

CPP 12: Confined Fluids

Time: Tuesday 11:00–12:30

Location: C 230

CPP 12.1 Tue 11:00 C 230

Direct measurement of the critical Casimir force in a binary liquid using TIRM — ●CHRISTOPHER HERTLEIN, LAURENT HELDEN, and CLEMENS BECHINGER — 2. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany

A colloidal particle suspended in a binary liquid at the critical composition close to a substrate experiences a critical Casimir force upon approaching the critical temperature of decomposition T_c . We have measured interaction potentials for a single polystyrene particle suspended in a mixture of water and 2,6-lutidine approaching T_c using Total Internal Reflection Microscopy (TIRM). TIRM is a technique for precise measurements of colloid-wall interaction potentials based on single particle evanescent wave light scattering. The measured interaction potentials display a clear contribution of the critical Casimir force which becomes stronger upon approaching T_c and is either attractive or repulsive depending on the preference for water or lutidine of substrate and/or particle. Theoretical calculations are in excellent agreement with experimental results. Switching the interaction from attraction to repulsion *in situ* is currently under investigation and could prove useful to control and fine-tune particle substrate potentials.

CPP 12.2 Tue 11:15 C 230

Fluctuation-induced interaction between ellipsoidal colloids at fluid interface — ●EHSAN NORUZIFAR and MARTIN OETTEL — Institut fuer Physik, WA 331, Johannes-Gutenberg-Universitaet Mainz, D-55099 Mainz, Germany

One part of the effective interaction between colloids trapped at the fluid interface originates from capillary wave fluctuations. The very presence of colloids at the interface of two fluids restricts the allowed spectrum of long-ranged capillary wave fluctuations, thereby the resulting force is of Casimir-Polder type and adds a long-ranged part to the effective inter-colloidal interaction [1]. This interaction is calculable by integrating over all admissible interface configurations weighted by a capillary wave Hamiltonian. In the present work, the Casimir interaction between ellipsoidal colloids placed at a fluid interface is calculated as an interaction energy between multipole fields on the interface boundaries generated by thermal fluctuations [2]. The results obtained are an explicit example for an anisotropic Casimir force which is caused by the colloid shape.

[1] H. Lehle and M. Oettel, Phys. Rev. E 75, 011602 (2007); H. Lehle, M. Oettel, and S. Dietrich, Europhys. Lett. 75, 174 (2006). [2] T. Emig, N. Graham, R. L. Jaffe and M. Kardar, Phys. Rev. Lett. 99, 170403 (2007).

CPP 12.3 Tue 11:30 C 230

Broadening of solid-liquid phase transitions due to influence of surrounding interfaces — ●RALF KÖHLER and HANS RIEGLER — MPI KGF, Abt. Grenzflächen, 14424 Potsdam, Germany

In objects with reduced dimensionality (films, particles), surfaces and interfaces become important for their physical behaviour like phase transitions. Despite its importance for fundamental and applied science (nucleation, sintering, etc.) relatively little is known about the influence of the surrounding interfaces on the phase behaviour due to the lack of quantitative experimental data. With Contrast Enhanced Interference Microscopy (1) we investigate long-chain alkanes which form two-dimensional aggregates (domains) of nanometer thickness on planar silicon oxide surfaces. Thus, we quantify the influence of the surrounding interface on the liquid-solid phase transition of the domains. The domains melt gradually below the bulk phase transition temperature, forming a coexisting liquid film, which wets the adjacent substrate surface. The film thickness varies with temperature i.e., the liquid and solid phases exchange reversibly alkanes, whereby converting melting enthalpy into interfacial energy. The melting behaviour is quantitatively described in a thermodynamic approach. The behaviour is universal for the phase behaviour of any adsorbed material, which wets surrounding interfaces.

(1) R.Köhler, P.Lazar, and H.Riegler, Appl.Phys.Lett. 89, 241906 (2006) (2) H.Riegler and R.Köhler, Nature Physics, 754 (2007)

CPP 12.4 Tue 11:45 C 230

Statics and dynamics of confined cluster forming systems — ●SVEN VAN TEEFFELEEN and CHRISTOS N. LIKOS — Institut für Theoretische Physik II, Heinrich-Heine-Universität Düsseldorf, Universitätsstrasse 1, D-40225 Düsseldorf, Germany

Ultrasoft repulsive particles are known to crystallize into BCC and FCC cluster crystals [1,2]. Here, we study with the help of accurate density functional theory how a system of ultrasoft repulsive particles, such as dendrimers, behaves under planar confinement.

In particular, we present the phase diagram and we show how the emerging equilibrium fluid and crystal structures differ from those in the bulk. Extending our considerations to non-equilibrium phenomena, we employ a Dynamical Density Functional Theory (DDFT) to examine the growth or loss of local crystallinity in confinement, induced by compression or expansion of the confining walls.

[1] B. Mladek, et. al., Phys. Rev. Lett. 96, 045701 (2006)

[2] M. A. Glaser, et. al., Europhys. Lett. 78, 46004 (2007)

CPP 12.5 Tue 12:00 C 230

Crystallization in layered films of confined charged colloids — ●STEFAN GRANDNER¹ and SABINE H. L. KLAPP^{1,2} — ¹Stranski-Laboratorium, Technische Universität Berlin, Straße des 17. Juni 115, D-10623 Berlin, Germany — ²Institut für theoretische Physik, Technische Universität Berlin, Hardenbergstraße 36, D-10623 Berlin, Germany

We consider a system of spherical charged colloids between two parallel walls. A characteristic property of such colloids is the screening of the Coulomb potential of the macroions due to the counterions and additional salt, which we take into account via DLVO theory. An earlier comparison of Monte-Carlo results with colloidal probe AFM experiments has demonstrated the applicability of the DLVO potential for confined systems [1]. Typical for confined fluids is a layering parallel to the walls, which was observed for charged colloids as well [1,2]. In our current investigations we employ grand canonical Monte-Carlo simulations to study the in-plane structure in dense states. In particular, by computing bond angle order parameters we search for evidence of crystallization in the layers. Previous work for bilayers discovered several crystal-like structures such as square, hexagonal or rhombic ordering [3]. Furthermore we discuss the dependence of the onset of crystallization on pore size and bulk density.

[1] S. H. L. Klapp, D. Qu, and R. v. Klitzing, J. Phys. Chem. B 111, 1296-1303 (2007).

[2] M. Kittner, and S. H. L. Klapp, J. Chem. Phys. 126, 154902 (2007).

[3] R. Messina, and H. Löwen, Phys. Rev. Lett. 91, 146101 (2003).

CPP 12.6 Tue 12:15 C 230

Structuring of colloidal suspensions confined in thin liquid films — ●YAN ZENG¹, SABINE KLAPP^{1,2}, and REGINE V. KLITZING¹ — ¹Stranski-Laboratorium für Physikalische & Theoretische Chemie, Institut für Chemie, TU Berlin — ²Institut für Theoretische Physik, TU Berlin

In order to study the structuring of colloidal suspensions Ludox silica solutions are confined between a microsphere and a flat interface in a colloidal probe AFM [1]. Oscillatory forces are measured due to layer by layer expulsion of the particles [2]. The period scales with the concentration with an exponent -1/3, this period has the same value as the particle distance in the corresponding bulk solution calculated from the position of the structure peak of SAXS measurements. The addition of salt decreases the period of oscillation, the amplitude and the scaling exponent of the particle distance in dependence of the salt concentration. In addition, simulations show that the scaling behavior changes from exponent -1/3 at low ionic strength to a concentration independent length at high ionic strength [3].

[1] M. Piech, J.Y. Walz, J. Colloid Interface Sci. 2002, 8, 2985

[2] J. Israelachvili, Intermolecular and surface Forces; Academic Press: San Diego, CA, 1992; Chapter 13

[3] S. Klapp, D. Qu, R.v. Klitzing, J. Phys. Chem. B 2007, 111, 1296.