X-ray scattering methods for studying lipid bilayers

Small-angle X-ray scattering (SAXS) and x-ray reflectometry (XRR) are fundamental methods for structure analysis of condensed matter. They have emerged as essential tools to unravel structural details with characteristic dimensions at length scales of nanometers. Various fields make use of these methods, from studies of metallic alloys to synthetic or biological molecules in solution or at interfaces. X-rays with a wavelength of 0.1-0.2 nm are elastic scattered at the sample, which is in solution or at the interface for SAXS or XRR, respectively.

SAXS became increasingly important in the study of biological macromolecules in solution. It allowed for the first time to yield low-resolution structural information on the overall shape and size of the particle without the need to grow crystals. The random orientation of particles in solution leads to an averaged scattering pattern, so that only information about the global average three-dimensional structure can be obtained. Moreover, SAXS also makes it possible to investigate real-time intermolecular interactions such as self-assembly and large-scale conformation changes, on which biological functionality often relies.

XRR is useful to investigate interfaces, e.g. adsorbed proteins, lipid bilayers or metal layers by using specular conditions, i.e. at the same incoming and reflected angle. X-rays are reflected at each interface, leading to constructive and destructive interference. In the case of periodical structures, also Bragg reflections are obtained. Analysis of reflectometry data enables to obtain high resolution electron density profiles and information, like layer thicknesses of periodical structures perpendicular to the interface.

In the offered module, we will give an introduction to both X-ray scattering techniques, including an insight into the analysis and parameters obtained from the experiments. We will investigate phase transitions of multilamellar lipid vesicles (by SAXS) and solid-supported multilayers of lipids (by XRR). It is possible to bring your own samples.