IMPRS on Multiscale Biosystems

Project description

Title: Light-induced transformations in biomembranes
PI: Rumiana Dimova
In collaboration with: Stefan Hecht, David Bléger
Project description:
Cellular processes such as endo- and exo-cytosis in vesicular transport, membrane tabulation and organelle formation require regulation of the lipid membrane structure and morphology. In cells, this is achieved by the action of proteins and changes in the environment, such as chemical signals and/or physical conditions. In this project, we will consider an artificial cell-like system where the membrane response is triggered by light. As model membranes, giant unilamelar vesicles (GUVs) will be employed (Dimova, J. Phys.: Condens. Matter 18:S1151, 2006). Their advantage over conventional vesicles is that the response of the membrane can be observed directly under the microscope. The changes in the membrane morphology will be triggered by conformational changes in azobenzene derivatives. The latter can be switched by illumination between two molecular conformations whereby changing the overall molecular length. Different types of azobenzene derivatives will be employed. One of them acts as a photo-responsive molecular glue of the type reported in Suzuki et al, J. Am. Chem. Soc. 134:15273, 2012. Upon adsorption onto one leaflet of the lipid bilayer and appropriate illumination, it is expected to trigger significant changes in the local lipid density but also on the membrane curvature leading to overall morphological transformation in the vesicle and eventually processes such as budding and tube formation. The second type of azobenzene derivative contains an "accordion-like" transmembrane part (see Bleger et al., Angew. Chem. Int. Ed. 50:12559, 2011), which upon illumination would lead to local constriction of the membrane. Similar light-induced conformational changes are displayed by transmembrane proteins such as bacteriorhodopsin. Establishing an accurate control over the deformation of giant vesicles is expected to yield mechanistic insights into a variety of natural phenomena associated with transmembrane processes, and eventually will allow for the development of sophisticated artificial molecular machines. The changes in the mechanical properties of the membrane associated with the incorporation or adsorption of the azobenzene derivatives will be characterized using advanced microscopy techniques. The research plan is subject to specific modification based on the applicant's interest and background.
Required background: Master in Physics, Chemistry or Biophysics; Profound knowledge on structure and function of biomembranes; Experience in optical and confocal microscopy will be advantageous
Paper to read before the interview: R. Dimova, S. Aranda, N. Bezlyepkina, V. Nikolov, K. A. Riske and R. Lipowsky, "A practical guide to giant vesicles. Probing the membrane nanoregime via optical microscopy", *J. Phys.: Condens. Matter* **18**, S1151-S1176 (2006)
Contact: www.dimova.de