SFB TR6
Physics of
Colloidal Dispersions
in External Fields

GEMEINDE BRIEF 2006
No. 1 / July 2006

## Editorial

Welcome to the first 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 soft matter Conferences, Schools and workshops.

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

Hartmut Löwen
Heike Kaminski

### Brief description of the Transregio SFB TR6
Physics of Colloidal Dispersions in External Fields

The Transregio-Sonderforschungsbereich TR6 is focused on the study of colloidal dispersions by three different complementary methods, namely experiment, computer simulation, and theory. Colloids play an exposed role as model systems for condensed matter in general. The expectation is that colloids will play a similarly dominant role in exploring changes of soft matter properties in external fields. Such fields can be realized by a shear flow or by the presence of electric and magnetic as well as laser-optical fields and topographical fields such as confining geometry. The motivation to study an external control via external fields is twofold: i) Soft matter reacts sensitively upon external perturbations and manipulations. The occurrence of stable colloidal bulk samples is the exception rather than the rule, i.e., one has to protect the sample carefully against shear and other perturbations. ii) Strong external fields can induce qualitatively novel non equilibrium effects.

33 scientists from 5 locations (Konstanz, Mainz, Düsseldorf, FZ Jülich and Utrecht) are carrying out collaborative research within the SFB TR6.

### NEW in the SFB
### Independent Junior researcher group lead by M. Oettel

*Martin Oettel*

A new SFB TR6 position was opened for an independent junior researcher. Last year 6 candidates were invited and interviewed together with DFG administrational people and 4 external referees. The position went to Martin Oettel who will start his research on July 1, 2006 at the University of Mainz in the institute of K. Binder.

The Oettel group will use theoretical techniques to investigate colloidal particles trapped at fluid-fluid interfaces studying their interaction, structure and self-assembly. Classical density functional theory of inhomogeneous liquids and liquid-integral equation theory will be employed as theoretical tools. There will be a strong mutual exchange with the Binder group who perform simulation studies.

### SFB TR6 Summer School on Soft Matter
### October 02 - October 13, 2006
**Colloids in external fields: Physics and applications**

organized by
G. Maret (Konstanz)
J. Bibette (Paris)

Institut d'Études Scientifiques de Cargèse

The scientific programme of the Cargese Summer School has now been finalized and the School is open for applications. SFB TR6 project section leaders will present the basic physics parts while external lectures have been invited to discuss various applications of colloids in external fields. A significant number of participants will be young SFB TR6 researchers.
*www.sfb-tr6.de/summerschool06/*

## In this issue

## The special 2005-workshop for young researchers of the SFB TR6

The third workshop for young researchers of the SFB was organized by R. Messina and held in Düsseldorf from 26.09.2005 to 27.09.2005. As is tradition now, young scientists are periodically presenting their research in the absence of the project leaders. This kind of workshop facilitates direct collaboration and exchange at the level of the young scientists. The 2005-workshop brought together the newly hired staff from the second funding period and was considered to be a great success. The next workshop for young researchers will be held in spring 2007 in Konstanz and will be organized by A. Erbe.

*Participants of the young researcher workshop together with R. Messina (front left)*

## Report about the internal 2006-workshop of the SFB TR6

This three-days symposium (20.3.-22.3.2006) took place in the Gustav-Stresemann-conference centre in Bonn, the same location known from the first CODEF conference. Presentations were made about each project section and the meeting was complemented by four external contributions: A. Ajdari (Paris) introduced the physics of microfluidics, F. Mugele (Twente) carried over ideas from solid colloidal particles to liquid droplets and reported about kissing and dancing of droplets. N. Willenbacher (Karlsruhe) focussed on applications of colloidal flow and rheology. Finally Prof. Gudehus (Karlsruhe) outlined the connection of colloidal research to the community of pelloids and discussed properties of real soils and clays. The meeting was also attended by A. Patkowski (Poznan) who maintains a strong collaboration with the SFB TR6.

A SFB TR6 member meeting was also held here on Monday evening.

*A. Ajdari*

*Poster discussions*

*M. Külzer and S. Richter on behalf on the Gudehus group*

*Scientific side discussions during the coffee breaks*

*The audience*

*F. Mugele*

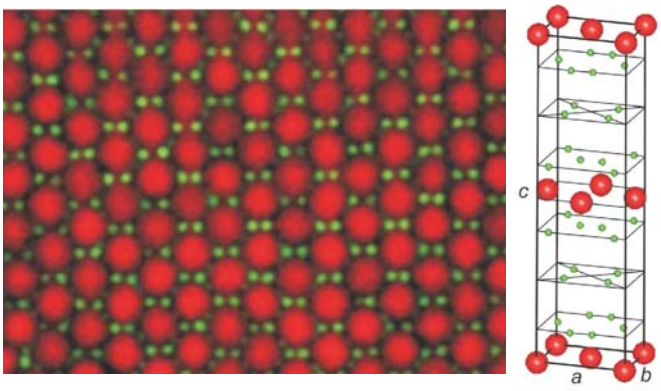
*N. Willenbacher*

## Selected scientific results

### Ionic colloidal crystals of oppositely charged particles

*M.E. Leunissen, C.G. Christova, A.-P. Hynninen, C.P. Royall, A.I. Campbell, A. Imhof, M. Dijkstra, R. van Roij & A. van Blaaderen, Nature **437,** 235 (2005)*

Oppositely charged colloids are shown to crystallize in various crystalline structures. When exposed to an external electric fields, the systems exhibits lane formation for sufficiently strong fields and also show a jamming phenomenon for very large fields in qualitative agreement with earlier theoretical investigations performed in the SFB TR6.
A detailed comparison between computer simulation is theory and currently under investigation.




*Confocal micrograph of a crystal plane consisting of negative particles with a diameter of 1 micrometer (red) and positive particles that are three times smaller (green). In this colloidal salt crystal every big particle is surrounded by six small particles. The model shows the three dimensional structure of this crystal.*

### Metal-like elasticity in colloidal crystals

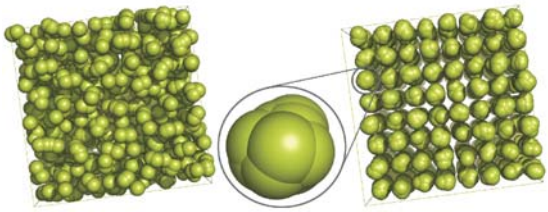
*D. Reinke, H. Stark, H.-H. von Grünberg, A.B. Schofield, G. Maret, and U. Gasser (preprint)*

Elastic constants in three-dimensional crystals of charged colloidal crystals are determined from the fluctuations of the particles around their lattice sites. Would the effective forces be radially symmetric (what is typically assumed in theory), the socalled Cauchy relation would be fulfilled. The measurements reveal strong deviations from the Cauchy relation. This is similar to metallic solids with conductions electrons, the role of the latter is now played by the classic microscopic ions. These experimental result challenge the theoretical description of pair interaction between charged colloids.

### Clustering in the absence of attractions

*Bianca M. Mladek, Dieter Gottwald, Gerhard Kahl, Martin Neumann and Christos N. Likos, Phys. Rev. Lett. **96**, 045701 (2006)*

Can clusters form even if interparticle interactions are purely repulsive? In 2001, Likos et al. postulated, on the basis of a generic criterion based on the Fourier transform of bounded potentials, that this should indeed be possible if the Fourier transform has negative components *C. N. Likos et al, Phys. Rev. E **63**, 031206 (2001)*. A recent paper by Mladek et al, highlighted here, explicitly confirmed this scenario and showed that the clustered crystals feature density-independent lattice constants. This brings forward the diverse possibilities that nature has in attempting to find the optimal configuration for a collection of soft particles. For a short commentary, see Daan Frenkel in Nature (Research Highlights), Vol. 440, 2 March 2006, p. 5 and for a more extensive one http://www.bell-labs.com/jc-cond-mat/march/march_2006.html.

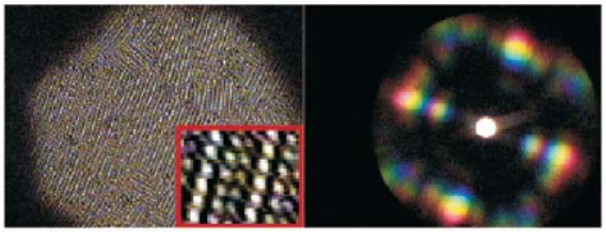


*A simulation snapshot of the soft particles, at low density (fluid, left) and high density (crystal, right). The middle picture shows a zoom of the site-cluster, comprising about 10 particles.*

### Fast Microscopic Method for Large Scale Determination of Structure, Morphology, and Quality of Thin Colloidal Crystals

*H.J. Schöpe, A. Barreira Fontecha, H. König, J. Marques Hueso, and R. Biehl, Langmuir **22**, 1828 (2006)*

A novel fast microscopic method to analyse the crystal structures of air-dried or suspended colloidal multilayer systems is presented. Once typical lattice spacings of such films are in the range of visible light, characteristic Bragg scattering patterns are observed. If in microscopic observations these are excluded from image construction, a unique color coding for regions of different structures, morphologies, and layer numbers results. Incoherently scattering defect structures, however, may not be excluded from image construction and thus remain visible with high resolution.



*Real space image and Fourier image (low $q$ scattering patterns) of cell colloidal samples. Image width 137,5 x 102,5 $\mu m^2$. The insert in the real space pictures is a cut-out with higher magnification. For a special plate separation a three-layer buckled crystal is visible.*

**Editorial Details**

**Editors:**
Hartmut Löwen & Heike Kaminski
SFB TR6 HHU Düsseldorf
Universitätsstr. 1, 40225 Düsseldorf

**Contact:**
Tel.: +49 211 81 12746
Fax: + 49 211 81 12262
transregio@thphy.uni-duesseldorf.de
www.sfb-tr6.de

## Colloids at the Soft Matter and Interfaces workshop in Lisbon

All locations of the SFB TR6 were represented at the workshop "Soft Matter and Interfaces" which was held in Lisbon (Portugal) from May 25-27 2006 to mark the sixtieth birthday of R. Evans (Bristol). The conference was organized by S. Dietrich (Stuttgart) and M. Telo da Gama (Lisbon). Six invited talks were presented by SFB members, namely K. Binder, M. Dijkstra, G. Gompper, P. Leiderer, H. N. W. Lekkerkerker, H. Löwen. Among the participants were the SFB TR6 project leaders C. N. Likos, M. Oettel and M. Schmidt.

## SOCOBIM '07

### Soft, Complex, and Biological Matter Conference

**Satellite Conference of StatPhys 23**
**Citta del Mare, Terrasini, Sicily**

**15 to 19 July 2007**

This conference has the goal of bringing together researchers from diverse backgrounds, working in the interdisciplinary and mutually related fields of soft matter, complex materials and biologically-inspired physics. The underlying connection between these is the complexity of the mesoscopically-sized constituent particles involved, the richness in the composition of the many-body systems and the flexibility to alter the systems' properties by chemistry, molecular architecture and external fields. Emphasis will be put in the physical aspects of the problems and the coordinated approach by experiment, theory and numerical simulation. As recent trends mark an increased interest and effort to approach problems of biological relevance by employing the tools and language of physics and chemistry, one important focus of SOCOBIM will be the presentation and critical discussion of recent developments in this context.
The Conference will consist of about thirty oral presentations and a poster session. The duration of oral presentations will be 30 minutes, including questions. Most of the talks will be presented by invited speakers, however there is space for a small number of poster contributions to be accepted as oral contributions. There will be no parallel sessions.

SOCOBIM is co-organized by the Italian Center of Excellence "**SOFT-CRS**: Complex Dynamics in Structured Systems" and the German-Dutch Collaborative Research Center "**SFB-TR6:** Physics of Colloidal Dispersions in External Fields"**.** Organizers: F. Sciortino (SOFT) and C.N. Likos (SFB). More about the conference you will find on web **www.socobim.de.**

## Personalia

**Dr Urs Gasser** (Konstanz, project section C2) followed a call from the Paul Scherrer Institute in Villingen (Switzerland). He will maintain a strong collaboration with the Konstanz group.

**Priv.-Doz. Dr. Matthias Schmidt** (Düsseldorf, project section D3) received a call to a lecturer position at Bristol University. He accepted and is formally on leave from Düsseldorf keeping a strong link to Düsseldorf.

**Prof. Dr. Dieter Richter** (Jülich, project section A2) received and declined an appointment to the Governor's Chair of the University of Tennessee in Knoxville, connected with a position as Director of the Joint Institute for Neutron Science at SNS, ORNL, USA.

The Royal Dutch Academy of Sciences announced the election of **Prof. H.N.W. Lekkerkerker** (Utrecht, project section C6) as Academy Professor.

## Special among the SFB TR6 guests:

**Prof. Dr. Surajit Sengupta, SN Bose National Centre for Basic Science, Kolkata, India,** January 8, 2006 to February 06, 2006**,** October 2007 visiting Mainz and Konstanz

**Prof. Dr. William van Megen, RMIT Melbourne Australia,** May 30, 2006 to September 30, 2006 visiting Konstanz, Düsseldorf, Jülich and Mainz

**Dr. J. Chakrabarti SN Bose National Centre for Basic Science, Kolkata, India,** November 9 to December 13, 2005 and July 17 to August 18, 2006 visiting Düsseldorf.

## upcoming

| Conference/Place | Date |
|---|---|
| **Colloids in external fields: Physics and applications Summer School** Cargese, France | **02-13 Oct. 06** |
| **SOCOBIM Satellite Conference of StatPhys 23** Terrasini, Sicily, Italy | **15-19 July 07** |
| **SFB TR6 PhD workshop** Konstanz, Germany | **spring 2007** |
| **CODEF II Conference** Bonn, Germany | **spring 2008** |

## Open positions

Open Postdoc and PhD positions are available in the experimental soft condensed matter group at the Heinrich-Heine-University in Düsseldorf.
The projects are concerned with the non-equilibrium behaviour of colloids and surfactants, respectively. For further details, please, contact Stefan.Egelhaaf@uni-duesseldorf.de.