BP 21: Membranes and Vesicles II

Time: Wednesday 15:00–16:30 Location: H46

Invited Talk BP 21.1 Wed 15:00 H46

Mimicking cellular membranes: lessons from reconstitution — •Eva Schmid — Department of Bioengineering, UC Berkeley, USA

Cellular membranes are much more than passive barriers that encapsulate biochemical reactions - they are actively involved in driving complex biological processes and play a critical role in the communication between cells and their surroundings. Biological membranes exhibit a meticulously controlled asymmetric distribution of phospholipids, and are populated by a surprisingly high density of proteins. It is now understood that proteins and lipids do not randomly diffuse in plane as a two-dimensional fluid but are laterally organized. However, it is not yet clear how this organization comes about and what physical consequences it has on different membrane processes such curvature generation, membrane fusion or the formation of membrane interfaces. Efforts to understand biological membranes are often held back by the interconnected complexity of biochemical reactions in the cell. An emerging complementary approach to traditional biological research is to build cellular features component-by-component from the bottom up, thereby isolating the pathway of interest.

This talk will describe recent in vitro reconstitution experiments using purified lipids and proteins that suggest how physical boundary conditions can be essential and sufficient regulators of membrane organization.

BP 21.2 Wed 15:30 H46

Optothermal manipulation of lipid membranes — •Patrick Urban, Silke Kirchner, Theobald Lohmüller, and Jochen Feldmann — Photonics and Optoelectronics Group, Physics Department and CeNS, Ludwig-Maximilians-Universität München, Amalienstrasse 54, 80779 München, Germany

Light absorbed by gold nanoparticles is very efficiently transformed into heat. Such particles can thus be used as small and localized heat sources that can be switched on and off by a short light pulse.

In our work, we take advantage of this property to investigate the physical consequences of heating on lipid membranes and thermosensitive trans-membrane proteins.

Giant unilamellar vesicles (GUVs) made of diphytanoylphosphatidylcholine (DPhPC) are prepared by electroformation and functionalized with 80 nm Au-nanoparticles. The particles are heated with a short laser pulse at the particle resonance frequency. The amount of heat can be controlled by the laser power and the pulse duration. The consequences of localized heating on the membrane properties are investigated by planar patch-clamp and fluorescence methods. Besides membrane studies, we aim to extend our approach to investigations of thermosensitive transmembrane proteins that are incorporated in the phospholipid bilayer.

BP 21.3 Wed 15:45 H46

Bilayer undulation dynamics in unilamellar phospholipid vesicles: Influence of temperature, cholesterol and trehalose — •Beate-Annette Brüning[1], Sylvain Prévost[1,2], Ralf Stehle[1], Roland Steitz[1], Peter Falus[3], Bela Farago[3], and Thomas Hellweg[4] — [1]Helmholtz Zentrum Berlin, Hahn-Meitner Platz 1, 14109 Berlin, Germany — [2]Technische Universität Berlin, Straße des 17. Juni 135, 10623 Berlin, Germany — [3]Institut Laue-Langevin, B. P. 156, 38042 Grenoble Cedex 9, France — [4]Universität Bielefeld, Universitätsstraße 25, 33615 Bielefeld, Germany

We report a combined dynamic light scattering (DLS) and neutron spin-echo (NSE) study on lipid vesicles composed of 1,2-dimyristoyl-sn-glycero-3-phosphatidylcholine (DMPC), respectively under the influence of temperature and the membrane additives cholesterol and trehalose. We study bilayer undulation and bulk diffusion dynamics using neutron spin-echo spectroscopy, on two distinct time scales, namely around 25 ns and 100 ns. Finally, we calculate the respective bilayer bending rigidities κ for all types of lipid vesicles. We observe a bilayer softening around the main phase transition temperature T_m of the single lipid model system, and a bilayer stiffening the more cholesterol is added, whereas the insertion of trehalose hardly changes the bilayer undulations and membrane rigidity κ [1]. We explain our findings on the basis of a free volume available to lipid molecules in the membrane plane, which encounters the most pronounced changes in the acyl chain regime. [1] B. Brüning, S. Prévost, R. Stehle, R. Steitz, P. Falus, B. Farago, T. Hellweg, submitted.

BP 21.4 Wed 16:00 H46

Non-Equilibrium Dynamics in Lipid Multilayers - Time Resolved X-Ray Diffraction at In-House and Synchrotron Sources — •Tobias Reusch[1], Markus Osterhoff[1], Christina Bömer[1], Florian Schülein[2], Andre Beerlink[3], Dong-Du Mai[1], Achim Wixforth[2], and Tim Salditt[1] — [1]Institut für Röntgenphysik, Georg-August Universität Göttingen, Germany — [2]Lehrstuhl für Experimentalphysik, Universität Augsburg, Germany — [3]Deutsches Elektronen Synchrotron, Hamburg, Germany

Collective excitations in biological membranes are of major importance for the understanding of numerous processes in living organisms. Studies of equilibrium properties revealed a rich spectrum of dynamics from the *ps* to the μs time scale. Out-of-equilibrium dynamics as driven by external forces, i.e. due to active membrane proteins, have remained largely unexplored.

We report on time resolved X-ray scattering experiments at in-house fs $Cu-K_\alpha$ and synchrotron (ID09B/ESRF, P08/PETRAIII) sources, using optical and surface acoustic wave (SAW) excitation mechanisms. Importantly, we were able to record specular and diffuse scattering at a signal level compatible with a full lineshape analysis. For SAW stimulated lipid bilayers the first time resolved electron density profile could be reconstructed at molecular resolution. A clear out of equilibrium behaviour can be observed for Texas-Red labeled lipid multilayers in case of short pulse optical excitation. These results are compared to theoretical predictions for non-equilibrium phenomena, possible implications for fluorescent microscopy experiments are discussed.

BP 21.5 Wed 16:15 H46

Physical vapor deposition (PVD) of 1,2-dipalmitoyl-sn-3-phosphoglycerocholine (DPPC) and membrane formation on SiO2/Si(100) substrate — •Ulrich G. Volkmann[1], María J. Retamal[1], Carmen González[1], Mauricio Sarabia[1], Marcelo Cisternas[1], Michael Kappl[2], and Tomás Corrales[2] — [1]Surface Lab, Facultad de Fisica, Pontificia Universidad Catolica de Chile, Chile — [2]Max Planck Institute for Polymer Research, Mainz, Germany

Phospholipids have been currently of great interest in nanotechnology and applied sciences. One of the most widely used and interesting phospholipids is the surfactant 1,2-dipalmitoyl-sn-3-phosphoglycerocholine (DPPC). Different techniques have been developed in order to assure the complete formation of bilayers or multilayers and particularly to improve thickness accuracy. Between the most popular are spin-coating, dip-coating and Langmuir-Blodgett. In this work we explore the possibility to achieve controlled deposition of a DPPC bio-membrane, combining physical vapor deposition (PVD) on SiO2/Si(100) substrates under high vacuum conditions with high resolution Ellipsometry for very precise thickness control. The well known phase transitions of DPPC layers were analyzed during temperature cycles with Imaging Ellipsometry, AFM and Raman. Previous to and after the application of temperature cycles the film was inspected with SEM. We suggest a method for prolonged membrane humidification by deposition of an ultra thin porous poliglusam interlayer.

M.J. R. and C. G. acknowledge CONICYT and VRI Nr. 10/2010 (PUC), resp. Work supported by FONDECYT grant Nr. 1100882.