# CPP 20: POSTERS Driven Soft Matter

Time: Wednesday 16:00–18:30 Location: Poster A

CPP 20.1 Wed 16:00 Poster A

**Alignment of microphase separated block-copolymers by ionic polarization** — •Peter Kohn, Klaus Schröter, and Thomas Thurn-Albrecht — Department of Physics, Martin Luther University Halle-Wittenberg, 06120 Halle, Germany

Microphase separated block-copolymers display well defined local periodic structures. In the absence of an external field the domains are oriented isotropically on a macroscopic scale. It is well known that by applying a static external electric field, which couples to the dielectric contrast of the domains, the system's thermodynamic equilibrium is changed to the state where the domain interfaces are oriented along the electric field direction.
In contrast to this approach we show that alignment can also be achieved with AC-electric fields which induce an additional polarization caused by mobile ions in a system with selective ion solubility in one block. In such a dissipative conducting system the resulting structure is governed by stability considerations rather than thermodynamic equilibrium, but an orientation of the interfaces parallel to the field is the stable domain-orientation with no torque acting on the domains. We use impedance spectroscopy to characterize the induced ionic polarization in a styrene-methylmethacrylate block-copolymer doped with lithium triflate. By small-angle x-ray scattering the effect of electric fields of different frequency and strength on the domain orientation is studied. Orientation based on mobile ion polarization is more efficient than the dielectric mechanism of orientation.

CPP 20.2 Wed 16:00 Poster A

**Bistable and chaotic solutions in polar nano-rod systems under shear** — •Stefan Grandner[1], Sebastian Heidenreich[2], Siegfried Hess[2], and Sabine H. L. Klapp[1,2] — [1]Stranski-Laboratorium, TU Berlin, Straße des 17. Juni 115, D-10623 Berlin, Germany — [2]Institut für theoretische Physik, TU Berlin, Hardenbergstraße 36, D-10623 Berlin, Germany

The orientational dynamics of rod-like particles with permanent dipole moment shows a time dependent response in a plane Couette flow. This behavior can be described by nonlinear mesoscopic relaxation equations for the alignment tensor [1] and the polarization [2] combined with a generalized Landau free energy. This yields an eight-dimensional coupled system of differential equations. For simplicity we assume a spatially homogeneous system. Numerical results are presented for longitudinal dipoles where the equilibrium state is a polarized nematic. The large variety of periodic, transient chaotic and chaotic states is summarized in solution diagrams [3]. Compared to the non-polar case we observe a preference of dynamic states out of the shear plane and a higher sensitivity to initial conditions, resulting in larger bistability regions. The time dependence of the electric polarization generates magnetic fields of measurable strength.
[1] S. Hess, Z. Naturforsch. **30a**, 728, 1224 (1975).
[2] S. Grandner, S. Heidenreich, P. Ilg, S. H. L. Klapp, and S. Hess, Phys. Rev. E **75**, 040701(R) (2007).
[3] S. Grandner, S. Heidenreich, S. Hess, and S. H. L. Klapp - Polar nano-rods under shear: From equilibrium to chaos (submitted).

CPP 20.3 Wed 16:00 Poster A

**Growth instabilities of thin colloidal crystals prepared by convective self assembly.** — José Marqués-Hueso and •Hans Joachim Schöpe — Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudinger Weg 7, 55099 Mainz, Deutschland

Colloidal particles have proved to be a suitable precursor to the formation of nanoscaled materials. More explicitly, crystalline arrays of colloidal particles (synthetic opals) show interesting optical properties with potential application as new types of optical gratings or optical filters. They further serve as a starting material of 3D photonic band gap materials. Their performance heavily relies on the material quality. One of the less studied defects in the case of colloidal crystals produced by vertical deposition is the modulation of the film thickness. Often a near regular periodic horizontal modulation in the thickness of the crystalline film can be observed. In our manuscript we present the first systematic measurements of the thickness modulation as a function of the volume fraction and the salt concentration of the suspension, of the tilting angle of the substrate, of the substrate material and of the pulling speed. We observe a variation of the growth velocity suggesting an inconstant behavior of the meniscus with a stick-slip motion like observed in simple droplet drying experiments. We suggest that a stick-slip motion of the meniscus during the evaporation process can explain the stripes morphology in the case of colloidal crystals.

CPP 20.4 Wed 16:00 Poster A

**Bouncing Droplets and Partial Coalescence with Polymer Solutions** — •Stephan Gier[1], Stéphane Dorbolo[2], and Christian Wagner[1] — [1]Technische Physik, Universität des Saarlandes, D-66123 Saarbrücken — [2]GRASP, Université de Liège, B-4000 Liège

We investigate bouncing droplets consisting of different polymer solutions on a vibrated Newtonian liquid surface. It is known that Newtonian liquid droplets on a vibrated bath of a high viscosity oil undergo a bouncing motion. In our experiments we see that adding different polymers or surfactants changes the bouncing behaviour of the droplets. This holds for both the shape of the droplets and the acceleration threshold of the vibrated bath. If one puts a liquid droplet on an interface between two fluids, where the lower one is the same as the droplet fluid, then partial or total coalescence can occur depending on four dimensionless parameters (Bond number, Ohnesorge numbers of both fluids, relative density difference between the two fluids). This is well known for Newtonian liquids. For our non-Newtonian solutions the coalescence is only nearly partial in all the experiments because the elasticity of the polymer solutions suppresses the forming of a so-called daughter droplet.

CPP 20.5 Wed 16:00 Poster A

**Colloids in non-equilibrium steady states - Direct measurement of a reponse function** — •Maximilian Semmling, Valentin Blickle, and Clemens Bechinger — 2. Physikalisches Institut, Universität Stuttgart

The Brownian motion in equilibrium has been studied for long time. In recent times remarkable progress in the understanding of non-equilibrium systems was made. The Jarzynski Relation and other fluctuations theorems of non-equilibrium systems have been tested for different experimental setups.

As the simplest case we study non-equilibrium steady states of colloidal particles. In our setup we use a rotating laser trap to apply a tilted periodic potential to the particle. We obtain different non-equilibrium steady states by changing the driving force of the laser. We measure the time dependent velocity response of the system driven from one steady state to another.

CPP 20.6 Wed 16:00 Poster A

**Salt concentration and particle density dependence of electrophoretic mobilities of spherical colloids in aqueous suspension** — •Tetyana Köller[1], Holger Reiber[1], Thomas Palberg[1], and Felix Carrique[2] — [1]Institut für Physik, Johannes Gutenberg Universitaet, 55099 Mainz, Germany — [2]Departamento de Fisica Aplicada 1, Universidad de Málage, Campus de Teatinos, 29071 Málaga, Spain

Using Laser Doppler Velocimetry in the super-heterodyne mode, we conducted a systematic study of the electrophoretic mobility of dispersions of small silica spheres (a=18nm) suspended in water at different salinity and particle concentration. The concentration of NaCl was varied from 40$\mu$M up to 16mM, while the particle concentrations were varied between 4,2x10ˆ18 mˆ-3 and 2,1x10ˆ20 mˆ-3. We find a decrease of mobility with increasing salt concentrations and an increase with increased particle number densities. The latter observation is not backed by the standard cell model of electrophoresis with Shilov-Zharkikh boundary conditions. Rather, if the experimental data are interpreted within that model an unexpected change of the zeta potential at constant added salt concentration results. Interestingly, all experimental data collapse on a single master curve, if plotted versus the ratio C* of particle counter ions to added salt ions. We obtain a logarithmic increase of mobility for C*<1 and a plateau for C*>1. This may indicate a change of the Stern layer structure not yet included in the theoretical model.

CPP 20.7 Wed 16:00 Poster A

**Polymer drift in a solvent by force acting on one polymer end** — •Semjon Stepanow[1] and Norio Kikuchi[2] — [1]Institut für

Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle, Germany — [2]Centre for Condensed Matter Theory, Department of Physics, Indian Institute of Science, Bangalore 560 012 India

We investigate the effect of hydrodynamic interactions on the non-equilibrium drift dynamics of an ideal flexible polymer pulled by a constant force applied at one polymer end using the perturbation theory and the renormalization group method. For moderate force, if the polymer elongation is small, the hydrodynamic interactions are not screened and the velocity and the longitudinal elongation of the polymer are computed using the renormalization group method. Both the velocity and elongation are nonlinear functions of the driving force in this regime. For large elongation we found two regimes. For large force but finite chain length L the hydrodynamic interactions are screened. For large chain lengths and a finite force the hydrodynamic interactions are only partially screened, which in three dimensions results in unusual logarithmic corrections to the velocity and the longitudinal elongation.

CPP 20.8 Wed 16:00 Poster A

**Instabilities in straight and curved microchannels** — •Virginie Vergnat and Christian Wagner — Technische Physik, Universität des Saarlandes, D-66123 Saarbrücken

We present experimental measurements on flow instabilities of pressure driven polymer solutions in curved microchannels. We investigate how these instabilities develop at the end of the curvature, when the microchannel becomes a straight, flat channel. The pressure driven flow of elastic liquids in curved channels is linear unstable whilst in straight channels it is stable. But the form of, and the threshold to, a nonlinar instability is controversially discussed. We use Micro-PIV to determine the type of instability, e.g if there might be convective or global instability regimes.

CPP 20.9 Wed 16:00 Poster A

**Fluctuation-dissipation theorem for soft matter systems in shear flow** — •Thomas Speck and Udo Seifert — II. Institut für Theoretische Physik, Universität Stuttgart, Germany

In equilibrium, the fluctuation-dissipation theorem (FDT) connects the response of an observable with the time-derivative of the correlation function between this observable and its conjugate with respect to the external perturbation. If we drive the system into a nonequilibrium steady state then entropy will be produced on average and the FDT breaks down. We have shown how to quantify the breakdown of the FDT for a single particle through an additive violation function [1]. We will extend this result to soft matter systems composed of many particles like polymers and colloidal suspensions. As an illustration, we calculate analytically the violation function in the case of a Rouse polymer in simple shear flow.

[1] T. Speck and U. Seifert, Europhys. Lett. **74**, 391 (2006).

CPP 20.10 Wed 16:00 Poster A

**AC field-induced shape change of nematic liquid crystalline droplets** — •Günter K. Auernhammer, Jinyu Zhao, Beate Ullrich, and Doris Vollmer — MPI Polymerforschung, Mainz, Germany

We investigate the influence of AC fields on nematic liquid crystalline droplets coexisting with and immersed in a continuous isotropic phase of the same mesogenic liquid. Its dielectric constant and (small but non-vanishing) electric conductivity depend on both the phase and the orientation. These dependences can give rise to convective motion in the nematic phase (electro-hydrodynamic convection, EHC) or near the droplet surface (leaky dielectric model, LDM). Due to the extremely low surface tension of nematic-isotropic interface, viscous stresses easily can induce substantial deformations visible under the microscope.

We follow the influence of frequency and electric field strength on the deformation of the droplets for liquid crystals with positive and negative dielectric anisotropy (5CB and MBBA). In both cases we find a disk-like (oblate) deformation which shows a maximum when plotted as a function of frequency at constant applied field. Isotropic droplets in a nematic surrounding behave in a similar manner but show an elongation (prolate deformation). Depending on the initial size of the droplets, the interaction between neighboring droplets is either attractive or repulsive. Added tracer particles in the isotropic phase reveal a convective motion around the nematic droplets driving the deformation of the droplet. We interpret our findings in the frame work of the LDM and find good agreement.

CPP 20.11 Wed 16:00 Poster A

**Quantitative test of Mode Coupling theory for quasi-hard spheres** — Fabian Weysser[1], Antonio Puertas[2], Thomas Voigtmann[3], and •Matthias Fuchs[1] — [1]Universität Konstanz, Fachbereich Physik, Germany — [2]Universidad de Almería, Departamento de Física Aplicada, Spain — [3]University of Edinburgh, School of Physics, Great Britain

Mode Coupling Theory (MCT), describes a dynamical phase transition to a glassy state for colloidal suspensions and molecular liquids. As only input to the theory the static structurefactor of the system is being used. The polydisperse hard sphere system is one of the simplest model system: While polydispersity prevents crystallization the system still exhibits a glass transition. Numerical solutions of the MCT equations were calculated for a Molecular Dynamics (MD) system of polydisperse quasi hard spheres. The structurefactor input originated from this MD system. The MCT solutions and the MD output were compared with special attention to the behavior of one and multi-component MCT calculations. The interesting dynamic quantities in these systems are the fluctuating density correlations describing the structural relaxation.

Fits to the dynamic output of the MD system were performed with the MCT results with the packing fraction as only fit parameter.

The final decay of the density correlations can be described better by multi-component systems than by one-component systems.

CPP 20.12 Wed 16:00 Poster A

**Constitutive equation for dense colloidal dispersions** — Brader Joe M.[1], Voigtmann Thomas[2], Cates Michael E.[2], and •Fuchs Matthias[1] — [1]Fachbereich Physik, Universität Konstanz, Germany — [2]SUPA, School of Physics, The University of Edinburgh, UK

We present a first principles approach to the rheology of dense colloidal suspensions subject to homogeneous but otherwise arbitrary flow. Starting from the fundamental Smoluchowski equation for interacting Brownian particles neglecting hydrodynamic interactions we derive exact results for calculating time dependent averages, which lead e.g. to a generalized Green-Kubo relation for the stress tensor. Using Mori-Zwanzig type projection operator steps we develop a formally exact equation of motion for the transient density correlator which captures structural relaxation under flow. Approximations to these quantities are then developed which lead to a general constitutive equation for dense dispersions under arbitrary homogeneous flow. As the approximations used are tailored to treat high density systems our final equations allow the time dependent rheology of glassy colloidal suspensions to be investigated. We demonstate the effectiveness of our approach by presenting numerical results for shear [1] and general flows, including step-strain/compression, steady-shearing and creep.

[1] J. Brader et al., Phys. Rev. Lett. 89, 058301 (2007); M. Fuchs and M.E. Cates, Phys. Rev. Lett. 89, 248304 (2002)

CPP 20.13 Wed 16:00 Poster A

**Hard spheres under shear** — •Erik Lange[1], Cristiano de Michele[2], Francesco Sciortino[2], and Matthias Fuchs[1] — [1]University of Konstanz — [2]Universita di Roma La Sapienza

Hard spheres are an important model system in equilibrium as well as in non-equilibrium statistical mechanics.

Adding Brownian motion, hard sphere systems serve as model for colloidal dispersions. Yet, the simulation of hard spheres with Brownian dynamics is difficult because of the singular nature of the interaction potential.

We develop an event-driven approach to simulate Brownian motion of (truly) hard spheres at high densities and present results for strongly sheared systems.

In particular we want to focus on the stress tensor:

$$\sigma_{xy} = \frac{1}{V}\left\langle \sum_i m_i (v_i)_x (v_i)_y + \sum_{i<j} (F_{ij})_x (r_{ij})_y \right\rangle .$$

This can be used to calculate not only the stress-stress correlation functions but also the viscosities, and non-linear flow curves.

These quantities can be measured directly in a sheared colloidal suspensions.

We present results from simulations of a system with a simple linear shear profile not including hydrodynamic interactions.

CPP 20.14 Wed 16:00 Poster A

**The crossover of transport properties of polymer solutions**

**from the high polymer limit to finite chain length** — •Dominik Stadelmaier, Jürgen Rauch, Marianne Hartung, and Werner Köhler — Physikalisches Institut, Universität Bayreuth

In our contribution we discuss the influence of polymer chain length and solvent viscosity on the Soret effect in polymer solutions. The Soret effect (thermal diffusion) describes the mass flow in a binary system with a temperature gradient. In most polymer solutions the polymer is moving to the cold side (thermal diffusion coefficient $D_T$ is positive) and $D_T$ does not depend on the polymer chain length in the high polymer limit as already recognized by de Gennes in 1981 and observed in previous experiments. This suggests to interpret $D_T$ as being a property of the monomer. Measurements of long chained polystyrene (PS) in different solvents in our group have identified the viscosity as the dominating solvent parameter. In order to investigate the crossover from the polymer regime to shorter chains we measured samples of polystyrene solutions with molar masses ranging from $4 \cdot 10^3 kg/mol$ down to the effective monomer ethylbenzene. Remarkably $D_T$ decreases with decreasing polymer chain length but remains positive for all solvents down to the dimer. For the effective monomer there is a sign reversal in three of the solvents. Our results suggest an interpretation for $D_T$ in terms of effective correlated segments acting as thermodiffusing entities that are much larger than a single monomer unit and approximately of the size of the Kuhn segment.

CPP 20.15 Wed 16:00 Poster A

**Effects of spatio-temporal forcing on phase separation** — •Vanessa Weith, Alexei Krekhov, and Walter Zimmermann — Theoretische Physik I, Universität Bayreuth, 95440 Bayreuth, Germany

Motivated by recent experiments on polymer blends with a large Soret effect [1,2] we have studied phase separation in the presence of an inhomogeneous temperature field. Within a generalized Cahn-Hilliard model [3] we have investigated the effects of an additive spatio-temporal forcing $\sim a\cos(qx - vt)$ on phase separation, which corresponds to a spatio-temporal temperature modulation in optical grating experiments [1,2].

For a stationary forcing with $v = 0$ one finds that beyond a critical forcing amplitude $a_0(q)$ spinodal decompostion is locked by the spatially periodic forcing. We show how this critical locking amplitude is changed by increasing the pulling velocity $v$. Furthermore we identify the changes of the bifurcation to the spatially periodic patterns as a function of $v$ and we present results about the spatio-temporal behavior of the solution of the generalized Cahn-Hilliard model in one and two spatial dimensions.

[1] S. Wiegand and W. Köhler, in Thermal Nonequilibrium Phenomena in Fluid Mixtures, edited by W. Köhler and S. Wiegand (Springer, Heidelberg, 2002)

[2] W. Enge and W. Köhler, Phys. Chem. Chem. Phys. 6, 2373 (2004)

[3] A. P. Krekhov and L. Kramer, Phys. Rev. E 70, 061801 (2004)

CPP 20.16 Wed 16:00 Poster A

**Isotope and isomer effect in thermal diffusion of binary liquid mixtures** — •Steffen Hartmann, Gerhard Wittko, and Werner Köhler — Physikalisches Institut, Universität Bayreuth

A temperature gradient induces a diffusive mass flow in a multicomponent system, which is counterbalanced in the stationary state by the Fickian mass diffusion. The occuring concentration gradient can be described by the Soret coefficient, defined as the ratio of the thermal and the Fickian diffusion. There still exists no rigorous theory for thermal diffusion in liquids and a few transient holographic grating experiments have been performed in which well definied parameters are systematically varied. The isotopic substitution leaves most molecular parameters unchanged and mainly affects the molecular mass and moment of inertia. Deuteration of one component leads to a change of the Soret coefficient, which is independent of concentration and temperature. For many binary mixtures there exists a certain concentration where the temperature dependence of the Soret coefficient vanishes. In contrast to the isotope effect, the change of the Soret coefficient due to isomeric substitution depends on the concentration.

CPP 20.17 Wed 16:00 Poster A

**Dynamic density functional theory: correlated Brownian motion in colloidal systems** — •Joachim Dzubiella — Physics Department, Technical University Munich, Germany

Classical density functional theory (DFT) has been proven to be a powerful mathematical tool to describe the equilibrium structure and phase behavior of correlated many-body systems (e.g., dense colloidal or biological fluids) in bulk or under the action of external potentials. Using the equilibrium functional a dynamic DFT can be constructed which accurately reproduces and predicts the strongly inhomogeneous steady-state or even time-dependent structure of systems in non-equilibrium. Here we present selected examples of colloidal systems out of equilibrium, such as driven polymer solutions, diffusion-controlled reactions, and sedimenting colloids in confinement.

CPP 20.18 Wed 16:00 Poster A

**Ultrafast Dynamics in Nanolayered Polyelectrolyte/ Metallic Structures Studied by Femtosecond Pump-Probe Spectroscopy** — •Mareike Kiel[1,2], Wolfram Leitenberger[1], and Matias Bargheer[1,2] — [1]Max-Planck-Institut für Kolloid- und Grenzflächenforschung, Potsdam — [2]Universität Potsdam

The dynamic response of hybrid nanolayer systems composed of polyelectrolytes and metals upon optical excitation is studied by ultrafast pump-probe experiments. Relative intensity changes of transient absorption and reflection spectra are measured with light in the visible and near-infrared region, providing information on the photoinduced dynamics within the structure. We investigate multilayer stacks of (MEPE/PSS) that is, a metallofunctionalized polyelectrolyte-amphiphile multilayer complex fabricated by the layer-by-layer technique, as well as gold colloid particle strata separated by several PAH/PSS layers. We compare the results to investigations of equivalent crystalline solid state multilayer structures with dimensions on the nanometer length scale. We compare the generation and propagation of specific hypersound waves in the frequency range of 1 THz, which is given by the speed of sound in the respective material ($\sim$2 nm/ps) and its artificial spatial layering period ($\sim$2nm). The timescale of the expansion mode of the entire structure is measured to lie in the $\sim$20ps range.

CPP 20.19 Wed 16:00 Poster A

**On multiplicative forcing effects in the Cahn-Hilliard model** — •Christian Feller, Alexei Krekhov, and Walter Zimmermann — Theoretische Physik I, Universität Bayreuth, 95440 Bayreuth, Germany

Phase separation in the presence of a spatially periodic temperature modulation has been investigated theoretically. The linear stability analysis of the homogeneous basic state of the Cahn-Hilliard model with periodic modulation $G\cos(Qx)$ of the control parameter has been performed.

The threshold for the onset of the bifurcation has been determined as function of the modulation amplitude $G$ and the modulation wave number $Q$. For harmonic and subharmonic solutions with respect to the modulation of the control parameter one obtains different thresholds for the bifurcation from the basic state. The threshold for the harmonic solutions is always lower. Beyond the threshold there exists a discrete set of periodic solutions characterized by the wave number $Q/m$ (with integer $m$) which become stable only beyond a certain second threshold.

It has been found that in the two dimensional case additional longitudinal perturbations do not influence the bifurcation diagram obtained for one dimension. Numerical simulations of phase separation dynamics in a quenched system in two dimensions are compared with the results of linear stability analysis.

CPP 20.20 Wed 16:00 Poster A

**Large deviation functions for the entropy production in driven systems** — •Jakob Mehl, Thomas Speck, and Udo Seifert — II. Institut für Theoretische Physik, Universität Stuttgart, Pfaffenwaldring 57/III, D-70550 Stuttgart

In stochastic thermodynamics, notions like work, heat, and entropy production can be defined along a single trajectory. For systems coupled to a heat bath and driven into a nonequilibrium steady state, we study the probability function for the entropy produced in the surrounding medium. In the long time limit, this probability function is determined through the large deviation function. Instead of obtaining the large deviation function from the probability function directly, we apply an operator technique. As an example for linear stochastic systems, we study a dumbell consisting of two particles connected through a spring in simple shear flow. As an example for non-linear systems, we focus on a single colloidal particle moving in a spatial

periodic potential confined to one dimension by a toroidal trap.

CPP 20.21 Wed 16:00 Poster A

**Crystallizing hard spheres** — •Sara Iacopini[1], Hans Joachim Schöpe[1], Eckhard Bartsch[2], and Thomas Palberg[1] — [1]Johannes Gutenberg Universität, Institut für Physik, Staudingerweg 7, D-55128 Mainz, Germany — [2]Albert Ludwigs Universität, Institut für Physikalische Chemie, Albertstraße 21, D-79104 Freiburg, Germany

Colloidal systems display phase transition that are totally analogous to those observed in atomic systems. In particular, a system of colloidal particles where only excluded volume interactions are relevant (a hard-spheres system) tends to form an ordered crystal phase upon increasing the particles volume fraction. Beyond the freezing line, the undercooling of the system acts as a driving force towards the formation of the solid phase. However, it is still a matter of theoretical and experimental investigations which path will the system actually follow in its journey towards the thermodynamically stable state, and which factors may influence it. We studied by means of light scattering the crystallization kinetics of polystyrene microgel colloids in an organic solvent, a system that has proved to display hard-sphere-like behaviour. Our experiments allowed for monitoring the phase transition from the metastable fluid, to the onset of nucleation and growth of the crystallites, up to the later stage of ripening of the polycrystalline material. We investigate how, with increasing particles volume fraction, the growing competition between the thermodynamic driving force and the approaching dynamical arrest modifies the crystallization scenario.

CPP 20.22 Wed 16:00 Poster A

**Growth and Pattern Formation in the Kardar Parisi Zhang equation** — •Hans Fogedby — Department of Physics and Astronomy, Aarhus University, Aarhus, Denmark

A nonperturbative weak noise scheme is applied to the Kardar-Parisi-Zhang equation for a growing interface in all dimensions. It is shown that the growth morphology can be interpreted in terms of a dynamically evolving texture of localized growth modes with superimposed diffusive modes. Applying Derrick's theorem it is conjectured that the upper critical dimension is four.

CPP 20.23 Wed 16:00 Poster A

**memory in paste and its application to control crack pattern** — •akio nakahara and yousuke matsuo — Nihon University, Funabashi, JAPAN

We experimentally find that paste (densely packed colloidal suspension) has memories of external mechanical fields such as vibration and flow. There is a transition in memory from memory of vibration to memory of flow as we decrease a volume fraction of colloidal particles in paste. These memories in paste are maintaned as anisotropic microstructures, and can be visualized as crack patterns which emerge when the paste is dried. When paste has a memory of vibration, the direction of crack propagation becomes perpendicular to the direction of the vibration. On the other hand, when paste has a memory of flow, the direction of crack propagation becomes parallel to the direction of the flow [1].

By using these memory effects, we can imprint direction of crack propagation into paste to control and produce various crack patterns, such as cellular, lamellar, radial, ring, spiral, and so on.

[1] A. Nakahara and Y. Matsuo, Phys. Rev. E 74, 045102(R) (2006).

CPP 20.24 Wed 16:00 Poster A

**Active components at interfaces** — •Thomas Fischer[1] and Pietro Tierno[2] — [1]Experimentalphysik V, Bayreuth, Germany — [2]Physics, Barcelona, Spain

We study the motion of paramagnetic colloidal particles placed above magnetic bubble domains of a uniaxial garnet film and driven through the lattice by external magnetic field modulation. An external tunable precessing field propels the particles either in localized orbits around the bubbles or in superdiffusive or ballistic motion through the bubble array. This motion results from the interplay between the driving rotating signal, the viscous drag force and the periodic magnetic energy landscape. We explain the transition in terms of the incommensurability between the transit frequency of the particle through a unit cell and the modulation frequency. Ballistic motion dynamically breaks the symmetry of the array and the phase locked particles follow one of the six crystal directions.

CPP 20.25 Wed 16:00 Poster A

**CRYSTAL SUPERSTRUCTURES OF COLLOIDAL CRYSTALS IN CONFINEMENT** — Ana Barreira Fontecha, •Hans Joachim Schöpe, and Thomas Palberg — Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudinger Weg 7, 55099 Mainz, Deutschland

Colloidal model systems have been used over three decades investigating the structural and dynamic properties of liquids, crystals and glasses as well as crystallization and the glass transition. Crystal superstructures have been observed in binary systems of repulsive spheres as well as oppositly charged sphere systems showing structures well known from atomic solids. We study the structural transition of colloidal crystals confined to low angle wedge geometry. Restricting the available space leads to an adaptation of the crystalline bulk structures to the symmetry of the confinement and a rich variety of strutures is found as a function of colloid packing fraction and confinement dimension. In addition to the known sequence of crystalline structures, crystal superstructures with dodecagonal symmetry are observed in one component colloidal model system under confinemen having no atomic counterpart.

PRL, submitted

CPP 20.26 Wed 16:00 Poster A

**Confined colloidal crystals.** — Ana Barreira Fontecha, •Hans Joachim Schöpe, and Thomas Palberg — Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudinger Weg 7, 55099 Mainz, Deutschland

The packing of spheres in confined geometry is of fundamental and practical interest for logistics, mathematics, condensed matter physics. For colloids in the bulk bcc packing is observed at long ranged repulsions, while fcc and hcp for short ranged interactions. Restricting the available space leads to adaptations of these structures to the symmetry of the confinement and a rich variety is found as a function of colloid packing fraction and confinement dimension. Their practical importance lies within their use as photonic and phononic materials, while at the same time there is a fundamental interest to understand this diversity in terms of thermodynamics, kinetics and the influence of external forces. We study the confinement of colloidal latex spheres subjected to lateral compression in a thin wedge, which allows us to investigate the structural changes taking place in the transition from 2 to 3 dimensions. In this presentation we extend former experimental work presenting new crystalline structures. In particular, we report on a vertically oriented hexagonally close packed (hcp) structure, a prism structure with triangular basis, a prism structure with square basis and a structure alternating between triangular and square symmetry. Following the maximum packing criterion we show that all these structures have their own range of maximum stability as function of the plate distance. PRE 76, 050402R (2007)

CPP 20.27 Wed 16:00 Poster A

**Energy elastic effects in flowing polymeric liquids, and the concept of nonequilibrium temperature** — •Markus Hütter, Clarisse Luap, and Hans Christian Öttinger — ETH Zürich, Department of Materials, Polymer Physics, CH-8093 Zürich, Switzerland

Entropy elasticity of rubbers serves as a starting point for most of the current models to describe the flow of polymeric liquids with an internal conformation tensor, while consideration of energetic effects is scarce. Such exclusive subscription to entropy elasticity can be considered a little surprising, in particular in view of microscopic modeling where potential forces between (united) atoms play a dominant role. In this regard, it is interesting to discuss the possible ramifications of energy elasticity on the flow behavior of polymeric liquids. After discussing previous approaches in literature for capturing energy elastic effects, we develop a thermodynami- cally consistent model in terms of the momentum density, the local entropy density, the mass density, and the conformation tensor as dynamic variables. The choice of the local entropy as a variable in contrast to temperature or total entropy is of primary importance, as will be explained in due detail. Specifically, we avoid working with a temperature concept that is ill-defined in flow. In order to render the conclusions of the model more specific, a microscopically motivated toy model with energetic effects is introduced, for which both the coarse-grained energy and entropy are calculated in a generalized canonical ensemble.

CPP 20.28 Wed 16:00 Poster A

**Viscoelastic Instabilities** — •Christian Wagner — Technische Physik, Universität des Saarlandes, 66123 Saarbrücken

Viscoelastic liquids are characterized by a complex viscosity with a dissipative and an elastic contribution. Similar to simple Newtonian liquids, above a critical threshold, one can observe a transition from laminar to complex flow situations. But other than in Newtonian liquids, the threshold might occur at Reynolds numbers Re << 1. The critical condition of the instability is mainly determined by the so called Weisenberg Number, the ratio of the flow rate to the characteristic relaxation time of the liquid. This leads to completely new instability mechanisms, like e.g. the subcritical formation of double whirl patterns in Taylor Couette flow, the occurrence of turbulent like flow in planar Couette flow at vanishing Reynolds numbers or the transition to elastic turbulence in Poiseuille flow that can lead to melt fracture, a severe problem in fiber spinning processes. We present a general introduction into the problem of elastic instabilities and present experimental and theoretical results on elastic instabilities in Poiseuille flow.

CPP 20.29 Wed 16:00 Poster A

**Non-affine deformations of inherent structure as signature of cooperativity in supercooled liquids** — •Emanuela Del Gado, Patrick Ilg, Martin Kroeger, and Hans Christian Oettinger — Polymer Physics, ETH Zürich

Experimental and theoretical investigations close to the glass transition indicate the presence of cooperatively rearranging regions of growing size, but it is still debated whether and how cooperativity can be related to structural changes. We search for a signature of the onset of cooperative dynamics in the structural features of supercooled liquids from a novel perspective [1]. We unveil the existence of non-affinely rearranging regions in the inherent structures (IS) by numerical simulations of model glass formers subject to static affine deformations combined with local energy minimizations [2]. In the liquid state IS, we find a broad distribution of rather large, non-affine displacements which are correlated only over small distances. At low temperatures, the onset of the cooperative dynamics corresponds to much smaller non-affine displacements correlated over larger distances. This indicates the presence of non-affinely rearranging domains of relevant size in the IS, which can be seen as the IS counterpart of the cooperatively rearranging regions in the dynamics. This idea suggests a new insight into possible structural signatures of slow cooperative dynamics of supercooled liquids and supports the connections with elastic heterogeneities found in amorphous solids.

[1] H. C. Oettinger, Phys. Rev. E 74, 011113 (2006). [2] E. Del Gado, P. Ilg, M. Kroeger and H.C. Oettinger, cond-mat/0711.1581.

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**Optimal control of many-electron systems with time-dependent density-functional theory** — •Alberto Castro and E. K. U. Gross — Institut für Theoretische Physik, Fachbereich Physik, Freie Universität Berlin, 14195 Berlin (Germany)

We propose the use of time-dependent density-functional theory (TDDFT) within the framework of quantum optimal control theory (QOCT). This amounts to controlling the time-dependent Kohn-Sham (KS) system of non-interacting particles, and driving it towards a desired objective. The obtained driving field will identically control the density of the real, interacting system – and those observables that can be written as simple density functionals. In practice, working with the KS system of equations implies the following peculiarities with respect to the usual QOCT formalism: (i) Since the system is non-interacting, the wave functions are restricted to be single Slater determinants. The basic variational variables are therefore the KS orbitals; (ii) The dependence of the KS Hamiltonian with the density forces us to consider a generalized QOCT formalism, able to tackle with non-linear propagation equations; (iii) The formulation of the target, which is an obvious task in standard QOCT, raises interesting theoretical questions when working with the KS system.

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**Transitions of Smectic Systems under Shear Investigated by Nuclear Magnetic Resonance** — Bruno Medronho[1,2], Shahram Shafaei[3], Gönül Ar[3], Michael Blaschke[3], Ulf Olsson[2], and •Claudia Schmidt[3] — [1]Department of Chemistry, University of Coimbra, 3004-535 Coimbra, Portugal — [2]Physical Chemistry 1, Center of Chemistry and Chemical Engineering, Lund University, Box 124, 221 00 Lund, Sweden — [3]Department of Chemistry, University of Paderborn, Warburger Str. 100, 33098 Paderborn, Germany

Smectic phases driven by shear show interesting structural transitions. Most interesting is the formation of monodisperse, close-packed, multilamellar vesicles (MLVs), also called onions, that is found in many lyotropic lamellar phases [1]. Other systems show transitions between different orientations of planar layers, when parameters such as shear rate or temperature are changed. These dynamic transitions, which can be continuous or discontinuous, have been investigated by deuterium NMR spectroscopy [2]. Results for the shear-induced formation and destruction of MLVs in an aqueous solution of the nonionic surfactant $C_{10}E_3$ will be presented [3].

[1] O. Diat, D. Roux, and F. Nallet, J. Physique IV, 3, 193 (1993).
[2] S. Müller, Claus Börschig, Wolfram Gronski, Claudia Schmidt, and D. Roux, Langmuir, 15, 7558 (1999).
[3] B. Medronho, S. Shafaei, R. Szopko, M. G. Miguel, U. Olsson, C. Schmidt, in preparation.

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**Velocity Autocorrelation Function in Driven Granular Gases** — •Andrea Fiege[1], Wolf Till Kranz[1], Timo Aspelmeier[1], and Annette Zippelius[1,2] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]Institute of Theoretical Physics, University of Göttingen, Germany

We study a system of granular gas particles in 2 and 3 dimensions, i. e. spherical particles which suffer energy loss due to inelastic collisions. An energy source (volume bulk driving) provides a stationary state, allowing us to compute time-delayed correlation functions. Here we concentrate on the velocity autocorrelation function, which is studied with the help of the Mori-Zwanzig projector operator formalism and molecular dynamic simulations. Diffusion coefficients are calculated within the Green-Kubo framework and their enlargement compared to the corresponding Enskog values is shown to exhibit a nonmonotonic dependence on the density. We also discuss the possibility of long time tails in the velocity autocorrelation.

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**Mesoscale hydrodynamics approach to viscoelastic fluids** — •Ingo Goetze, Yu-Guo Tao, Hiroshi Noguchi, and Gerhard Gompper — Forschungszentrum Juelich, Juelich, Germany

Multi-particle collision (MPC) dynamics is a well-established, highly efficient particle-based hydrodynamics simulation technique for Newtonian fluids. The standard version of MPC does not conserve angular momentum. However, there are situations, where this leads to non-physical results. Therefore, we have developed a new method with angular momentum conservation.[1] We show that this method has to be employed, for example, to correctly describe circular Couette flow of multiphase fluids.[2]

Moreover, many complex fluids show viscoelastic behaviour. Therefore, an efficient MPC method for viscoelastic fluids is highly desirable. We present such an algorithm, that shows Maxwell fluid behaviour.

[1] H. Noguchi, N. Kikuchi, and G. Gompper, Europhys. Lett. **78**, 10005 (2007).
[2] I. O. Götze, H. Noguchi, and G. Gompper, Phys. Rev. E **76**, 046705 (2007).
[3] Y-G. Tao, I. O. Götze, and G. Gompper, submitted

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**Event-Driven Simulation of Cluster Aggregation under Periodic and Steady Shear** — •Daniel Rings and Klaus Kroy — Institut für theoretische Physik, Universität Leipzig, Vor dem Hospitaltore 1, 04103 Leipzig

Aggregation of colloids has an impact on various technological as well as biological systems. Consider for example the accumulation of dust in bearings, or the clotting within blood vessels.

In the framework of our toy model we study universal features as well as distinct differences of a two-dimensional colloidal suspension under steady shear stress and periodic driving. Especially, the gelling behavior and thus macroscopic observables differ in that there appears a transition from (quasi-)stationarity to irreversible gelation. We present improvements to our collision-driven dynamics simulation, by which the investigations have been conducted. Its main features comprise a spatial coarse-graining scheme as well as approximative reduction of local event queues, which results in good algorithmic efficiency at high precision.

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**The concept of temperature in driven granular suspensions** — •Matthias Schröter, Alexander Buck, Leen Alawieh, and Harry L. Swinney — CNLD, UT Austin, Texas

Dense granular suspensions driven by a flow field show signatures of glass formation like dynamical heterogeneities, rate-dependence, or increase of timescales. The possibility to describe such non-equilibrium phenomena with an effective temperature is still debated. Our measurements using a torsion pendulum and tracking of tracer particles test the applicability of fluctuation-dissipation theorem based temperature concepts.

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**Colloids in AC fields: Edge localized instabilities in dielectrophoretic bottles** — Jinyu Zhao, •Günter K. Auernhammer, and Doris Vollmer — MPI Polymerforschung, Mainz, Germany

Dielectric colloids dispersed in a dielectric liquid experience a body force in gradients of AC fields. This force is due to the contrast in the dielectric properties between the colloids and the surrounding liquid. It allows to tune the concentration of colloids in the dielectrophoretic bottle by changing the applied field.

We investigate the process of filling the dielectrophoretic bottle, i.e., directly after turning the field on. Our system consists of sterically stabilized PMMA colloids in a density-matching mixture of decaline and cyclohexyl bromide. At high frequencies of the applied field (100 kHz to 1MHz), we find that the spatially homogeneous migration of the colloids can be unstable against localized colloidal flows. Our experiments indicate a critical value of the driving force for the instability. The onset is at a field of $\approx 0.5V/\mu m$ in the dielectrophoretic bottle. We analyze this instability in analogy to the Rayleigh-Taylor instability. In contrast to the standard Rayleigh-Taylor instability, the driving body force is not due to gravity but due to the applied field gradient.

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**Towards magnetic response of composite materials: Nanoparticle incorporation into polymer matrix** — •Marta Kolasinska[1], Rumen Krastev[1], Thomas Gutberlet[2], and Helmuth Möhwald[1] — [1]Max Planck Institut für Kolloid- und Grenzflächenforschung, 14424 Potsdam/Golm, Deutschland — [2]Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

Nanometer thick polymer materials with embedded nanoinhomogeneities possess a number of specific properties which depend strongly on the inter particle distances in the matrix. Fabrication of well-defined nanostructures is a prerequisites to obtain materials of desired functions.

We incorporated magnetite nanoparticles onto/into polyelectrolyte multilayers (PEMs) and found that a 2D ordering of particles into *monolayers* depends on treatment of underlying PEM changing it from metastable to equilibrium. The metastable glassy PEM were permeable for the nanoparticles while in the melted PEM the particle penetration was blocked. They were concentrated at the film *surface* forming 2D ordered layer. The magnetic moment of the sample was checked by neutron reflectometry. We found pronounced magnetic response in the reflectivity curves. This proves that structures with appropriate concentration of magnetic particles were achieved which makes such materials suitable to prepare new magnetic responsible materials.