Colloidal Dispersions in External Fields, Bonn-Bad Godesberg (29 March to 1 April 2004)

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PREFACE

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This special issue reflects the scientific program of the CODEF conference (**CO**lloidal **D**ispersions in **E**xternal **F**ields) that took place in Bonn-Bad Godesberg from 29 March to 1 April, 2004 and was held in conjunction with the German–Dutch Collaborative Research Centre **Transregio SFB TR6**, with the title *Physics of colloidal dispersions in external fields*. Scientists working within this network as well as international invited guest speakers contributed to this meeting.

Colloidal dispersions are solutions of mesoscopic solid particles with a stable (i.e., non-fluctuating) core, suspended in a molecular fluid solvent. Among the various soft matter systems, colloidal dispersions play a prominent role, since they can be both prepared and characterized in a controlled way. The effective interaction between the colloidal particles can be tailored by changing, e.g., the salt concentration in the solvent. Moreover, colloidal suspensions can be regarded as the simplest prototype of soft matter: there are only two structural length scales in the problem, that of the microscopic solvent and that of the mesoscopic particles and the separation between these is large, comprising many orders of magnitude. Spherical particles without any additional structure on the mesoscopic length scale possess the simplest and highest possible symmetry. This directly implies that a simple theoretical modelling of the effective particle-particle interaction, without many fitting parameters, is possible. The exciting questions that can be asked thereafter, are concerned with collective many-body effects induced by cooperation and self-organization of many particles. A striking advantage of colloidal dispersions lies in the fact that these questions can be studied simultaneously by using three different complementary methods, namely experiment, computer simulation, and theory. Experimental real-space techniques are very useful and promising to provide direct comparison with theory and simulations, opening thereby a new way of looking at the suspensions that is richer than the traditional scattering methods operating in reciprocal (wavenumber) space.

A profound theoretical understanding also provides insight into the general basic principles and mechanisms of phase transformations. In this way, colloids play a pivotal role as model systems for condensed matter in general. Colloids play a similarly prominent role in exploring changes of soft matter properties *in external fields* which can be used to control the colloidal samples. Such external control can materialize by a shear flow or by the presence of electric and magnetic as well as laser-optical fields and geometrical confinements [1].

The motivation to study external control via external fields arises through two main factors. (i) First, by definition, 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 in order to achieve a stable bulk configuration. (ii) The second reason is that strong external fields can induce qualitatively novel effects, including a modification of the effective interparticle interaction itself.

In order to put the study of colloidal dispersions in non-equilibrium onto firm footing, the equilibrium structure, dynamics and bulk phase behaviour have to be understood first. Even this is not an easy task, in particular for particles displaying active *internal* degrees of freedom, e.g., for flexible, polydisperse and anisotropic particles. Hence, using rigid particles provides the simplest non-trivial realization of soft matter under external control. Employing a suitable external field, one can recover and systematically investigate equilibrium bulk properties. An external magnetic field can be used to tune the interparticle interactions and to trigger a host of new phase transitions. Furthermore, a laser-optical field can constitute a periodic external potential posing again an inhomogeneous but nevertheless equilibrium problem. In non-equilibrium, hydrodynamic effects, including the hydrodynamic interactions between the colloids, pose a challenging problem for their efficient numerical implementation. Several competing approaches to this task are discussed in this special issue.

This special issue is organized according to the type of the external fields with the first section focusing on pure bulk problems (i.e., in the absence of any external fields). The classification of the papers into subsections has been carried out according to the following scheme:

- Bulk
- Shear fields
- Electric fields
- Laser-optical and magnetic fields
- Confining geometries
- Gravity and 'thermodynamic' driving forces

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Guest Editors

References

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Participants of the CODEF meeting during the conference dinner.

Participants

D Aarts (Utrecht), C Addison (Cambridge), O Alarcon-Waess (Puebla), E Allahyarov (Düsseldorf), J L Arauz-Lara (San Luis Potosi), A Archer (Bristol), G K Auernhammer (Mainz), A Barreira Fonteha (Mainz), P Bartlett, (Bristol), E Bartsch (Mainz), C Bechinger (Stuttgart), N Ben Braham (Fribourg), J J Berriel Mastretta (Cinvestav), K Binder (Mainz), R Blaak (Düsseldorf), A Blumen (Freiburg), E Boek (Cambridge), G Bossis (Nice), W Briels (Twente), P Bryk (Lublin), H-J Butt (Mainz), J B Caballero (Almeria), R Castaneda Priego (Konstanz), M E Cates (Edinburgh), P Chaikin (Princeton), D Chapot (Lyon), A Chatterij (Mainz), M Chauez-Paez (San Luis Potosi), G Ciccotti (Rome), V de Villeneuve (Utrecht), D Derks (Utrecht), J K G Dhont (Jülich), R Di Leonardo (Rome), S Dietrich (Stuttgart), M Dijkstra (Utrecht), Z Dogic (Cambridge, MA), R Dullens (Utrecht), B Dünweg (Mainz), J Dzubiella (Cambridge), F Ebert (Konstanz), S Egelhaaf (Edinburgh), C Eisenmann (Konstanz), A Esztermann (Düsseldorf), B Evans (Bristol), B U Felderhof (Aachen), A Fernandez-Nieves (Almeria), A Fortini (Utrecht), K Franzrahe (Konstanz), V Froltsov (Düsseldorf), M Fuchs (Konstanz), U Gasser (Konstanz), J-C Gimel (Le Mans), T Gisler (Konstanz), G Gompper (Jülich), D Gottwald (Vienna), I Götze (Düsseldorf), D Grier (Chicago), C Grodon (Stuttgart), T Gruhn (Golm), J-P Hansen (Cambridge), P Henseler (Konstanz), S Herminghaus (Ulm), S Hess (Berlin), N Hoffmann (Düsseldorf), C Holm (Mainz), J Horbach (Mainz), J-P Huang (Mainz), A-Pekka Hynninen (Utrecht) P Ilg (Berlin), A Imhof (Utrecht), M Jenkins (Edinburgh), P M Johnson (Utrecht), R B Jones (London), A Jusufi (Bayreuth), G Kahl (Vienna), H Kaminski (Düsseldorf), K Kang (Jülich), S Karanikas (Cambridge), K Kegler (Leipzig), P Keim (Konstanz), R Kirchhoff (Düsseldorf), S Klapp (Berlin), R Klein (Konstanz), M Klokkenburg (Utrecht), M Koeppl (Konstanz), M Konieczny (Düsseldorf), P König (Stuttgart), H König (Mainz), T Kreer (Mainz), K Kremer (Mainz), F Kremer (Leipzig), P Lang (Jülich), M Laurati (Jülich), H N W Lekkerkerker (Utrecht), P Lettinga (Jülich), M Leunissen (Utrecht), J J Lietor-Santos (Almeria), C N Likos (Düsseldorf), V Lobaskin (Mainz), A Louis (Cambridge), H Löwen (Düsseldorf), R Lund (Jülich), C Lutz (Konstanz), K Mangold (Konstanz), F Mantegazza (Milan), G Maret (Konstanz), C Mayer (Düsseldorf), M McPhie (Jülich), M Medenbach (Mainz), J Miguel Mendez-Alcaraz (Cinvestav), R Messina (Düsseldorf), K Mussawisade (Jülich), G Nägele (Jülich), T Nicolai (Maine), P Nielaba (Konstanz), H Noguchi (Jülich), N Oskolkov (Moscow), J Padding (Cambridge), T Palberg (Mainz), I Pasichnyk (Mainz), G Petekidis (Heraklion), A P Philipse (Utrecht), R Piazza (Milan), D Pini (Milan), K Planken (Utrecht), P Poulin (Pessac), P Pusey (Edinburgh), G M Range (Berlin), S Rathgeber (Jülich), L Reatto (Milan), S Rehwald (Düsseldorf), H Reich (Düsseldorf), M Reichert (Konstanz), D Reinke (Konstanz), M Rex (Düsseldorf), A Ricci (Mainz), W Richtering (Kiel), M Ripoll (Jülich), L Rodriguez Maldonado (Almeria), L Rojas (Fribourg), G Rother (Jülich), P Royall (Utrecht), S Sacanna (Utrecht), N Sadowsky (Berlin), A Sarlah (Berlin), S Savenko (Utrecht), P Schall (Cambridge, MA), T Schilling (Mainz), M Schmidt (Utrecht), J Schneider (Mainz), P N Segre (Huntsville), C Spöler (Berlin), I Stankovic (Berlin), H Stark (Konstanz), J Stellbrink (Jülich), P Tartaglia (Rome), J Thijssen (Utrecht), G Tommaseo (Mainz), R von Klitzing (Berlin), A van Blaaderen (Utrecht), A van der Horst (Utrecht), R L C Vink (Mainz), H H von Grünberg, (Konstanz), G J Vroege (Utrecht), P Wessels (Düsseldorf), S Wiegand (Jülich), L Willner (Jülich), R Winkler (Jülich), Y L Wu (Utrecht), A Wysocki (Düsseldorf), B Zoetekouw (Utrecht).