THE SOFT MATTER LAB

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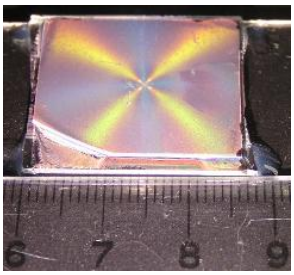
The primary experimental technique used in my laboratory is fluorescence laser scanning confocal microscopy, a technique that is very commonly used in biophysics. Undergraduate students also typically learn computational (image processing) skills and learn to use one of a range of other experimental techniques: nuclear magnetic resonance (NMR), rheology, scanning electron microscopy and atomic force microscopy.

1. Colloids in Electric Fields: Tunable colloidal self-assembly

Colloidal particles are micrometer-to-nanometer-sized objects suspended in a fluid that undergo constant Brownian motion. We study the three-dimensional structure and the dynamics of fluorescent-labeled colloids using a laser-scanning confocal microscope. We use colloidal suspensions as model experimental systems to mimic atomic systems. The advantage is we get obtain 3-dimensional structure as well as dynamics simultaneously in real times.

Using this and in collaboration with the group of Prof. Ivan Saika-Voivod (Physics, Memorial), we can compare experiment with computer simulation, and thus quantitatively study crystallization, melting, and the glassy behaviour.

2. Advanced Photonic and Magnetic Materials from Colloidal Templates

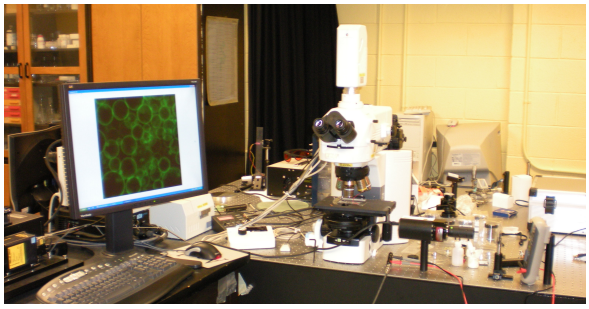


Colloidal self-assembly can be used to make crystalline colloidal patterns on the micrometer- and sub-micrometer length scales. In collaboration with Prof. Kristin Poduska and Prof. Martin Plumer are exploring ways to make colloidal crystals that are usable as sacrificial templates in order to make patterned photonic & magnetic materials over large areas (centimeters).

3. Diffusometry and Relaxometry of Macromolecular Aggregates

We are using NMR diffusometry (along with relaxometry and chemical shifts) to obtain quantitative information about macromolecular aggregates in aqueous polymer--surfactant, protein solutions and other multi-component complex fluids. The key element is the ability to get spectrally resolved diffusion coefficients: this means we can track the mobility of all components in multi-component solutions simultaneously. From this we can make quantitative statements about the partitioning of the components: e.g. in surfactant--polymer aggregates, how much of the surfactant is free, how much is in a polymer-surfactant aggregate, what fraction is in free micelles with no polymer.

4. The Physics of Vesicle Electroformation.



Phospholipid bilayers in an aqueous medium naturally close up to form sacs with water inside. These “vesicles” have many specialized biological functions. They can be made more efficiently using electric fields, but its not really clear why. In addition, there is a huge distribution in vesicle sizes. This project involves the use of electric fields of variable frequency and high-speed microscopic imaging, to look for size selection mechanisms in vesicle electroformation.