

4:20-5:00

Exploring the collective dynamics of lipid membranes with inelastic neutron scattering

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While most spectroscopic techniques, as e.g. nuclear magnetic resonance or dielectric spectroscopy, probe macroscopic responses, neutron and within some restrictions also x-ray scattering experiments give the unique access to microscopic dynamics at length scales of intermolecular or atomic distances. Only recently, it has become possible to study collective dynamics of planar lipid bilayers using neutron spectroscopy techniques [1]. We determined the dispersion relation of the coherent fast picosecond density fluctuations on nearest neighbor distances of phospholipid acyl chains in the gel and in the fluid phases of a DMPC bilayer. The experiments shed light on the evolution of structure and dynamics and the relation between them in the range of the gel-fluid main phase transition. The scattering volume restriction for inelastic neutron experiments was overcome by stacking several thousand highly aligned membrane bilayers.

By combining different neutron scattering techniques, namely three-axis, backscattering and spin-echo spectroscopy, we present measurements of short and long wavelength collective fluctuations in biomimetic and biological membranes in a large range in momentum and energy transfer, covering time scales from about 0.1 ps to 150 ns and length scales from 3Å to 1000 Å. A recent backscattering study gives information about slow molecular dynamics of lipid acyl chains and the 'membrane-water', i.e. the water molecules in between the stacked bilayers, in the nanosecond time range [2]. The dispersion relations of the long wavelength undulation modes in lipid bilayers can be determined by quasielastic reflectometry on spin-echo spectrometers and give direct access to the elasticity parameters of the membranes.

[1] Rheinstaedter, M.C. and Ollinger, C. and Fragneto, G. and Demmel, F. and Salditt, T., Phys. Rev. Lett. **93**, 108107,(2004).

[2] Rheinstaedter, Maikel C. and Seydel, Tilo and Demmel, Franz and Salditt, Tim, Phys. Rev. E, in print (2005), cond-mat/0501752.