CPP 39: Colloids and Complex Liquids II - Dynamics and Mechanical Properties

Time: Thursday 10:30–13:00 Location: ZEU 222

CPP 39.1 Thu 10:30 ZEU 222

Simplified particulate model for coarse-grained hemodynamics simulations — •Florian Janoschek[1,2], Federico Toschi[1,3], and Jens Harting[1,2] — [1]Eindhoven University of Technology, P.O. Box 513, 5600MB Eindhoven, The Netherlands — [2]University of Stuttgart, Pfaffenwaldring 27, 70569 Stuttgart, Germany — [3]CNR-IAC, Via dei Taurini 19, 00185 Rome, Italy

Human blood flow is a multi-scale problem: in first approximation, blood is a dense suspension of plasma and deformable red cells. Physiological vessel diameters range from about one to thousands of cell radii. Current computational models either involve a homogeneous fluid and cannot track particulate effects or describe a relatively small number of cells with high resolution, but are incapable to reach relevant time and length scales. Our approach is to simplify much further than existing particulate models. We combine well established methods from other areas of physics in order to find the essential ingredients for a minimalist description that still recovers hemorheology. These ingredients are a lattice Boltzmann method describing rigid particle suspensions to account for hydrodynamic long range interactions and—in order to describe the more complex short-range behavior of cells—anisotropic model potentials known from molecular dynamics simulations. Paying detailedness, we achieve an efficient and scalable implementation which is crucial for our ultimate goal: establishing a link between the collective behavior of millions of cells and the macroscopic properties of blood in realistic flow situations. We present our model and demonstrate its applicability to conditions typical for the microvasculature.

CPP 39.2 Thu 10:45 ZEU 222

Structure and Dynamics of AOT Microemulsions with Amphiphilic Diblock Copolymers — •Markus Appel, Robert Wipf, Tinka Spehr, and Bernd Stühn — Institut für Festkörperphysik, TU Darmstadt

We investigate the influence of amphiphilic diblock copolymers on structure and dynamics of the droplet phase of water-in-oil microemulsions based on the surfactant AOT. The size of the droplets is determined by small angle X-Ray scattering experiments, while broadband dielectric spectroscopy (1 Hz to 3 GHz) is used to probe micellar interactions. The temperature-dependent phenomenon of dynamic percolation can be used to estimate the bending modulus of the AOT layer, which is known to be influenced by certain hydrophilic polymers adsorbing to the surfactant layer [1]. Furthermore the dielectric relaxation process in the frequency range $f > 1$ MHz reveals details on droplet-droplet interactions, especially in combination with the static permittivity constant [2].

We are particularly interested in a comparison between simple hydrophilic homopolymers and amphiphilic diblock copolymers in order to study possible 'anchoring effects' of the polymers to the surfactant shell.

[1] R. Wipf et al., Colloid Polym. Sci. (2010) **288**:589-601
[2] D'Angelo et al., Phys. Rev. E (1998) **58**:7657-7663

CPP 39.3 Thu 11:00 ZEU 222

Transient Soret-melting of binary glasses by hot colloids — •Florian Schwaiger and Werner Köhler — Physikalisches Institut, Universität Bayreuth, Germany

Metallic nanoparticles have been investigated for many years in manifold research fields due to their outstanding optical, electronic and thermal properties in soft condensed matter. We have heated gold colloids with a diameter of 250 nm by laser irradiation and used them as microscopic heat sources in a polystyrene/toluene solution. Due to the high absorbance at the plasmon resonance wavelength around 532 nm, significant temperature gradients $\nabla T \propto 1/r^2$ can be achieved in the close vicinity of the particles on length scales below the diffraction limit. As a consequence of the Soret effect, there is a strong nonlinear coupling to the order parameter, the local composition of the binary system. In this binary glass former, a bubble of high mobility due to local toluene enrichment, accompanied by a drastic lowering of the glass transition temperature T_g, is created around the laser-heated particle. Accordingly, the colloidal particle is trapped within a cage of low friction that dynamically forms around the colloid and follows its position with a certain retardation. Outside of this bubble the colloids are virtually immobile.

CPP 39.4 Thu 11:15 ZEU 222

Self-Propelled Thermophoretic Motion of Gold Capped Microparticles — Andreas Bregulla[1], Markus Selmke[1], Ralf Seidel[2], Michael Mertig[3], Klaus Kroy[4], and •Frank Cichos[1] — [1]Molecular Nanophotonics Group, University Leipzig, Linnéstraße 5,04103 Leipzig — [2]DNA Motors Group, BioTeC, University of Technology Dresden, Tatzberg 47-51, 01307 Dresden — [3]Physikalische Chemie, Mess- und Sensortechnik, Technische Universität Dresden,Eisenstuckstr. 5 01069 Dresden — [4]Soft Condensed Matter Theory Group, University Leipzig, Vor dem Hospitaltore 1, 04103 Leipzig

Molecular Motors are the machinery of cells that convert chemical into mechanical energy and transport material in a directed manner. Inspired by these molecular machines a number of different artificial self-propelled swimmers have been realized to mimic the same function for future applications in chip-sized laboratories. Most of these swimmers are, however, based on chemical reactions, which are difficult to control or to interrupt. Here we present the design and function of self-propelled microparticles, which can be addressed and switched externally by a laser field. The self-propelled motion is controlled by optical heating of a thin gold cap on polystyrene particles to generate a temperature gradient. The results on the directed motion of different sized particles provide strong evidence for a thermophoretic driving mechanism. Thus the presented particles provide for the first time a detailed control of the speed of each individual particle.

CPP 39.5 Thu 11:30 ZEU 222

Transport studies of colloidal systems through channels and across barriers — •Christian Kreuter[1], Peter Nielaba[1], Paul Leiderer[1], and Artur Erbe[2] — [1]Universitaet Konstanz — [2]Helmholtz-Zentrum Dresden-Rossendorf

Colloidal particles are ideal model systems for processes on a mesoscopic scale, because the energies, which are determined by the interactions of the particles, are on the same range as the thermal energy provided by the solvent. In these studies we investigate the behavior of superparamagnetic particles, which are driven gravitationally through narrow channels and across lithographically defined barriers. Such systems model many aspects of the behavior of charge carriers in nanoscale conductors. By comparing the experimental results with Brownian dynamics simulations, we can explore a large range of parameters and mimic a large number of known situations. Especially, we find ordering processes, which are induced by the interparticle interactions caused by the magnetic dipole moments of the particles. This leads to a movement of the particles in layers and strongly affects the diffusion behavior of the system.

CPP 39.6 Thu 11:45 ZEU 222

Colloidal particles in multiphase flow — •Florian Günther — TU Eindhoven

Emulsions stabilized by particle are ubiquitous in the food and cosmetics industry, but our understanding of the influence of microscopic fluid-particle and particle-particle interactions on the macroscopic rheology is still limited. In this contribution we present a simulation algorithm based on a multicomponent lattice Boltzmann model to describe the solvents combined with a molecular dynamics solver for the description of the solved particles. In nature colloids are generally not spherical, such as clay particles, which have a platelet like shape. As an example of anisotropic particles we study ellipsoids. Our model allows a wide variation of fluid properties, the aspect ratio m of the ellipsoid and arbitrary contact angles on the particle surfaces. We investigate some features of a single particle at a flat interface between two fluids such as the contact angle depending on particle attributes and the adsorption trajectories. Furthermore, we study the parameter dependence of the model and demonstrate its applicability by studying, at least for the special case of m=1, the formation and rheology of a "bicontinuous interfacially jammed emulsion gel" (bijel) and of a "Pickering emulsion".

CPP 39.7 Thu 12:00 ZEU 222

The effective hydrodynamic radius of single DNA-grafted colloids as measured by fast Brownian motion analysis —

•Olaf Ueberschär, Carolin Wagner, Tim Stangner, Christof Gutsche, and Friedrich Kremer — Universität Leipzig

Optical tweezers accomplished with fast position detection enable one to carry out Brownian motion analysis of single DNA-grafted (grafting density: ˜1000 molecules per particle, molecular weight: 4000 bp) colloids in media of varying NaCl concentration. By that the effective hydrodynamic radius of the colloid under study is determined and found to be strongly dependent on the conformation of the grafted DNA chains. Our results compare well both with recent measurements of the pair interaction potential between DNA-grafted colloids (Kegler et al. Phys Rev Lett 2008;100:118302) and with microflu-idic studies (Gutsche et al. Microfluid Nanofluid 2006;2:381-386). The observed scaling of the brush height with the ion concentration is in full accord with the theoretical predic-tions by Pincus, Birshtein and Borisov.

CPP 39.8 Thu 12:15 ZEU 222

Force Measuments between colloidal Particles across aqueous electrolytes using CP-AFM — •Liset Luederitz and Regine von Klitzing — Stranski-Laboratorium fuer Physikalische und Theoretische Chemie, Institut fuer Chemie, Technische Universitaet Berlin, Strasse des 17. Juni 124, D-10623 Berlin

The interaction forces between two colloidal silica particles across different electrolytes, CsCl, KCl, NaCl and LiCl were measured using CP-AFM technique. In our study the adsorption of counterions follows the Hofmeister series for CsCl, KCl and NaCl but LiCl has anomalous behaviour. The instability of the hydration shell of lithium could be a reason for the observed anomaly. The DLVO theory explains the interactions between the colloidal particles assuming only two types of forces, repulsive electrostatic forces and attractive van der Waals forces. At short separation some deviations from the theory are reported [1]. These deviations are called non DLVO forces and are present in water and electrolyte solutions. In this work we measured short range attractions at 10^{-4}M ionic strength whereas at 10^{-3}M short range repulsions are observed. Another interesting phenomenon observed was the charge reversal with the studied monovalent ions at 10^{-3}M ionic strength and low pH.

1. Valle-Delgado, J.J.; Molina-Bolivar, J.A.; Galisteo-González, F.; Galvéz-Ruiz, J.; Feiler, A.; Rutland, M.W. J. Chem. Phys. 2005, 123, 12.

Topical Talk CPP 39.9 Thu 12:30 ZEU 222

Combining structure and mechanical properties of colloidal systems — Marcel Roth[1], Chris Grigoriadis[2], Jinyu Zhao[1], Burkhard Mayer[1], Doris Vollmer[1], George Floudas[2], and •Günter. K. Auernhammer[1] — [1]MPI Polymerforschung, 55128 Mainz, Germany — [2]University of Ioannina, 45110 Ioannina, Greece

While observing the sample with confocal microscopy we either determine the mechanical properties with a home-build piezo-rheometer or we submit the sample to electric or magnetic fields. Two examples will be discussed.

In case of PMMA colloids dispersed in the isotropic phase of the liquid crystalline compound 4 cyano-4'-biphenyl (5CB), aggregation is induced by simple cooling through the isotropic-nematic transition. This leads to a complete phase separation of a colloid-free nematic phase and a colloid-rich isotropic phase within a temperature range of (1-2)K, creating a sponge-like network. 5CB is a solvent of PMMA in its isotropic phase and plastificizes PMMA at lower temperatures, as confirmed by rheology [1] and dielectric spectroscopy.

In relatively weak colloidal systems, like colloidal crystals, magnetic probe particles can be used to test the mechanical properties of the system. With the confocal microscope we follow both the motion of the magnetic particles and of the surrounding matrix particles. This allows us correlating the structural changes in the matrix with the mobility of the probe particle.

[1] M. Roth, D'Acunzi, D. Vollmer, and G. K. Auernhammer, J. Chem. Phys. **132**, 124702, (2010).