Polymorphic Biofilaments and Their Interaction with Biological Membranes

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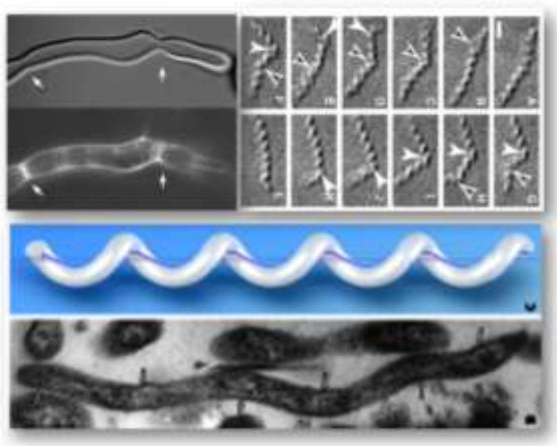
Lipid membranes are ubiquitous in the biological cell. They have to fulfill a variety of tasks such as molecule sorting or signal transduction. Consequently, it is of vital importance for a cell to control and change not only the composition but also the shape of its membranes. One tool the cell employs for such shape changes are conformationally switching, polymorphic biofilaments. Polymorphic biofilaments are found everywhere in nature where they perform important mechanical tasks. They determine the shape of bacterial cells, enable viruses to inject their genomes and generate mechanical forces and motion in many microorganisms. Prominent examples of switchable biopolymers are FtsZ, MrB, bacterial flagellin, actin filaments, and microtubules.



Starting from the theory of polymorphic transitions in biofilaments [1,2] in the present thesis, the interplay between switchable filaments, protein complexes, and membranes will be theoretically developed. We will study how a conformational state coexistence of a biofilament (or a protein complex) can induce dynamic shape changes in a membrane to which it adheres. Furthermore the inherent multi-stabilty properties of membranes (due to their internal prestresses and mechanical non-linearity) will be investigated and developed into a coherent unified theory of cooperative polymorphic states of extended elastic objects.

The thesis will be co-supervised by experienced experts in theoretical polymer physics and biophysics. The candidate should bring a solid knowledge of general physics, statistical mechanics, elasticity theory, hydrodynamics, nonlinear physics and above all a fearless desire to face the unknown. Biological background knowledge can be obtained during the project that is set within an inspiring and vibrant working environment.

[1] H. Mohrbach, A. Johner & I.M. Kulić, Phys. Rev. Lett. 105 (26), 2010
[2] H. Mohrbach, A. Johner & I.M. Kulić, Europ. Biophys. J. 41(2) ,217 (2012)