SYSO 5: Self-Organizing Surfaces and Interfaces IV

Time: Thursday 11:00–12:30 Location: GÖR 226

SYSO 5.1 Thu 11:00 GÖR 226

Establishment and Maintenance of Compartment Boundaries in Growing Tissues — •Jonas Ranft[1], Reza Farhadifar[1], Katharina Landsberg[2], Thomas Bittig[1], Christian Dahmann[2], and Frank Jülicher[1] — [1]Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, 01187 Dresden, Germany — [2]Max Planck Institute of Molecular Cell Biology and Genetics, Pfotenhauerstraße 108, 01307 Dresden, Germany

In many developing epithelia, which are essentially two-dimensional tissues, distinct cellular compartments emerge. Cells within a given compartment show a characteristic signature of gene expression. Boundaries between compartments are typically sharp and often straight. Furthermore, these boundaries are lineage boundaries, i.e., the progeny of a cell lies in the same compartment. Such compartment boundaries can be considered as interfaces in the tissue. We discuss the role of cell division and cell mechanics for the morphology of compartment boundaries between two cell populations. Using a vertex model which can describe cell packing geometries, we study the conditions which give rise to stable and straight compartment boundaries during growth. We find that increased cell boundary tension at the interface between two cell populations can prevent the mixing of cells and leads to sharp boundaries. In order to quantify the morphology of these interfaces, we study the scaling behavior of interface fluctuations. We quantitatively compare our simulation results with experimental observations of the anteroposterior compartment boundary in the developing wing of the fruit fly *Drosophila*.

SYSO 5.2 Thu 11:15 GÖR 226

DNA interaction with freestanding cationic lipid bilayers — •Christoph Herold, Eugene P. Petrov, and Petra Schwille — Biophysics, BIOTEC, TU Dresden, Tatzberg 47-51, 01307 Dresden

We study interaction of DNA molecules of different lengths (∼10...50 kbp) with freestanding (giant unilamellar vesicles) and supported cationic lipid bilayers. Upon adsorption on supported cationic bilayers DNA molecules behave as 2D random self-avoiding coils, in agreement with observations previously reported in the literature. A completely different picture is observed when DNA molecules adsorb on freestanding cationic bilayers: In this case, shortly after adsorption, the adsorbed DNA molecules collapse from the coil conformation (gyration radius of ca. 2 μm) into a globule with a size below the optical resolution limit (gyration radius of ca. 0.3 μm). The DNA globules stay attached to the bilayer and exhibit translational Brownian motion on the membrane with a diffusion coefficient of ∼0.6 $\mu m^2/s$ corresponding to the size of ∼100 nm, in agreement with the dimensions expected for globules produced upon DNA condensation. We present results of a systematic study of this phenomenon as a function of the DNA fragment length and cationic lipid membrane composition using fluorescence video microscopy with single particle tracking, transmission electron microscopy, and atomic force microscopy.

SYSO 5.3 Thu 11:30 GÖR 226

Translational diffusion in lipid membranes with phase separation: A Monte Carlo study — Jens Ehrig, •Eugene P. Petrov, and Petra Schwille — Biophysics, BIOTEC, TU Dresden, Tatzberg 47-51, 01307 Dresden

The intriguing phenomenon of subdiffusion frequently observed in cell membranes in SPT, FCS, and FRAP experiments is usually ascribed to the presence of membrane heterogeneities with dimensions below the optical resolution limit. In order to understand how the submicrometer-scale phase separation in the cell membrane can affect the lipid diffusion and manifest itself experimentally, we carry out dynamic Monte Carlo simulations of a two-lipid membrane (DMPC/DSPC) with the size on the micrometer scale over time intervals of order of a second. To be able to do that with reasonable computational efforts, we simplify the traditional lattice model of a membrane – coupled lipid chains on a triangular lattice – and represent the membrane as a square lattice of lipid molecules. By comparing our simulation results with differential scanning calorimetry data for DMPC/DSPC membranes, we demonstrate that, with a proper choice of the lipid interaction parameters, our model correctly reproduces the thermodynamic properties, as well as the phase diagram of the lipid mixture. For certain ranges of the membrane compositions and temperatures we find that the Brownian motion of lipid molecules shows strong deviations from the normal diffusion law. Possible effects of the dynamic phase separation in SPT, FCS, and FRET experiments will be discussed.

SYSO 5.4 Thu 11:45 GÖR 226

Min proteins make waves: Self-organization of bacterial cell division proteins in vitro — •Martin Loose[1,2], Elisabeth Fischer-Friedrich[3], Christoph Herold[1], Karsten Kruse[4], and Petra Schwille[1,2] — [1]Biophysics, Biotec, TU Dresden, Dresden, Germany — [2]Max-Planck-Institute for Molecular Cell Biology and Genetics, Dresden, Germany — [3]Max-Planck-Institute for Physics of Complex Systems, Dresden, Germany — [4]Theoretische Physik, Universität des Saarlandes, Saarbrücken, Germany.

In the bacterium Escherichia coli, the Min proteins oscillate between the cell poles to select the cell center as division site. This dynamic pattern has been proposed to arise by self-organization of these proteins, and several models have suggested a reaction-diffusion type mechanism. We found that the Min proteins spontaneously formed planar surface waves on a flat supported membrane in vitro. We developed TIRF based single-molecule imaging experiments that revealed the dynamics of individual proteins during wave propagation.

SYSO 5.5 Thu 12:00 GÖR 226

Lamella and Cylinder Morphologies in Confined Copolymer-Homopolymer Mixtures — •Kostas Daoulas and Marcus Müller — Institut für Theoretische Physik, Georg-August-Universität, Göttingen

The Self Consistent Field Theory (SCFT) is a powerful method for predicting the morphologies in dense, self-organizing, polymeric systems. Usually within SCFT the chain architecture is captured via a Gaussian chain model, while non-bonded interactions are considered within a Flory-Huggins approach under the assumption of total or finite incompressibility of the liquid. In the later case, the spatial density variations are commonly described within the Helfand's quadratic potential. Here we present an alternative approach, using a more elaborated representation of the non-bonded interactions in spirit of a third order virial expansion with respect to the densities of the system components. The approach allows the description of the coexistence of the polymer liquid with its vapor; an important issue when modeling thin polymer films and topographical properties (e.g. terrace formation) of the free polymer surface. The approach is illustrated considering thin films formed by blends of PEO-b-PS (polyethylene oxide, polystyrene) copolymers with PAA (polystyrene-co-acrylic acid) homopolymers. We discuss how the parameters of the model should be selected such that a specific polymeric system (here, the PEO-b-PS/PAA blends) is represented. The morphologies are studied as a function of the PAA molecular weight and concentration in the mixture, showing that they change from cylinders to lamellae upon increasing the PAA content.

SYSO 5.6 Thu 12:15 GÖR 226

Packing Frustration of bicontinuous and multicontinuous cubic Gyroid mesophases — •Gerd E Schröder-Turk[1], Karsten Grosse-Brauckmann[2], and Stephen T Hyde[3] — [1]Theoretische Physik, Universität Erlangen-Nürnberg, Staudtstr. 7, D-91058 Erlangen — [2]Fachbereich Mathematik, Technische Universität Darmstadt, Schlossgartenstr. 7, D-64289 Darmstadt — [3]Applied Maths, Research School of Physical Sciences, Australian National University, 0200 ACT, Australia

For the self-assembly of copolymers and lipids into cubic bicontinuous triply-periodic interfaces, domain thickness variations relate to packing frustration and affect phase stability. Domain thickness variations can be analysed by a medial surface approach [1]. We study triply-periodic space-partitions with interfaces modelled by constant mean curvature (cmc) representations of three-coordinated srs networks. These include the $Ia\bar{3}d$ double-Gyroid geometry found in AB diblock copolymers. We find that the volume fraction of the minority (network) component at which the $Ia\bar{3}d$ Gyroid is typically stable in AB diblocks ($\approx 38\%$) corresponds to the case where the relative domain thickness variations (or packing frustration) of minority and matrix component are approximately equal. We discuss multi-continuous geometries based on three

or more entangled cmc srs-network domains with relatively low packing frustration, possibly relevant for novel lipid mesophases [2].

[1] G.E. Schröder, S.J. Ramsden, A.G. Christy, S.T. Hyde, Eur. Phys. J. B **35**, 551-564 (2003) [2] S.T. Hyde, G.E Schröder, Curr. Op. in Coll. and Interface Sc. **8**, 5-14 (2003)