DY 28: Pattern formation in colloidal and granular systems II

Time: Friday 10:15–13:15 Location: HÜL 386

DY 28.1 Fri 10:15 HÜL 386

Axial segregation in oscillatory driven colloidal binary mixtures — •Adam Wysocki and Hartmut Loewen — Institut fur Theoretische Physik II: Weiche Materie, Heinrich-Heine-Universitaet Duesseldorf, Universitaetsstrasse 1, D-40225 Duesseldorf, Germany

Using computer simulations we show that binary mixtures of colloids driven in opposite directions by an oscillating external field exhibit axial segregation in sheets perpendicular to the drive direction. The segregation effect persists also for strong hydrodynamic interactions. For increasing driving forces axial segregation ceases and is taken over by lane formation in direction of the driving field.

DY 28.2 Fri 10:30 HÜL 386

Granular segregation phenomena in rotating containers — Lama Naji, Tilo Finger, and •Ralf Stannarius — Otto-von-Guericke-Universität Magdeburg

Segregation of granular mixtures in rotating drums and the subsequent coarsening of segregation patterns are well investigated phenomena. But still, many basic questions are poorly understood, among them the mechanism of coarsening of stripe patterns in cylindrical tubes, and the role of lateral boundaries. We investigate slurries, mixtures of glass beads in liquid environment (water). These systems do not only allow the optical observation of surface patterns, but also a three-dimensional structure characterization by NMR tomography. Experiments with cylindrical and spherical mixers are reported.

DY 28.3 Fri 10:45 HÜL 386

Critical Casimir forces between colloids and chemically patterned substrates — •Matthias Tröndle[1,2], Svyatoslav Kondrat[1,2], Andrea Gambassi[1,2], Ludger Harnau[1,2], and Siegfried Dietrich[1,2] — [1]Max-Planck-Institut für Metallforschung, Heisenbergstr. 3, D-70569 Stuttgart — [2]Institut für Theoretische und Angewandte Physik Universität Stuttgart, Pfaffenwaldring 57, D-70569 Stuttgart

We study the effective critical Casimir forces acting on colloids immersed in a binary liquid mixture in the presence of a chemically structured substrate with laterally varying adsorption preference. Close to the critical point of the fluid, long-ranged correlations in the mixture cause pronounced normal and lateral critical Casimir forces between the colloids and the confining wall. The sign and the magnitude of these forces depend on the surface properties so that the colloids tend to align with the substrate pattern. This allows, for example, the formation of highly ordered colloidal monolayers. Recently, the measurement of critical Casimir interactions in such a system has been reported [F. Soyka, O. Zvyagolskaya, C. Hertlein, L. Helden, and C. Bechinger, PRL 101, 208301 (2008)]. Based on general renormalization group arguments, we calculate the universal scaling functions for the critical Casimir forces acting on a spherical colloid close to a chemically patterned substrate as well as for the corresponding interaction potential and compare our results with experimental data.

DY 28.4 Fri 11:00 HÜL 386

Random-Close Packing in Binary Mixtures in Two Dimensions — •Elmar Staerk[1], Stefan Luding[2], and Matthias Sperl[1] — [1]Institut fuer Materialphysik im Weltraum, DLR, Koeln — [2]Universiteit Twente, The Netherlands

Binary mixtures are investigated at the transition from loose to load-bearing packings. The transition is determined both in computer simulation and experimentally in assemblies of stress-birefringent particles. Both the size ratio of smaller to bigger particles as well as the concentration of smaller particles is varied systematically. The transition is determined accurately by observing a discontinuity in the number of contacts per particle. It is found that the variation of the transition density follows qualitatively recent predictions for the glass transitions in binary mixtures of colloidal particles. At the transition point – especially for asymmetric mixtures – we find non-trivial variations of contact numbers, apparent exponents, and the number of rattlers.

DY 28.5 Fri 11:15 HÜL 386

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

The packing of spheres in confined geometry is of both fundamental and practical interest for logistics, mathematics, condensed matter physics, and recently also in colloid science. We study the structural transition of colloidal crystals confined between two plates. Restricting the available space leads to an adaptation of the crystalline bulk structures (bcc, hcp, fcc) to the symmetry of the confinement and a rich variety of structures is found as a function of colloid packing fraction and confinement dimension. We extend former experimental work presenting new exotic crystalline structures having no atomic counterpart. In addition we present first results of bidisperse colloidal crystals in confinement.

DY 28.6 Fri 11:30 HÜL 386

The flow field of glass beads around a fixed obstacle — •Matthias Raithel[1], Christoph Krülle[2], and Ingo Rehberg[1] — [1]Experimentalphysik V, Universität Bayreuth, D-95440 Bayreuth, Germany — [2]Maschinenbau und Mechatronik, Hochschule Karlsruhe - Technik und Wirtschaft, D-76133 Karlsruhe,Germany

In this experiment a dish filled with glass beads is shaken horizontally, so every point on that dish moves on a circular path. Controlled by the filling fraction, the oscillation frequency and amplitude, the system shows phase transitions [1] and the change from reptation to rotation [2]. By inserting an intruder the system becomes more complex. In the case of a freely moving intruder segregation occurs. The flow field around a fixed obstacle is examined in order to understand that segregation.

[1] S. Aumâitre, T. Schnautz, C. Kruelle, I. Rehberg, Phys. Rev. Lett. 90, 114302 (2003)

[2] M. Scherer, V. Buchholtz, T. Pöschel, I. Rehberg, Phys. Rev. E 54, R4560 (1996)

15 min. break.

DY 28.7 Fri 12:00 HÜL 386

Convection in thermosensitive colloidal suspensions — •Florian Winkel[1], Stephan Messlinger[1], Wolfgang Schöpf[1], Ingo Rehberg[1], Miriam Siebenbürger[2], and Matthias Ballauff[2] — [1]Experimentalphysik V, Universität Bayreuth, D-95440 Bayreuth, Germany — [2]Physikalische Chemie I, Universität Bayreuth, D-95440 Bayreuth, Germany

We investigate thermal convection in a microgel suspension that consists of core-shell colloids which change their size with temperature. The swelling and shrinking of the particles dramatically modifies the volume fraction and therefore the viscosity of the suspension. As a consequence, a temperature gradient applied to the suspension also induces a gradient of the colloid concentration which strongly influences both the onset and the nonlinear behavior of thermal convection. In our experiment we expose a Hele-Shaw convection cell to a constant temperature difference. The thermal convection is monitored via a shadowgraph setup. We report on the formation and evolution of convection patterns in our microgel suspension.

DY 28.8 Fri 12:15 HÜL 386

A new convection scenario in granulates under geometrical restriction — •Frank Rietz and Ralf Stannarius — Universität Magdeburg, FNW, IEP, Abteilung Nichtlineare Phänomene

An experiment is presented that extends the diversity of pattern forming phenomena found in granular media. A flat container (Hele-Shaw cell) is filled with a granular mixture and slowly rotated about its horizontal long axis. The filling fraction is crucial for the observed effects.

At partial filling of the container, the material can be fluidized during rotation and patterns of axially segregated stripes appear which undergo slow coarsening. This effect resembles stripe patterns commonly found in rotating drums.

A novel interesting phenomenon emerges under geometrical restrictions when the container is nearly filled. Although the particles are on the brink of jamming, and their mobility is almost inhibited, we observe regular convection rolls that are accompanied by, and decorated by a conspicuous serpentine segregation pattern. In contrast to the loosely moving beads at partial filling, the particles move in collective clusters. Furthermore the number of convection rolls is long-term stable and only related to the container geometry.

Even though there are some superficial similarities to well known convection rolls in vibrated granular systems, there are striking differences concerning driving forces, segregation patterns, and number of rolls. Our system complements convection phenomena found in agitated granulates and brings up new questions that are discussed in the study. *Phys. Rev. Lett.* **100**, 078002 (2008).

DY 28.9 Fri 12:30 HÜL 386

Dynamical polarization and unusual flow response in the shear flow of dipolar colloidal rod suspensions — •Sebastian Heidenreich[1], Siegfried Hess[1], and Sabine H. L. Klapp[2] — [1]Institute für Theoretische Physik, TU Berlin, 10623, Germany — [2]Institut für Theoretische Physik, FU Berlin, 14195 Berlin, Germany

The flow properties of colloidal rod suspensions are strongly affected by the dynamical behavior of the orientation. Shear banding is an example of the remarkable non-Newtonian feedback that is possible in such systems. For colloidal rods with a permanent electric (magnetic) dipole moment additional exciting effects are expected. The calculations presented here are based on a self-consistent hydrodynamic model including feedback effects between orientational motion and velocity profile [1]. The competition between shear-induced tumbling motion (observed in colloidal suspensions of rod-like fd virus [2]) and the boundary conditions imposed by plates leads to oscillatory alignment structures. These give rise to a spontaneous time-dependent polarization and to oscillating local spurts of the velocity profile [3]. Moreover, our model can be extended to polar active biomaterials by including “activity terms”. Finally, some preliminary results of the local spurt effect in active polar colloidal suspensions are presented.

[1] S. Grandner, S. Heidenreich, S. Hess and S. H. L. Klapp, EPJE 24, 353 (2007).; M. G. Forest, S. Heidenreich, S. Hess, X. Yang and R. Zhou JNNFM 155, 130 (2008). [2] M. P. Lettinga, Z. Dogic, H. Wang, J. Vermant, Langmuir 21, 8048 (2005). [3] S. Heidenreich, S. Hess, and S. H. L. Klapp, submitted to PRL.

DY 28.10 Fri 12:45 HÜL 386

Unstable Kolmogorov flow in granular matter — •Klaus Roeller and Stephan Herminghaus — MPI for Dynamics and Self-Organization, Bunsenstr. 10, D-37073 Göttingen, Germany

We report on simulations of an instability in granular flow, which is driven by a time-constant spatially periodic shear force. This type of forcing is known as Kolmogorov flow. We performed molecular dynamics type simulations, both time-driven and event-driven, in two and three dimensions [1,2]. For small values of the applied shear force we observe the usual shear bands. Above a critical value, however, the shear bands become unstable resulting in the formation of a dynamically stable pattern with swirls. This effect was observed in dry as well as in wet granular matter, although the morphology of the swirls strongly differs for the two cases.

[1] S. Herminghaus Advances in Physics 54, 221 (2005)
[2] A. Fingerle, et al, New J. Phys. 10, 053020 (2008)

DY 28.11 Fri 13:00 HÜL 386

Statics and dynamics of a continuous Asakura-Oosawa model near the critical point — •Peter Virnau[1], Jochen Zausch[1], Jürgen Horbach[2], and Kurt Binder[1] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz — [2]DLR Köln

We propose a continuous variant of the Asakura-Oosawa model which allows us to study dynamics, too. The phase behaviour of the system is determined with grandcanonical Monte Carlo simulations and found to be in good agreement with the original hardcore model. Dynamical quantities near the critical point are investigated with Molecular Dynamics simulations. While the self-diffusion of polymers increases slightly when the critical point is approached, the self-diffusion of colloids decreases. Critical slowing down of interdiffusion is observed, which is qualitatively similar to the behavior of a symmetric binary Lennard-Jones mixture near criticality.