CPP 20: Complex Fluids and Soft Matter (original: DY, joined by CPP, BP)

Time: Tuesday 9:30–11:30 Location: ZEU 118

CPP 20.1 Tue 9:30 ZEU 118

Microrheology of shear thinning solutions — •Juan Ruben Gomez-Solano[1,2] and Clemens Bechinger[1,2] — [1]Universitaet Stuttgart, 2. Physikalisches Institut, Pfaffenwaldring 57, 70569 Stuttgart, Germany — [2]Max-Planck-Institute for Intelligent Systems, 70569 Stuttgart, Germany

Colloidal probes embedded in complex fluids have been extensively employed to investigate their rheological response to small stress. However, this approach is not evident for fluids subjected to large stresses, where a variety of non-Newtonian behaviors can occur. One example of such systems are semi-dilute micellar solutions, which consist of surfactant molecules forming worm-like micelles entangled in aqueous solution. In this work, we study the motion of a colloidal probe dragged by an optical trap through a semi-dilute micellar solution of cetylpyridinium chloride. The motion of the probe creates a shear strain, which depends linearly on its mean velocity v. We measure the effective viscous drag on the probe and the fluctuations of its position as a function of v. We find that at small v, the system can be characterized by a constant viscosity, whereas the position fluctuations are statistically the same as in thermal equilibrium. However, above a certain value, the viscosity decreases as a function of v. The fluctuations of the particle position are also affected in the shear-thinning regime, and their power spectral density increases with increasing v. We find that the transition between both regimes typically occurs when the shear rate exceeds the inverse relaxation time of the entangled micelles.

CPP 20.2 Tue 9:45 ZEU 118

Shear driven instabilities in anisotropic colloidal mixtures — •Rodrigo Lugo-Frias and Sabine H. L. Klapp — Institut für Theoretische Physik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

In recent years much attention has been paid in understanding the orientational order of anisotropic hard bodies in the presence of steady shear flow [1,2]. On the other hand, sheared systems of binary mixtures of hard disc and rodlike particles have also been examined [3].

We focus in the nonequilibrium dynamics of a binary mixture of rodlike nematic polymers under shear flow. To do so, we derive from density functional theory (DFT) a mesoscopic free energy in terms of the alignment tensor for each component. We proceed to investigate their dynamical behavior using the well known mesoscopic Doi–Hess theory, which lead to a set of nonlinear differential equations [4,5,6]. Finally, we examine the total alignment of each component and its dependencies with the physical properties of the system.

[1] S. H. L. Klapp and S. Hess, Phys. Rev. E **81**, 051711 (2010).
[2] D. Strehober, H. Engel and S. H. L. Klapp, Phys. Rev. E **88**, 012505 (2013).
[3] F. Tardani, L. Gentile, G. A. Ranieri and C. La Mesa, J. Phys. Chem. C, **117**, 8556 (2013).
[4] S. Hess, Z.Naturforsch. A **31a**, 1034 (1976).
[5] M. Doi, J.Polym. Sci., Polym. Phys. Ed. **19**, 229 (1981).
[6] S. Hess and M. Kröger, J.Phys.: Cond. Matter, **16**, S3835 (2004).

CPP 20.3 Tue 10:00 ZEU 118

Friction of Colloidal Crystals on Commensurate and Incommensurate Substrates — •Aleksandar Mijailović and Michael Schmiedeberg — Theoretische Physik 2, Heinrich-Heine Universität, Düsseldorf, Germany

Among the fascinating properties of quasicrystals - structures that possess long range order but no translational symmetry - is the very low friction that was observed when a periodic crystal is moved over the surface of a quasicrystal [1]. Here we want to explore whether there are geometrical reasons for the small friction.

Using Brownian Dynamics simulations, the friction properties of 3D colloidal fcc-crystals on substrates with different geometries are studied. We measure the friction as a function of the drag force applied on the crystal, from which the friction coefficient is extracted. We repeat this analysis for commensurate, incommensurate perodic, and quasicrystalline substrates and investigate the effect of incommensurability as well as aperiodicity.

The (charged) colloidal particles are interacting via the Asakura-Oosawa Model, i.e., a superposition of the screened-Coulomb potential and an attractive term, which is due to the presence of non-adsorbing polymers (not treated explicitly). Finally, our results are compared to the 2D case (cf., e.g., [2].

1. J. Y. Park *et al.*, *Science* **309**, 1354 (2005).
2. T. Bohlein *et al.*, *Nat. Mat.* **11**, 126 (2012).

CPP 20.4 Tue 10:15 ZEU 118

Complex dynamics of a bilamellar vesicle as a simple model for leukocytes — •Badr Kaoui — Theoretical Physics I, University of Bayreuth, 95440 Bayreuth, Germany — Department of Applied Physics, Eindhoven University of Technology, P. O. Box 513, 5600 MB Eindhoven, The Netherlands

The influence of the internal structure of a biological cell (e.g., a leukocyte) on its dynamics and rheology is not yet fully understood. By using 2D numerical simulations of a bilamellar vesicle (BLV) consisting of two vesicles as a cell model, we find that increasing the size of the inner vesicle (mimicking the nucleus) triggers a tank-treading-to-tumbling transition. A new dynamical state is observed, the undulating motion: the BLV inclination with respect to the imposed flow oscillates while the outer vesicle develops rotating lobes. The BLV exhibits a non-Newtonian behavior with a time-dependent apparent viscosity during its unsteady motion. Depending on its inclination and on its inner vesicle dynamical state, the BLV behaves like a solid or a liquid [Badr Kaoui, Timm Krüger and Jens Harting, Soft Matter 9, 8057 (2013)].

15 min break

CPP 20.5 Tue 10:45 ZEU 118

Random Organization and Jamming within a unifying model system — •Lars Milz[1] and Michael Schmiedeberg[2] — [1]Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany — [2]Institut für Theoretische Physik 2: Weiche Materie, Heinrich-Heine-Universität Düsseldorf, D-40204 Düsseldorf, Germany

We show that both random organization and jamming occur within the same model packing problem despite the obvious differences between these two transitions: The random organization transition describes the change from reversible to irreversible dynamics in a non-equilibrium system and the athermal jamming transition occurs when particles can no longer avoid overlaps if quenched from infinite to zero temperature.

In our unifying model system the particles are initially randomly distributed and then displaced in each step if they overlap. For random displacements we obtain a random organization transition while jamming occurs in case of deterministic shifts. For the random organization transition, we also determine the critical exponents. For the jamming transition we observe a divergence of the relaxation time of our method.

Within our model system, random organization and jamming are opposite limits of random sphere packings. In future, we want to study intermediate packing problems or mixtures or random organization and jamming that probably correspond to other equilibrium or non-equilibrium transitions.

CPP 20.6 Tue 11:00 ZEU 118

Foam morphology, frustration and topological defects in a Negatively curved Hele-Shaw geometry — •Adil Mughal, Myfanwy Evans, and Gerd Schröder-Turk — Institut fur Theoretische Physik, Friedrich-Alexander Universitat Erlangen-Nurnberg, Staudtstr. 7, D-91058 Erlangen, Germany

We present preliminary simulations of foams and single bubbles confined in a narrow gap between parallel surfaces. Unlike previous work, in which the bounding surfaces are flat (the so called Hele-Shaw geometry), we consider surfaces with non-vanishing Gaussian curvature.

We demonstrate that the curvature of the bounding surfaces induce a geometric frustration in the preferred order of the foam. This frustration can be relieved by the introduction of topological defects (disclinations, dislocations and complex scar arrangements). We give a detailed analysis of these defects for foams confined in curved Hele-Shaw cells and compare our results with exotic honeycombs, built by bees on surfaces of varying Gaussian curvature.

Our simulations, while encompassing surfaces of constant Gaussian

curvature (such as the sphere and the cylinder), focus on surfaces with negative Gaussian curvature and in particular triply periodic minimal surfaces (such as the Schwarz P-surface and the Schoen's Gyroid surface). We use the results from a sphere-packing algorithm to generate a Voronoi partition that forms the basis of a Surface Evolver simulation, which yields a realistic foam morphology.

CPP 20.7 Tue 11:15 ZEU 118

Molecular simulation methods to compute interfacial free energies — •Ronald Benjamin and Juergen Horbach — Theoretical Physics II, Heinrich-Heine Universitaet, 40225 Duesseldorf, Germany

Knowledge of interfacial free energies are crucial to understanding physical phenomena such as wetting and nucleation. In this talk we discuss several ways to extract this quantity for wall-liquid and wall-crystal interfaces. Chiefly, we discuss a new thermodynamic integration scheme developed to determine the interfacial free energy and compare it to a non-equilibrium work method and a Gibb's-Duhem type of approach known as "Gibb's-Cahn integration".

We also extended our thermodynamic integration scheme to obtain the excess free energy of a supercooled liquid in contact with amorphous walls having the same structure as the liquid. Our results shed new light on the thermodynamic behavior of supercooled liquids and help explain their slowing down in the presence of such rough walls.