Time-resolved SANS: lipids, surfactants, and foams

Neutron scattering is a powerful tool for monitoring the self-assembly and molecular exchange kinetics in soft materials that we encounter in our everyday lives. Personal care products, food products, fuel additives, as well as next generation drugs, vaccines, and antibiotics all contain lipids, surfactants, or polymers that assemble on the nanoscale and can evolve over time. In these experiments, we will take advantage of contrast variation and neutron scattering to study kinetic processes in two different systems. In the first example, we will study the exchange of induvial lipid molecules in model lipid membranes in the presence of additives such as organic solvents or antimicrobial peptides. Other methods to study molecular exchange kinetics often rely on the use of bulky fluorescent molecules that can even be larger than the molecules of interest and often perturb the very processes they are trying to measure. Here, we will instead rely on isotopic substitution and a clever contrast matching scheme to watch distinct populations of hydrogen- and deuterium-labelled lipids mix over time and extract rate constants for the exchange processes. For the second example we will use contrast variation to isolate the signals that arise from the liquid films and the micelles within the films in a foam while it is draining in situ. Much like dish soap, over time the bubbles in a foam coarsen and eventually disappear as the liquid in the bubbles drains into the fluid reservoir. With neutrons we capture information about the thinning of the liquid films while also measuring the composition of the liquid within the films.

In this summer school module students will learn how to plan static and kinetic experiments. Experiment optimization including instrument choice and configuration, sample environment selection, estimation of count rate will be discussed. Students will learn to calculate and measure scattering length densities, and how to use scattering length density as a tool to explore complicated systems. Hands on experience with data reduction and analysis will be emphasized.