CPP 24: Colloids

Time: Wednesday 14:00–15:15 Location: ZEU 160

CPP 24.1 Wed 14:00 ZEU 160

Forbidden Symmetries in 2D Colloidal Systems — •Jules Mikhael, Sebastian Rausch, Laurent Helden, and Clemens Bechinger — 2. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart

Until 1984, it was unanimously established that rotational symmetries like 5-, 7-, 8-fold or higher are forbidden to ordered matter. However some metal alloys, polymers or micelles have defied these crystallographic rules and self-organized into so-called quasicrystals. Only four rotational symmetries mainly the 5-, 8-, 10- and 12-fold were reported although geometrical models predict any n-fold symmetry (where n is an integer number). Why? Are there forbidden symmetries even to quasicrystals?

Here we artificially create one of the symmetries, never observed in nature, by interfering seven coherent laser beams. Due to optical forces, the generated pattern acts as a template for a colloidal monolayer whose phase behavior is studied in real space. Our results demonstrate that for interference patterns of 7 laser beams the colloids organize in large domains with strict periodic, i.e. crystalline, order. This is in contrast to interference patterns comprised of 5 laser beams where the colloids adopt the quasicrystalline order imposed by the substrate[1]. Based on the substrate potential depth distribution of interference patterns with different rotational symmetries, we provide a possible explanation why 5-, 8-, and 10-fold symmetries can occur in self organized systems while 7-, 9-, 11-fold do not.

[1] Mikhael, Roth, Helden & Bechinger, Nature 454, 501 (2008).

CPP 24.2 Wed 14:15 ZEU 160

Testing geometrical aspects in the particle insertion free energy and depletion interaction between colloids — Martin Oettel, Vitalie Boţan, and •Florian Pesth — University of Mainz, Institute of Physics / KOMET 331, Germany

Morphological measures appear to be a useful tool to calculate the insertion free energies of particles in a solution, which is otherwise a difficult task to calculate in the case of large, irregularly shaped objects. A morphological theorem introduced by Mecke et al. states [1], that if some physical restrictions are imposed on the solute, the insertion free energy depends on only four geometric quantities. The corresponding coefficients can be obtained for the same type of particle but with a more regular shape (spheres, cylinders...) thus simplifying the calculation of the insertion energy. Dumbbell shaped objects are the first non trivial objects for studying the validity of the theorem. The dumbbell insertion free energy is also related to the depletion interaction between two hard spheres or a sphere and a wall immersed in a solvent. For such systems, it has been shown recently that standard techniques such as bulk integral equations and the Derjaguin approximation fail to describe the depletion interaction [2,3]. The morphometric approach is a natural extension of the Derjaguin approximation, is superior to it for intermediate size ratios between solute and solvent particles and compares well to explicit DFT results.

[1] P.-M. König, R. Roth, and K. R. Mecke, PRL 93, 160601 (2004) [2] M. Oettel, PRE 69, 041404 (2004) [3] A. R. Herring and J. R. Henderson, PRL 97, 148302 (2006)

CPP 24.3 Wed 14:30 ZEU 160

Effect of Interface Mediated Interaction between Anisotropic Colloids at Fluid Interface — •Ehsan Noruzifar and Martin Oettel — Institut fuer Physik – Johannes Gutenberg-Universitaet, Staudinger Weg 7, 55099 Mainz, Germany

The effective interaction between colloidal particles trapped at the interface between two fluid phases is influenced by the presence of the deformable interface. Interfacial changes in such a system are responsible for new types of interactions that are not present in the bulk. As an instance, thermal fluctuations of the interface induce a Casimir type interaction between nano scale colloids, which was studied extensively for isotropic particles [1]. In the present work, by adding anisotropy to the colloids, we have investigated the effect of these fluctuation induced forces on possible ordering phenomena. On the other hand, for increasing the size of the trapped anisotropic particles, static deformations of the interface lead to more and more dominating capillary interactions between the colloids [2]. In the second part of the work, using this capillary potential, we have studied the dynamic behavior of colloids at the interface by employing Langevin dynamics simulations.

[1] H. Lehle, M.Oettel, and S. Dietrich, Europhys. Lett. 75, 174 (2006), H. Lehle and M. Oettel, Phys. Rev. E 75, 011602 (2007)
[2] H. Lehle, E. Noruzifar, and M. Oettel, Eur. Phys. J. E 26, 151-160 (2008)

CPP 24.4 Wed 14:45 ZEU 160

The effect of mixing and spatial dimension on the glass transition — •David Hajnal[1], Joseph M. Brader[2], and Rolf Schilling[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, Staudinger Weg 7, D-55099 Mainz, Germany — [2]Fachbereich Physik, Universität Konstanz, D-78457 Konstanz, Germany

We study the influence of composition changes on the glass transition of binary hard disk and hard sphere mixtures in the framework of mode coupling theory.

We derive a universal formula for the local variation of the critical packing fraction upon composition changes. For low concentration limits of one particle species, we evaluate our formula by using a perturbation ansatz. This new method allows a fast prediction of some properties of the glass transition lines. In addition, we present a glass transition diagram for binary hard disks and compare these two-dimensional results with the corresponding results for hard spheres in three dimensions from previous studies.

CPP 24.5 Wed 15:00 ZEU 160

Influence of the attraction range on the reentrant glass transition in colloid polymer mixtures — •Carl Stilke and Eckhard Bartsch — Institut f. Physikal. Chemie, Universität Freiburg, Albertstr. 21, D-79104 Freiburg

Recently the occurrence of a reentrant glass transition has been observed in a binary mixture of polystyrene microgel colloids in a good, isorefractive solvent to which linear polystyrene with a size ratio δ = Rg(polymer)/R(colloid) = 0.08 was added [1] to introduce depletion attractions. This phenomenon has been predicted by mode coupling theory (MCT) for such systems [2]. MCT predicts further that for smaller size ratios δ the reentry effect should become even stronger and that for $\delta > 0.0465$ there should emerge a glass-glass transition line ending in a critical point (a A3 singularity in the MCT language).

To check up on these predictions we prepared colloid-polymer mixtures with a size ratio $\delta = 0.03$. The short range order and the dynamics of these colloid-polymer mixtures were then studied with light scattering techniques in order to localize the glass transition lines. As the glass-glass transition line should be most easily detectable by a discontinuous jump in the plateau modulus Gp the rheological behaviour was studied as well. The obtained results are contrasted with the predictions of MCT.

[1] T. Eckert, E. Bartsch, J. Phys.: Condens. Matter 16, S4937,(2004) [2] K. Dawson etal., Phys. Rev. E 63, 011401, (2001)