SFB TR6
Physics of
Colloidal Dispersions
in External Fields

GEMEINDE
BRIEF 2012

Editorial

Welcome to the sixth issue of the annual SFB TR6 Gemeindebrief. This newsletter is a forum to present the recent research highlights and scientific activities of the collaborative research centre SFB TR6. It is directed both to researchers in the network and to other scientists interested in the physics of colloidal dispersions. The newsletter also includes a short personalia section and information about SFB TR6 and soft matter conferences, schools and workshops.

Those who want to know more about the SFB TR6 are invited to visit our web page: www.sfb-tr6.de

Hartmut Löwen, Brigitte Schumann and Anna Borghorst

New assistant secretary in the SFB TR6

A. Borghorst B. Schumann

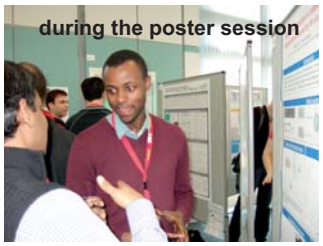
Since October 2011, Anna Borghorst is also working for the SFB TR6 in the secretary in Düsseldorf. She is helping Ms. Brigitte Schumann as a student assistant.

CODEF III 2012 - International Conference, Bonn, Germany

The International CODEF III conference on „Colloidal Dispersions in External Fields“ was held in Bonn-Bad Godesberg from 20 March to 23 March 2012. This central SFB conference continued the CODEF I meeting in 2004 and the CODEF II meeting in 2008 and covered the whole topic of the SFB TR6. There were 167 registered participants from 15 countries. 13 international leading scientists were invited to present talks and every project of the SFB TR6 was represented by a talk. Moreover 110 posters were presented. The conference included also a bus excursion to the Drachenfels.

In this issue

The SFB TR6 CODEF III


during the poster session


panoramic view
(top of the Drachenfels)


in the lecture hall

conference dinner

Selected scientific results

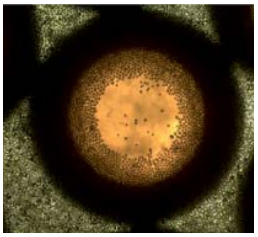
Universal Critical behavior of Curvature-Dependent Interfacial Tension

S.K. Das, K. Binder, Phys. Rev. Lett. ***107****,235702 (2011).*

From the analysis of Monte Carlo simulations of a binary Lennard-Jones mixture in the coexistence region, evidence is provided that the curvature dependence of the interfacial tension can be described by a simple theoretical function $\sigma(R)\xi^2 = C_1/[1+ C_2(\xi/R)^2$, where ξ is the correlation length and R is the droplet radius. The universal constants C_1 and C_2 are estimated. In the model, a Tolman length is strictly absent, but, since its critical behavior is believed to be much weaker than ξ, we argue that it only provides a correction to scaling and does not affect the leading critical behavior.

Colloidal crystallization in quasi 2D induced by electrolyte gradients

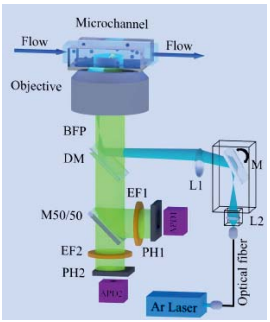
A. Reinmüller, E. Oguz, R. Messina, H. Löwen, H. J. Schöpe and T. Palberg, J. Chem. Phys. ***136****, 164505 (2012).*



Driven crystal formation events in thin layers of sedimented colloidal particles under low salt conditions were investigated. Using optical microscopy, particles in a thermodynamically stable colloidal fluid to move radially converging towards cation exchange resin fragments acting as seed particles were observed. When the local particle concentration has become sufficiently large, subsequently crystallization occurs. Brownian dynamics simulations of a 2D system of purely repulsive point-like particles exposed to an attractive potential, yield strikingly similar scenarios, and kinetics of accumulation and micro-structure formation.

Studying flow close to an interface by total internal reflection fluorescence cross-correlation spectroscopy: Quantitative data analysis

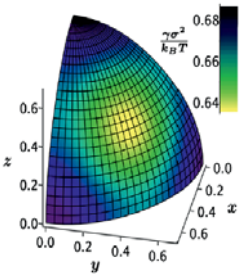
R. Schmitz, S. Yordanov, H. J. Butt, K. Koynov, and B. Dünweg, Phys. Rev. E ***84****, 066306 (2011)*



Total Internal Reflection Fluorescence Cross-Correlation Spectroscopy uses fluorescent colloidal particles to probe the properties of a flow field near a surface. The article shows how careful experiments combined with a detailed theoretical analysis employing large-scale computer simulations are able to measure properties like the slip length with competitive or even superior accuracy. The results also show clearly that the method requires detailed modeling of the diffraction phenomena at the confocal microscope's objective, and that this aspect needs further improvement.

Tension and Stiffness of the Hard Sphere Crystal-Fluid Inter-face

A. Härtel, M. Oettel, R. E. Rozas, S. U. Egelhaaf, J. Horbach, and H. Löwen, Phys. Rev. Lett. ***108****, 226101 (2012)*

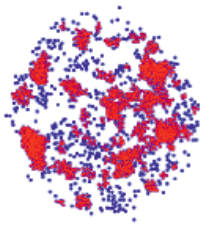


A combination of fundamental measure density functional theory and Monte Carlo computer simulation is used to determine the orientation-resolved interfacial tension and stiffness for the equilibrium hardsphere crystal-fluid interface. Microscopic density functional theory is in quantitative agreement with simulations and predicts a tension of $0.66k_BT/\sigma^2$ with a small anisotropy and stiffnesses with, e.g., $0.53k_BT/\sigma^2$for the (001) orientation and $1.03k_BT/\sigma^2$ for the (111) orientation. Here k_BT is denoting the thermal energy and σ the hard-sphere diameter.

Selected scientific results

Shock waves in capillary collapse of colloids: a model system for two–dimensional screened Newtonian gravity

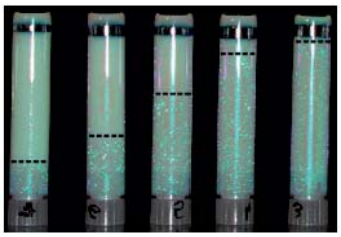
J. Bleibel, S. Dietrich, A. Domínguez, and M. Oettel, Phys. Rev. Lett. ***107****, 128302 (2011).*



Using Brownian dynamics simulations, density functional theory, and analytical perturbation theory, the collapse of a patch of interfacially trapped, micrometer-sized colloidal particles, driven by long-ranged capillary attraction was studied. This attraction is formally analogous to two-dimensional (2D) screened Newtonian gravity with the capillary length (lambda) over cap as the screening length: cosmology in a Petri-dish!

Core–shell microgels as model colloids for rheological studies

M. Siebenbürger, M. Fuchs and M. Ballauff, Soft Matter ***8****, 4014 (2012).*

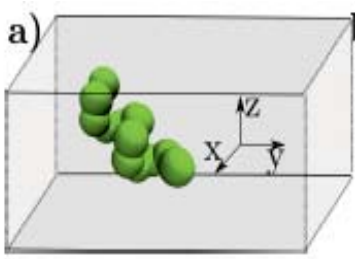


Recent work on the rheology of thermosensitive core–shell lattices is reviewed. These sus-pensions are a well-characterized model system for the study of the flow behavior of con-centrated suspensions. Their nonlinear rheology compares favourably with the predictions of the mode-coupling theory of dispersions under flow. Excellent agreement is found concerning yielding, shear-thinning and large amplitude oscillatory shearing.

Separation of chiral particles in micro- or nanofluidic channels

S. Meinhardt, J. Smiatek, R. Eichhorn and F. Schmid, Phys. Rev. Lett. ***108****, 214504 (2012).*

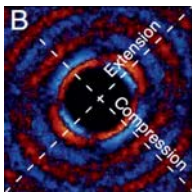
A method is proposed to separate enantiomers in microfluidic or nanofluidic channels. It requires flow profiles which break chiral symmetry and have regions with high local shear. Such profiles can be generated in channels confined by walls with different hydrodynamic boundary conditions (e.g., slip lengths). Due to a nonlinear hydrodynamic effect, particles with different chirality migrate at different speed and can be separated. - This paper was discussed as a research highlight in "Chemistry World".



Yielding of Hard-Sphere Glasses during Start-Up Shear

N. Koumakis, M. Laurati, S. U. Egelhaaf, J. F. Brady, and G. Petekidis, Phys. Rev. Lett. ***108,*** *098303 (2012).*

Concentrated hard-sphere suspensions and glasses were investigated with rheometry, confocal microscopy, and Brownian dynamics simulations during start-up shear, providing a link between microstructure, dynamics, and rheology. The microstructural anisotropy is manifested in the extension axis where the maximum of the pair-distribution function exhibits a minimum at the stress overshoot. The interplay between Brownian relaxation and shear advection as well as the available free volume determine the structural anisotropy and the magnitude of the stress overshoot.



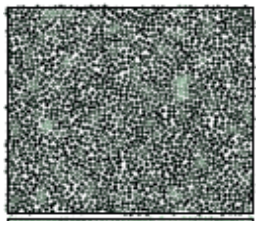
Active Nonlinear Microrheology in a Glass-Forming Yukawa Fluid

D. Winter, J. Horbach, P. Virnau, and K. Binder, Phys. Rev. Lett. ***108,*** *028303 (2012) .*

A molecular dynamics computer simulation of a glass-forming Yukawa mixture was used to study the anisotropic dynamics of a single particle pulled by a constant force. Beyond linear response, a scaling regime was found where a force-temperature superposition principle of a Peclet number holds.

Crystallization in a Dense Suspension of Self-Propelled Particles

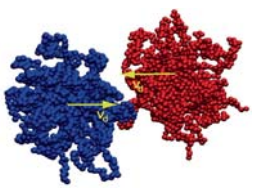
J. Bialké, T. Speck, and H. Löwen, Phys. Rev. Lett. ***108****, 168301 (2012).*



Selfpropelled (“active“) colloidal particles are shown by simulation to crystallize at sufficiently high densities. The transition is accompanied by pronounced structural heterogeneities. This leads to a transition region between liquid and solid in which the suspension is globally ordered but unordered liquidlike ´“bubbles“ still persist.

Nonequilibrium Forces between Dragged Ultrasoft Colloids

Sunil P. Singh, Roland G. Winkler, and Gerhard Gompper, Phys. Rev. Lett. ***107****, 158301 (2011).*



The dynamical deformation of ultrasoft colloids as well as their dynamic frictional forces are numerically investigated, when one colloid is dragged past another at constant velocity. Hydrodynamic interactions are captured by a particle-based mesoscopic simulation method. At large drag velocities, an apparent attractive force is found for departing colloids along the dragging direction. The deformation, in the close encounter of colloids, and the energy dissipation are examined as a function of the drag velocity and their separation.

Editorial Details

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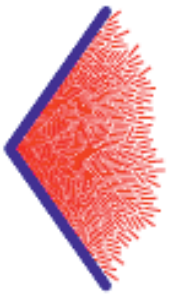
Cooperation of the SFB TR6 with a Japanese core-to-core soft matter program

The collaboration with the Japanese core-to-core program and the SFB TR6 was continuated. J. K. G. Dhont and H. Löwen were invited speakers on the international Yukawa-Institute meeting "Phase Transition Dynamics in Soft Matter: Bridging Microscale and Mesoscale" which took place in Kyoto 20.2.-22.2.2012.

Selected scientific results (continued)

How to capture active particles

A. Kaiser, H. H. Wensink, H. Löwen, Phys. Rev. Lett. ***108****, 268307 (2012)*



For many applications, it is important to catch collections of autonomously navigating microbes and man-made microswimmers in a controlled way. An efficient trap to collectively capture self-propelled colloidal rods is proposed. By means of computer simulation in two dimensions, it is shown that a static chevron-shaped wall represents an optimal boundary for a trapping device. Its catching efficiency can be tuned by varying the opening angle of the trap. For increasing angles, there is a sequence of three emergent states corresponding to partial, complete, and no trapping. A trapping `phase diagram' maps out the trap conditions under which the capture of self-propelled particles at a given density is rendered optimal.

Calls of SFB members to other universities

H.H. Wensink

R. Messina

M. Oettel

Henricus H. Wensink has received a permanent CNRS position at the Université Paris-Sud 11 - CNRS Orsay (France). **René Messina** assumed a professor-ship at the University of Metz (France). **Martin Oettel** received a call for a W3 professor-ship at the University of Tübingen (Germany).

Prizes and honors

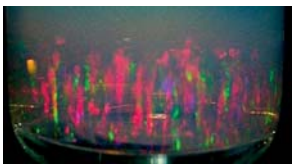
Alfons van Blaaderen received an ERC Advanced Investigator Grant to do research on nanocolloids.

Rene van Roij received a Dutch VICI grant on nanoparticles in fluids and fluids in nanostructures.

Special among SFB TR6 guests

07/2011 **H. Tanaka (Tokyo)** visited Mainz/Ddorf
07/2011 **J. Chakrabarti (Kolkata)** visited Düsseldorf
09/2011 **O. Vinogradova (Moscow)** visited Mainz
01/2012 **B. Cichocki (Warsaw)** visited Jülich
01/2012 **N. Wilding (Bath)** visited Mainz
03/2012 **A. Banchio (Cordoba)** visited Jülich
03/2012 **A. Yethiraj (St John's)** visited Ddorf
05/2012 **S. K. Das (Bangalore)** visited Mainz

Colloidal calendar



In summer 2011 the SFB TR6 successfully participated in the total work of art of colloidal crystals of the Spectrale 2011 (as one of the events of the scientific city of Mainz). In this process and in collaboration with Artefont Mainz (Tanja Labs) a 2012 calendar was created. A copy of this calendar was distributed to all the Pi's of the SFB.

Coming up next:

Final SFB meeting in Schloss Waldthausen

The final SFB meeting will take place in Schloss Waldthausen from 5-7 March 2013. Here all SFB projects will present the final results of the last funding period. The program will be include talks by 5 invited external speakers (E. Furst (Delaware), S. Klapp (Berlin), K. Mecke (Erlangen), K. Neyts (Gent), D.J. Norris (Zürich)).

Young Researcher Meeting

The Young Researcher Meeting 2012 will be held in Konstanz, from 10th-12th of September. Further information at http://cms.uni-konstanz.de/physik/maret/seminars0/transregio-sfb-tr-6/

Statistical Mechanics: Interplay of Theory and Computer Simulations

In September 19-21, 2012 there will be the meeting "Statistical Mechanics: Interplay of Theory and Computer Simulations" in Mainz to honor the achievements of Kurt Binder who will become emeritus at Mainz in 2012. The meeting is organized among others by F. Schmid and B. Dünweg and is sponsored and supported by the SFB TR6.

ELOPTO 2012

The next international conference on colloidal and molecular electro-optics ELOPTO will held in Gent (Belgium) from the 2nd - 5th September 2012. This conference will be supported by the SFB TR6 and is a follow-up of the successful ELOPTO meeting 2010 which was organized by T. Palberg in Mainz.