CPP 28: Crystallization, Nucleation and Self Assembly II

Time: Wednesday 15:00–16:30 Location: H40

Invited Talk CPP 28.1 Wed 15:00 H40

Self Organization of Colloidal Crystals and of Co-operative Propulsion by Salt Gradient Induced Flows — •Thomas Palberg — Inst. of Physics, Johannes Gutenberg Univ., Mainz, Germany

Colloidal crystallization from a meta-stable colloidal melt has been extensively studied with optical techniques. Most studies of charged colloidal spheres in aqueous suspension. were performed at low and homogeneous salt concentrations in a quiescent solvent. Recently we focused on the influence of salt gradients on the formation of crystals and their micro-structure. Gradients were obtained from a granular, electrolyte releasing particle settled under gravity onto the charged substrate. Depending on the electrolyte chosen and the charge sign of the substrate, strong, radially symmetric solvent flow is induced along the substrate, either towards or away from the granule. Release of HCl combined with an anionic substrate leads to a convergent flow. We use this flow to assemble micron sized colloidal particles sedimented to the substrate and swept towards the granule. Crystal formation kinetics are well understood in a simple theoretical model. Emerging microstructures are well reproducible. An equivalent behavior is also seen in three dimensions. Together this offers a flexible way to manipulate and pattern the micro-structure of colloidal solids, which may be useful for the fabrication of photonics related materials. Very recently we observed that beyond the self organization of structures, the flow patterns may also be useful to self organize the linear propulsion of the granule-colloid complex. This possibly offers an alternative approach to swimming at low Reynolds numbers

CPP 28.2 Wed 15:30 H40

Self-Assembly of Janus-particles in critical fluids — •Marcel Labbé-Laurent[1,2], Matthias Tröndle[1,2], Ludger Harnau[1,2], and Siegfried Dietrich[1,2] — [1]Max-Planck-Institut für Intelligente Systeme, Stuttgart, Germany — [2]Universität Stuttgart, Germany

Critical fluctuations in simple fluids or binary liquid mixtures give rise to forces acting on immersed colloidal particles. These Casimir-like forces are attractive or repulsive depending on the chemical surface properties [1]. Spacial ordering of colloids opposite to chemically structured surfaces, induced by the critical Casimir effect, is observed experimentally for colloidal particles immersed in a critical water-2,6-lutidine mixture and is in agreement with theory [2]. Janus-particles immersed in a critical fluid are subject to orientation-dependent stabilizing and destabilizing forces. Within density functional theory we study the phase diagram of cylindrical and spherical Janus-particles. We find first and second order phase transitions between isotropic and structured colloidal phases. Janus-particles self-assemble into a doublelayer phase, which is tunable by temperature, density and external potentials.

[1] C. Hertlein, L. Helden, A. Gambassi, S. Dietrich, and C. Bechinger, Nature **451**, 172 (2008).

[2] M. Tröndle, O. Zvyagolskaya, A. Gambassi, D. Vogt, L. Harnau, C. Bechinger, and S. Dietrich, Mol. Phys. **109**, 1169 (2011)

CPP 28.3 Wed 15:45 H40

Heterogeneous Nucleation in colloidal melts at periodically structured substrates — •Achim Lederer[1] and Hans Joachim Schöpe[2] — [1]Johannes Gutenberg Universität, Mainz, Germany — [2]Max Planck Institut für Polymerforschung, Mainz, Germany

Monodisperse suspensions of colloidal spheres with known interaction are a terrific model system for testing predictions by statistical physics. Their typical length scales are accessible via optical methods like light scattering in reciprocal and microscopy in real space. We investigate heterogeneous nucleation and the microstructure evolution of colloidal model systems with hard sphere like behavior by Confocal Laser Scanning Microscopy (CLSM) observing local parameters on a single particle scale. In our studies we observe heterogeneous nucleation at fcc(111) patterned substrates as function of lattice spacing. By analyzing local order parameters we locate crystalline particles in clusters, determining cluster sizes and shape during nucleation and growth. By varying the lattice spacing we observe a transition from a commensurable to an incommensurable situation.

CPP 28.4 Wed 16:00 H40

Nanoparticle Assembly in a modular Fluidic System — •Dominik Gerstner, Philip Born, and Tobias Kraus — Leibniz-Institut für Neue Materialien (INM), Campus D2.2, 66123 Saarbrücken

Nanoparticles are widely used in industrial and research applications. Agglomeration occurs in most use cases. We investigate structure formation during agglomeration to find which mechanisms govern the morphology of the agglomerates. For alkylthiol-stabilized gold nanoparticles with 6 nm core diameter, we found that the morphology depends crucially on the exact behavior of the ligand monolayer. Crystalline agglomerates only formed for a molten monolayer. Based on this study, we suggest that the particles' microscopic packing is dominated by contact mechanics rather than colloidal interactions [1].

The ligands' directing effect may be partially kinetic. We will discuss experiments to study agglomeration under defined mixing conditions and for different ligands efficiently. A modular fluidic system enables the preparation and direct observation of agglomerating nanoparticles in flow. Nanoparticle dispersion and agglomeration agent are merged in a micromixer. UV/Vis spectrometers or Light Scattering detectors subsequently provide characteristics of the growing agglomerates. The versatility of the setup allows rapid experimentation with a wide range of particles and conditions. Correlation of spectroscopic and real-space TEM data yields a detailed understanding of agglomerate morphologies. We use it to search for ligands that lead to agglomerates with predictable morphologies applicable in hybrid materials.

[1] T. Geyer et al. *Phys. Rev. Lett.* 109 (2012), 128302.

CPP 28.5 Wed 16:15 H40

Free energy and concentration of thermal vacancies in closed-packing solids — •Mostafa Mortazavifar, Mohammad Hossein Yamani, and Martin Oettel — Institut für Angewandte Physik, Eberhard Karls University of Tübingen, Tübingen, Germany

The free energy and the equilibrium concentration of thermally excited vacancies in crystals has been studied since long ago using simulations in classical statistical mechanics or theoretical considerations on the phonon spectrum in the solid with vacancies. Here, we present a simple estimate of the vacancy free energy and concentration in close-packing solids using the leading-order term in an expansion in correlated free particles in a frozen, crystalline matrix [1]. For hard spheres, results are in excellent agreement with available simulation data, and have an intuitive interpretation in terms of available volumes of a free particle in the frozen matrix either next to a vacancy or in a perfect, crystalline surrounding. For solids of atoms interacting with soft potentials, computations can be easily done for broad ranges of temperature and density. We present results for the Lennard-Jones system and compare to available data from simulation and other theory.

[1] Stillinger et al, J. Chem. Phys. 43, 932 (1965).