DY 32: Soft Matter II

Time: Friday 10:00–12:30

Location: MA 144

DY 32.1 Fri 10:00 MA 144

Deformation of Platonic foam cells: Effect on growth rate
— •Myfanwy Evans[1], Johannes Zirkelbach[1], Gerd Schröder-Turk[1], Andrew Kraynik[1,2], and Klaus Mecke[1] — [1]Theoretische Physik, Friedrich-Alexander Universität Erlangen-Nürnberg, Germany — [2]Manchester, UK

Coarsening is the process by which gas diffuses through the films that separate foam cells, and causes them to grow or shrink over time. The growth rate for 2D foams is fully described by von Neumann's law, and relies solely on cell topology. The situation for 3D foams is poorly understood, despite claims to the contrary, where growth rate depends on that cell shape as well as topology. Isotropic Plateau polyhedra (IPP) are hypothetical 3D foam cells, composed of F regular spherical-capped faces, that fulfill Plateau's laws and enable an analytical solution for the growth rate in terms of F.

We use the Surface Evolver to model the deformation of Platonic foam cells that are suspended from wire frames. The deformed cells satisfy Plateau's laws when subjected to compression, extension, shear and torsion. For all three Platonic foams, which are the realisable IPP, we observe different responses in the growth rate to deformation, depending on cell type, deformation mode and frame size. The growth rate can increase or decrease with increasing cell distortions: in the case of pentagonal dodecahedron cells subjected to torsion, even the direction of diffusion can change. Our analysis of the relation between cell deformation and growth rate offers insight into the coarsening of real foams, where cells are not necessarily regular and isotropic.

DY 32.2 Fri 10:15 MA 144

Colloid crystallization on strained substrates —
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The crystallization behavior of charge-stabilized polystyrene colloids on a colloidal monolayer [1] is modeled by kinetic Monte Carlo simulations. In this context, the local properties of particles in simply shaped colloid clusters are studied as a function of substrate strain due to lattice mismatch. The colloidal depletion interaction is described by a short-range Morse potential. It is shown the experimental data for isotropically strained square lattices can be reproduced. Putting the focus on a particular intermediate strain, the behavior of the colloid crystals is examined with regard to the dependence on temperature. Remarkably, one observes the crystals melt with decreasing temperature, contrary to general expectation. Based on a particle dimer, this is explained by the interplay of energy and entropy both of which show a distinct dependence on the height of the particles as well as the particle-particle distance.

[1] R. Ganapathy, M. R. Buckley, S. J. Gerbode, I. Cohen, Science, 327, 445 (2010).

DY 32.3 Fri 10:30 MA 144

Gravitational-like collapse in a petri dish: shock waves in the capillary compactification of a colloidal patch —
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Interfacially trapped, micrometer-sized colloidal particles interact via long-ranged capillary attraction which is analogous to two-dimensional screened Newtonian gravity with the capillary length λ as the tunable screening length. Using Brownian dynamics simulations, density functional theory, and analytical perturbation theory, we study the dynamics of a finitely-sized patch of colloids. Whereas the limit $\lambda \to \infty$ corresponds to the global collapse of a self-gravitating fluid, for intermediate λ we predict theoretically and observe in simulations a ring-like density peak at the outer rim of the disclike patch, moving as an inbound shock wave [1]. For smaller l the dynamics crosses over to spinodal decomposition showing a coarsening of regions of enhanced density which emerge from initial fluctuations [1,2]. The influence of

hydrodynamic interactions on this capillary collapse will be discussed.

[1] J. Bleibel, A. Domínguez, S. Dietrich, and M. Oettel, Phys. Rev. Lett. 107, 128302 (2011).

[2] J. Bleibel, A. Domínguez, M. Oettel, and S. Dietrich, Eur. Phys. J. E 34, 125 (2011).

DY 32.4 Fri 10:45 MA 144

Influence of Striped Surface-Inhomogeneities on the Conformations of a Single Self-Interacting Polymer near an Attractive Substrate —
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Specific interaction between a polymer and a solid substrate is a key ingredient of the problem of how the polymer can recognize a target surface with a specific pattern. The statistics of homopolymer adsorption onto homogeneously attractive substrates has been studied quite extensively in the past. In our own recent studies [1,2], we investigated thermal fluctuations of energetic and structural quantities to identify a variety of pseudophases of a semiflexible off-lattice homopolymer for a range of different surface attraction strengths and temperatures and complemented this by a microcanonical analysis. By slowly "switching on" a striped surface potential we now study how this conformational behavior is modified and the collapse, freezing, adsorption and surface-recognition of an individual chain are related. The width of the stripe is also varied to some extent since it turns out to have a considerable influence. Shape anisotropy is discussed as well. In all cases studied, the adsorption and the recognition are found to be well-separated. The data are obtained by parallel tempering Monte Carlo simulations.

[1] M. Möddel, M. Bachmann, and W. Janke, J. Phys. Chem. B **113**, 3314 (2009); [2] M. Möddel, W. Janke, and M. Bachmann, Phys. Chem. Chem. Phys. **12**, 11548 (2010); Macromolecules, **44**, 9013 (2011).

DY 32.5 Fri 11:00 MA 144

Bifurcations of films of binary liquid mixtures on a solid substrate and with a free surface —
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Model-H is used to describe the phase separation of a free surface film of a binary liquid mixture on a horizontal solid homogeneous substrate [see e.g., U. Thiele, S. Madruga and L. Frastia, *Phys. Fluids* **19**, 122106 (2007)]. We consider the incompressible and isothermal case. The spatial distribution of the two components of the mixture is characterised by the local difference in concentrations. The upper surface of the film (liquid-gas interface) is free to move and characterised by the film thickness profile. The present study focuses on (i) the linear stability (in time) of steady stratified (layered) critical films and (2) fully two-dimensional steady states characterised by their concentration profiles and film thickness profiles for the critical (mean concentration equals zero) and off-critical (mean concentration does not equal zero) cases. The bifurcation structure is determined for various steady states employing as control parameter the lateral domain size and mean concentration for the critical and off-critical case respectively. Thereby the mean film thickness and the energetic bias at the free surface (corresponding to a linear Marangoni effect) are fixed at several particular values.

DY 32.6 Fri 11:15 MA 144

Soft tetramer model for diblock copolymers —
•Thomas Michael and Wolfgang Paul — Institut für Physik, Martin-Luther-Universität, 06099 Halle

Analytical results for a soft-particle model for diblock copolymers are presented. The tetramer model consists of a soft dumbbell for each block. The overall four beads interact by an effective soft-particle pair-potential. The interaction length is finite. The analytical calculations result in a phase diagram of the melt depending on the composition of the diblock copolymer and the temperature. The corresponding collective structure factor of the polymer melt is calculated in RPA.

The compressible and incompressible case is discussed and the results are compared to Monte-Carlo simulations [1] based on the same model and to experiments.

[1] C. Gross and W.Paul, Soft Matter, **6**, 3273 (2010)

DY 32.7 Fri 11:30 MA 144

Charged Colloids under Gravity — •Erdal Celal Oğuz[1], René Messina[2], and Hartmut Löwen[1] — [1]Institut für Theoretische Physik II: Weiche Materie, Heinrich-Heine-Universität Düsseldorf, Universitätsstraße 1, D-40225 Düsseldorf, Germany — [2]Laboratoire de Chimie et Physique - Approche Multi-Echelle des Milieux Complexes, Université de Lorraine, Institut de Chimie, Physique et Matériaux (ICPM), 1 Bld Arago, 57078 Metz - Cedex 3, France

In the ongoing presentation we report the structural solid-solid transitions of purely repulsive colloidal particles under gravity. We perform Monte Carlo simulations, where the constitutive particles are governed by the Yukawa pair interaction and the colloids are initially confined onto a hard planar surface by the gravity. For sufficiently high gravitational strengths particles are arranged in a riangular monolayer lattice. Reducing the gravitational strength leads to more layers of the same symmetry but less particle density, a superlattice respectively. Thus, our model enables a controlled layering mechanism. Furthermore, theoretical predictions are proposed to characterize the monolayer-multilayer transitions.

DY 32.8 Fri 11:45 MA 144

Freezing behavior of parallel hard spherocubes — Matthieu Marechal, •Urs Zimmermann, and Hartmut Löwen — Institut für Theoretische Physik II, Heinrich-Heine-Universität Düsseldorf, Universitätstraße 1, 40225 Düsseldorf, Germany

The monocomponent fluid of parallel hard cubes exhibits a continuous freezing transition, whereas hard spheres possess a first order freezing transition. We introduce the model of parallel hard spherocubes, a class of colloidal shapes characterized by the cube parameter q that describes the continuous deformation from parallel hard cubes ($q = 1$) to hard spheres ($q = 0$). The extended-deconvolution fundamental measure theory is used as well as Monte Carlo and event-driven Molecular Dynamics simulations to determine the phase boundaries. The qualitative change from continuous freezing to first order freezing is analyzed with respect to the shape of the spherocubes. The continuous freezing is found to be persistence for cubes with finite rounding ($q < 1$). We present a phase diagram of packing fraction and the cube parameter q, discuss deviations between theory and simulations and observe an anomalous high vacancy concentration ($> 10\%$) in the solid phase. Furthermore a new stable crystalline structure corresponding to a sheared simple cubic phase is found.

DY 32.9 Fri 12:00 MA 144

Randomly Charged Polymers in Porous Environments — Viktoria Blavatska[1] and •Christian von Ferber[2,3] — [1]Institute for Condensed Matter Physics, NAS Ukraine, UA-79011 Lviv — [2]Applied Mathematics Research Centre, Coventry University, Coventry, UK — [3]Theoretische Polymerphysik, Universitat Freiburg, 79104 Freiburg

Macromolecules in solution as they are encountered in chemical and biological physics may often be described as long flexible chains. Their conformations are strongly influenced by monomer-monomer interactions. In the absence of other interactions the excluded volume interaction governs the behaviour in the long chain limit. Here, however we we consider the influence of two additional effects namely positive or negative charges along the chain (as observed e.g. for peptides) and secondly a disordered environment that displays long range correlations (that decay with a power law). Both of these long range effects induce additional interactions. We discuss in detail the interplay between these three interactions and determine the situations in which they may govern the conformational behaviour of the polymer.

DY 32.10 Fri 12:15 MA 144

Nonlocal effective average action approach to crystalline phantom membranes — •Nils Hasselmann[1] und Fabio L. Braghin[2] — [1]MPI f. Festkörperforschung, Heisenbergstr. 1, D-70569 Stuttgart — [2]Instituto de Fisica, UFG, Goiania, Brazil

We investigate the properties of crystalline phantom membranes, at the crumpling transition and in the flat phase, using a nonperturbative renormalization group approach. We avoid a derivative expansion of the effective average action and instead analyse the full momentum dependence of the elastic coupling functions. This leads to a more accurate determination of the critical exponents and further yields the full momentum dependence of the correlation functions of the in-plane and out-of-plane fluctuation. The flow equations are solved numerically for $D = 2$ dimensional membranes embedded in a $d = 3$ dimensional space. Within our approach we find a crumpling transition of second order which is characterized by an anomalous exponent $\eta_c \approx 0.63(8)$ and the thermal exponent $\nu \approx 0.69$. Near the crumpling transition the order parameter of the flat phase vanishes with a critical exponent $\beta \approx 0.22$. The flat phase anomalous dimension is $\eta_f \approx 0.85$ and the Poisson's ratio inside the flat phase is found to be $\sigma_f \approx -1/3$. At the crumpling transition we find a much larger negative value of the Poisson's ratio $\sigma_c \approx -0.71(5)$. We discuss further in detail the different regimes of the momentum dependent fluctuations, both in the flat phase and in the vicinity of the crumpling transition, and extract the crossover momentum scales which separate them.