CPP 57: Complex Fluids and Soft Matter - Part I (joint session DY, CPP, BP)

Time: Wednesday 15:00–16:45 Location: BH-N 333

CPP 57.1 Wed 15:00 BH-N 333

Particle segregation in a sedimenting bidisperse soft sphere system — Matthias Kohl and •Michael Schmiedeberg — Institut für Theoretische Physik II: Weiche Materie, Heinrich-Heine-Universität Düsseldorf, 40204 Düsseldorf, Germany

We explore the sedimentation process of a binary soft colloidal sphere system. In case of large overlaps of the particles the segregation dynamics differs significantly from that of hard particles. By using Brownian dynamics simulations and theoretical predictions, we find new complex states [1]. For example, multiple-phase-stackings where large particles gather both at the top and the bottom of the system or metastable network-like structures occur. We analyze the comprehensive dynamics of the segregation process. Usually, we observe a multiple-step process: First there is local segregation, then clusters are formed, and finally the clusters sink to their equilibrium position.

[1] M. Kohl and M. Schmiedeberg, Soft Matter 10, 4340 (2014).

CPP 57.2 Wed 15:15 BH-N 333

Suppression of Ostwald Ripening by Chemical Reactions in Active Emulsions — •David Zwicker[1,2], Anthony A. Hyman[3], and Frank Jülicher[2] — [1]Harvard University, Cambridge MA, USA — [2]Max Planck Institute for the Physics of Complex Systems, Dresden, Germany — [3]Max Planck Institute of Cell Biology and Genetics, Dresden, Germany

Ostwald ripening is a coarsening process of droplets in an emulsions that is driven by the surface tension of the droplets. This coarsening must be suppressed to stabilize emulsions, e.g. to control the properties of pharmaceuticals, food, or cosmetics. Ostwald ripening must also be suppressed in biological cells, which contain liquid-like compartments, e.g. germ granules, Cajal-bodies, and centrosomes. Such systems are often driven away from equilibrium by chemical reactions and can thus be described as active emulsions.

Here, we show that non-equilibrium chemical reactions can suppress Ostwald Ripening, leading to stable, monodisperse emulsions. Using a coarse-grained description of the droplet dynamics, we derive analytical approximations of the typical droplet size, droplet count, and time scale of the dynamics. We also compare these results to numerical simulations of the continuous concentration fields. We thus show how chemical reactions can be used to stabilize emulsions and control their properties.

CPP 57.3 Wed 15:30 BH-N 333

Binary mixtures of hard rod–like colloids: mesoscopic equilibrium theory and shear-driven instabilities — •Rodrigo Lugo Frias and Sabine Klapp — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

Mixtures of rod–like particles occur in a wide range of biological contexts and technological applications, and their equilibrium phase behavior has been intensely studied in recent years. Here we investigate a binary mixture of rod–like colloidal particles driven out of equilibrium by means of a steady shear flow (Couette geometry).

Using classical density functional theory (DFT), we first derive a mesoscopic free energy functional for a mixture of hard spherocylinders with different length–to–length ratio in terms of tensorial order parameters that describe their alignment. The resulting free energy displays a strong dependence on the microscopical properties of the system. Based on the equilibrium analysis, we then discuss the dynamical behavior of the mixture using a natural extension of the mesoscopic Doi–Hess theory. In particular we analyze the orientational dynamics under shear for varying shear rate, concentration and aspect ratio.

[1] F. Tardani, L. Gentile, G. A. Ranieri and C. La Mesa, J. Phys. Chem. C, **117**, 8556 (2013).
[2] S. Hess, Z.Naturforsch. A **31a**, 1034 (1976). M. Doi, J.Polym. Sci., Polym. Phys. Ed. **19**, 229 (1981).
[3] R. Lugo-Frias and S. H. L. Klapp, in preparation (2015).

CPP 57.4 Wed 15:45 BH-N 333

Dynamics of the Critical Casimir Effect in a Binary Fluid — •Sutapa Roy, Felix Höfling, and S. Dietrich — Max-Planck-Institut für Intelligente Systeme, Stuttgart and Institut für Theoretische Physik IV, Universität Stuttgart, Germany

A binary fluid mixture near its consolute point exhibits critical fluctuations of the local composition. While the static properties of the mixture are well described by the 3D Ising universality class [1], the dynamic properties involving conservation of particle number and concentration, energy, and momentum are classified as model H' [2]. Confinement of critical fluctuations in such a mixture leads to critical Casimir forces (CCF) [3] acting on the confining surfaces.

We present results for the CCF in a symmetric binary Lennard-Jones model fluid, confined in a slit pore, close to its bulk critical point. Utilizing the computing resources of GPUs [4], molecular dynamics (MD) simulations were performed for system sizes of up to 216,000 particles and 5 orders of magnitude in time which is well beyond common computational efforts. Our results from MD and Monte Carlo simulations, for various static and dynamic quantities, both in bulk and in confinement, are compared to theory and experimental observations.

[1] S.K. Das *et al.*, J. Chem. Phys. **125**, 024506 (2006).
[2] P.C. Hohenberg and B.I. Halperin, Rev. Mod. Phys. **49**, 435 (1977).
[3] C. Hertlein, L. Helden, A. Gambassi, S. Dietrich and C. Bechinger, Nature **451**, 172 (2008).
[4] P. Colberg and F. Höfling, Comput. Phys. Commun. **182**, 1120 (2011).

CPP 57.5 Wed 16:00 BH-N 333

Simulating many-body Casimir interactions in colloidal suspensions — •Hendrik Hobrecht and Fred Hucht — Fakultät für Physik, Universität Duisburg-Essen and CENIDE, 47048 Duisburg

We study the fluctuation-induced (Casimir) interactions in colloidal suspensions, especially between colloids immersed in a binary liquid close to its critical demixing point for two-dimensional systems. To simulate those systems, we present a Monte Carlo cluster algorithm based on geometric symmetries of the Hamiltonian. Utilizing the principle of universality, the suspension is represented by an Ising system while the colloids are areas of spins with fixed orientation. Our results for the Casimir interaction potential between two particles agree quantitatively with the theoretical predictions [1], where we find that the behavior depends strongly on whether the order parameter is hold fixed or is allowed to fluctuate. Finally we present our results for the three-body interaction Casimir potential.

[1] T. W. Burkhardt and E. Eisenriegler, Phys. Rev. Lett. 74 (1995) 3189.

CPP 57.6 Wed 16:15 BH-N 333

Flow induced deflection of a liquid-crystal topological defect — Tillmann Stieger[1], Martin Schoen[1], and •Marco G. Mazza[2] — [1]Technische Universität Berlin — [2]Max-Planck-Institut für Dynamik und Selbstorganisation

We perform nonequilibrium molecular dynamics simulations of a nematic liquid crystal flowing around a colloidal particle. We study the flow-induced modifications of the Saturn ring defect and the surface ring defect in the liquid crystal. By varying the strength of the interaction between liquid crystal and colloid we can produce Saturn rings of different sizes. We study the deflection of the topological defect as a function of applied stress, and find a linear, that is Hookean, stress-strain dependence. We relate this finding to the elastic properties of the nematic liquid crystal and to the properties of the core of the topological defect.

CPP 57.7 Wed 16:30 BH-N 333

Modeling drying droplets on porous substrates — •Christian Diddens[1], Hans Kuerten[1], Cees van der Geld[1], and Herman Wijshoff[1,2] — [1]Eindhoven University of Technology, The Netherlands — [2]Océ Technologies B.V., Venlo, The Netherlands

We investigate the drying of an inkjet-printed picoliter droplet on a porous substrate in the framework of a numerical model. The evolution of the droplet is governed by evaporation at the liquid-air interface and absorption of the liquid into the porous substrate.

When a binary mixture is considered, an interplay of preferential evaporation, composition-dependent viscosity and the absorption dynamics can interestingly result in a slower drying for faster evaporation rates.

Since solute particles and their deposition to the surface are also taken into account, the present model can be utilized as predictive tool for deposition patterns in ink-jet printing processes.