each disc using photoelasticity. We sample randomly generated configurations of discs by dilating and rearranging the system, and the angoricity is computed as a function of the confining pressure. In this talk, we discuss the apparent geometry-dependence of angoricity, and present alternative theoretical predictions that are currently being tested using the aforementioned data.

Experiments utilized to realize such granular force information are largely confined to two-dimensions. As a related project, conducted at FAU Erlangen, we utilize x-ray computer tomography to probe the internal structure of three-dimensional granular packings of soft PDMS microspheres under various levels of external pressure. Using a modular algorithm, from these tomographies we approximate the interparticle Hertzian normal force at each interface, constructing a force network. A first test of the accuracy of this approach is particle force balance. This method allows us to examine fundamental properties of granular packings: force chain percolation, distributions in stress and force, and particle coordination. We will present the current status of this project, with the hope that improvements to image quality and refinements in our algorithm could lead to the more general application of this technique to soft spherical granular systems.