Welcome to the Soft Matter Lab!

We study the generic problem of elastic media in a random potential e.g., adhesion, lubrication, friction, wetting and two-fluid interfaces in random porous media. The work focuses on the study of novel systems, novel phenomena and development of new experimental techniques to study them. Our future work builds upon the work already completed, as described here, as well as newer areas.

Elasticity in disordered media

In crystalline solids in thermodynamic equilibrium, the onset of rigidity is a direct consequence of the appearance of long-range positional order and the broken continuous translational symmetry. No such overarching principles are known to govern amorphous solids which are frequently out of equilibrium. We have used space-filling assemblies of athermal hydrophobic particles floating at an air-water interface as a model system to study the issues related to the onset of rigidity in amorphous solids.

Flow of Liquids through Porous Media

The flow of fluids in porous media is important in diverse areas of science and technology, such as soil mechanics, carbon sequestration, filtration, packed bed reactors, and oil recovery. A detailed understanding of the dynamics and the morphology of the two-fluid interface is of paramount importance for the case of displacement of one fluid by another in a porous medium. The central question in this field is to connect the knowledge of pore geometry to the macroscopic transport properties. The field is very empirical for it lacks imaging results at the pore scale. We have developed a table-top setup to perform a 3D real-time imaging using a modified laser light-sheet method and have demonstrated its performance by studying the growth of the well-known viscous fingering instability in a 3D model porous medium.

The problem of sticking

We worry about how things stick to each other. Our model system is a colloidal particle, suspended in a fluid medium sticking to a rigid substrate. The evolution of the frictional coupling between the two as a function of their separation is detected by the diffusivity of the particle and also by its phase sensitive response to an in-plane external oscillatory drive applied to the substrate. Upon contact, the coupling changes abruptly from viscous to elastic for a rigid silica particle, while it evolves slowly with time, similar to aging in glassy systems, for a soft and deformable polystyrene particle. Depending on the relative strengths of the particle-substrate interaction, the tweezer-potential and the external drive, three regimes of dynamics - stuck, aging and non-stuck – are observed in the dynamical phase.

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