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Relating the microscale to the macroscale in granular materials

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Abstract:

Granular materials, like soils and powders, play crucial roles in diverse applications from construction to agriculture to pharmaceuticals. Unlike continuous media, where strength can be determined by bulk material properties, the strength of granular materials is highly dependent on grain connectivity (fabric), force transmission, and frictional mobilization at the particle scale. Furthermore, these bulk properties are strongly dependent on the geometry and history of loading. It is well established that anisotropy in fabric and force transmission through a granular packing directly relates to the bulk scale strength of the packing. Although the relationship between particle-scale anisotropy and macroscale properties has been verified through simulated conditions, we have observed that it is valid for a broad variety of loading histories and geometries in experimental granular packings.

In this talk, I will present experiments conducted on a photoelastic granular system -- allowing us to measure individual interparticle contact forces -- subject to compressive and shear loading. By tracking both particle positions and interparticle contact force vectors, we map the anisotropy of the fabric and forces to the macroscale stress and strain. We find excellent agreement between the anisotropic particle-scale measures and the macroscale responses in experiments, independent of the loading geometry, showing that with knowledge of the forces and positions of the particles, one can predict the strength of the packing.

Date:
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Time:
9:00 AM-10:15 AM (PT)

About the speaker:

Carmen Lee is an experimental physicist investigating fluid dynamics and granular physics, with an interest in exploring fundamental principles and interdisciplinary connections. Her research delves into understanding the behaviour of fluids and granular materials, drawing parallels between physical phenomena and natural systems.

Carmen is currently a postdoctoral researcher at North Carolina State University in the Department of Physics. She completed her Ph.D. in Physics at McMaster University, focusing on the driven flow of droplets and bubbles.

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