Bilayers at the ILL

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Active fluctuations in model membranes

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Membranes exhibit thermal fluctuations, but transmembrane protein activity breaks the fluctuation-dissipation theorem leading to out-of-equilibrium fluctuations. Active fluctuations have been widely described theoretically [1], but to a lesser extent experimentally.
We will present our recent results on the investigation of out-of-equilibrium fluctuations of phospholipid membranes induced by transmembrane protein activity. Transmembrane protein Bacteriorhodopsin (BR) was used as a light-driven proton pump, which activity was triggered by visible light to induce active membrane fluctuations. In this context, model systems such as solid-supported single and floating phospholipid bilayers were used for the protein reconstitution studies and to investigate phospholipid membranes and their interactions. A detergent-mediated incorporation method [2] was adapted to perform the BR reconstitution into the phospholipid bilayer at the interfaces.
The combination of neutron reflectometry, QCM-D, fluorescence microscopy and AFM allow us to develop the robust protocol of BR reconstitution and to demonstrate that it is possible to insert BR in model bilayer systems without losing their structural integrity. An activity of the incorporated proteins through its effect on the structure and on the fluctuations of a double bilayer system and the reversible effect of light illumination on BR activity was demonstrated by specular and off-specular synchrotron radiation reflectometry experiments.
The preliminary analysis of the synchrotron measurements is consistent with the magnification of membrane shape fluctuations induced by BR activity. The obtained results open the way to investigate, for the first time, the fluctuation spectrum of a planar membrane-protein system at the nanoscale and to access the physical properties of the system such as bending modulus, surface tension and interaction potential between adjacent membranes.

References:

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