Soft Matter Laboratory

Welcome to the Soft Matter Lab!

The soft matter research program is mainly inspired by our experience with interesting but non-intuitive phenomena with everyday materials, such as peeling of paint, sticking of particulate matter to surfaces, formation of cloud, structure and dynamical response of a sandpile. Questions of basic and general nature are extracted from them and experimental methods are devised in order to find precise answers about them in model systems that retain the essence of the original observations. The experimental systems typically consist of building blocks that are larger than atomic dimensions, from ten nanometers to centimeters, both in and out of mechanical and thermodynamically equilibrium. The investigations are aimed to provide deeper understanding of the world around us. We use experimental tools like optical tweezers, various types of rheometry and high speed imaging techniques. We also develop new techniques, experimental protocols and their interpretive framework. The broad aim is to ask interesting questions and devise novel ways to study them.

Examples of recently studied problems

Microscopic understanding of the laws of friction.

Physics of weakly adhering systems.

Origin of rigidity in amorphous materials.

Self-organization in granular matter.

Electrohydrodynamics in oil-in-oil emulsion

Mixing in highly viscous environment.

Wetting properties of surfaces

Dynamical instabilities in bulk fluids and in spatially constrained environment such as random porous media.

Highlights from this years work.

Autotuning of friction: Self-organization is ubiquitous in nature, although a complete understanding of the phenomena in specific cases is rare. We have elucidated a route to self-organization in a model granular system. From this, a key ingredient for achieving robustness emerges, namely, a continuously variable relative fraction of time the objects spend in two distinct motional degrees of freedom, rolling and sliding. In so doing, they access a large range of effective friction coefficients that allows self-tuning of the system to adjust its response to changing environments and guarantees a protocol-insensitive unique final state, a previously unidentified paradigm for self-organization

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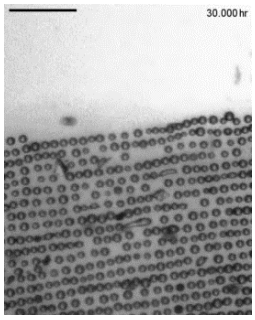
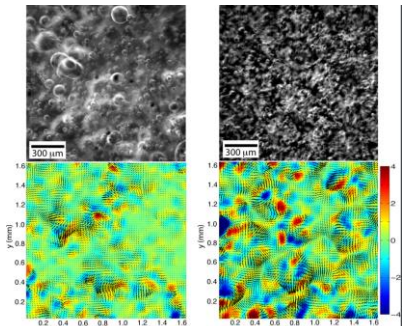
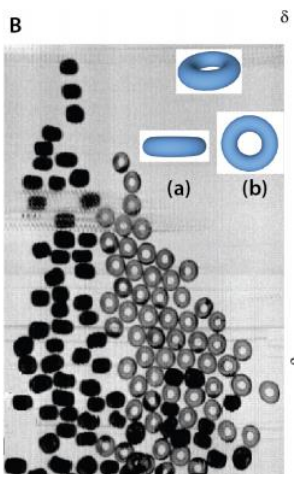


Triboelectric charging induced adhesion – an example of weak adhesion which illustrates the presence of a critical self organized state in a driven frictional system



Electric field driven chaotic flows in a highly viscous system.



Auto-Partitioning of particles into rolling and sliding states, a mechanism via which friction can be self- adjusted by the system

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