

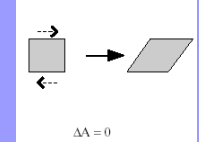
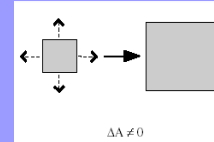
Soap films, or protein and polymer layers, control familiar and important processes like foam drainage and emulsion stability. These in turn have wide importance, affecting the texture and shelf life of foods and enabling oil recovery from reservoirs. At the root of these challenges are fundamental physical problems related to the special nature of confinement to two dimensions: flow on a plane, and nonequilibrium liquid to solid transitions (Glass transitions) as a function of density or temperature, are very different from their 3D counterparts.

I am currently looking for students interested in the following broad projects:
Surface rheology: colloid films, mixed colloid/surfactant systems, glass transition, Jamming and granular systems in 2D.
Biological filaments and filament gels. Together with the membrane, these are the fundamental structural units in biological cells. The Mechanical properties of these systems are very interesting and are ideally studied with Optical Tweezers.
Model and real biological membranes. There are many remaining puzzles surrounding these systems: viscosity, bending, shear, compression, coupling to bulk deformation. They can be studied by combining experiments on surface rheology together with optical tweezers for bulk deformation.

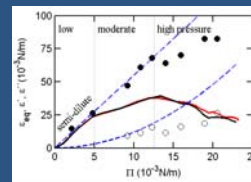
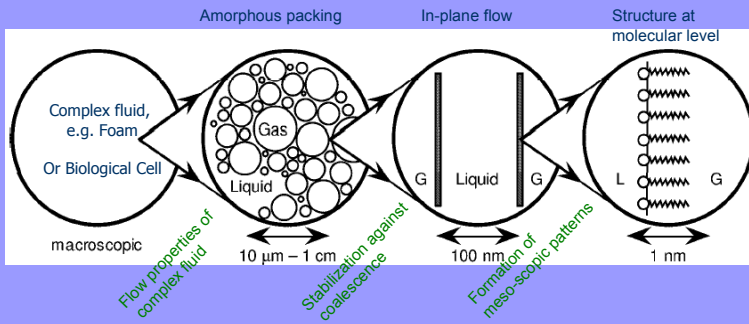
Mechanical deformation

dilation/compression ϵ

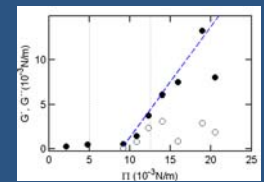
shear G



Lengthscales and processes

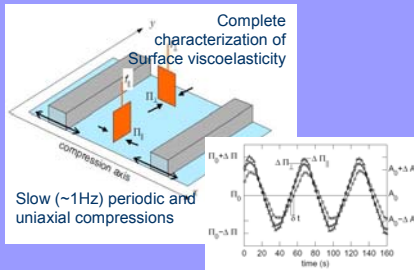


These results on the protein β -lactoglobulin show an initial dependence of the compression (ϵ' and ϵ'') on the surface pressure that is the same as for simple polymers (linear and quadratic).

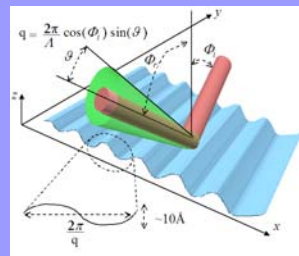


β -lactoglobulin layers develop a shear modulus G above a critical concentration. G then grows linearly with the surface pressure. The emergence of a G is part of the evidence of a 2D glass transition [1].

Experimental Techniques



The anisotropy in the surface tension of a film that is being compressed is a measure of both the compression and shear complex moduli [3,4]. Raw data from this experiment are shown.



Liquid surfaces are continuously roughened by thermal fluctuations these are affected by the presence of a surface film. Laser light scattering is a sensitive probe of this dynamics.



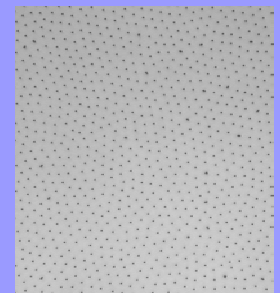
This is a state-of-the-art laser trap. It can be used to independently move a large number of colloids, to perform microrheology and to measure very small interaction forces (in the pN range) between particles.



The motion of particles confined to interfaces can be tracked through an optical microscope. This can be used to study crystal formation in 2D, and to address other open questions such as the inter-colloid interaction for particles confined to an interface [1].



These images are of "Giant Unilamellar Vesicles", visualized through fluorescence microscopy. There is phase separation within the membrane plane, into regions rich and poor in cholesterol. It is possible to track the motion of the bright domains as a function of time. This can be used to measure the diffusion coefficients of phase separated domains in model biological membranes (plots on the right) [2]. The diffusion coefficient is related to the membrane's viscosity. In future work, these model systems will be made more similar to real cells by introducing a model "cytoskeleton".



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- References:
- [1] Cicuta, Stancik and Fuller, *Phys. Rev. Lett.* **90**, 236101 (2003)
 - [2] Cicuta, Keller, Veatch, *submitted* 2006
 - [3] Cicuta and Terentjev, *Eur.Phys.J. E*, **16** 147 (2005)
 - [4] Ferenczi and Cicuta, *J.Phys. Cond. Mat.*, **17**, 3445 (2005)