CPP 24: Complex Fluids and Colloids II (joint session CPP/DY)

Time: Tuesday 9:30–11:45 Location: C 264

CPP 24.1 Tue 9:30 C 264

Effective Landau description of ferronematics — •Grigorii Zarubin[1,2], Markus Bier[1,2], and Siegfried Dietrich[1,2] — [1]Max Planck Institute Int. Sys. — [2]University of Stuttgart, Germany

A ferromagnetic phase of anisotropic particles suspended in a nematic liquid crystal (NLC) was predicted as early as 1970 [1]. A recent experimental realization [2] confirmed that a dilute suspension of magnetic platelets in NLC forms ferromagnetic phase which is susceptible to weak magnetic fields. In this work we develop a Landau-like description of such a suspension starting from a microscopic model. Our functional represents an expansion in powers of two spatially varying fields: i) magnetization field and ii) director field and their cross terms. Using this result we can compare our theory to the one proposed in [2], in particular we have an access to the effective coupling coefficient between magnetization and director field which provides a way to estimate coupling of the director to the surface of the single platelet experimentally.

[1] F. Brochard and P.G. de Gennes, J. Physique 31, 691 (1970).

[2] A. Mertelj, D. Lisjak, M. Drofenik and M. Copic, Nature 504, 237 (2013).

CPP 24.2 Tue 9:45 C 264

Self-assembly of colloidal particles with a magnetic coating under external magnetic fields — Gabi Steinbach[1,2], Michael Schreiber[1], Dennis Nissen[3], Manfred Albrecht[3], •Ekaterina Novak[4], Pedro A. Sanchez[5], Sofia Kantorovich[4,5], Sibylle Gemming[1,2], and Artur Erbe[2] — [1]Institute of Physics, Technische Universität Chemnitz, 09107 Chemnitz, Germany — [2]Lenin Av.51 — [3]Institute of Physics, University of Augsburg, 86159 Augsburg, Germany — [4]Ural Federal University, Lenin av. 51, Ekaterinburg, 620000, Russia — [5]Computational Physics, Universität Wien, Sensengasse 8, Vienna, 1090, Austria

In recent years, in order to build tailored structures, magnetic nanoparticles and colloids that deviate from the model of a spherical particle with a dipole moment at its center were studied. Among them are dumbbells, magnetic core-shell particles, elongated ferroparticles, and colloidal particles with a magnetic cap. In this contribution, we both experimentally and numerically shows how an equilibrium state with non-collinear arrangement of the magnetic moments of colloidal particles with a magnetic cap enables the controlled self-assembly of diverse structures in two dimensions via constant and low-frequency external magnetic fields. Branched clusters of staggered chains, compact clusters, linear chains, and dispersed single particles can be formed and interconverted. The presented precise control of structure formation and reconfiguration under external fields of only a few mT open new potential for using in responsive materials for highly sensitive magnetic and optical applications.

CPP 24.3 Tue 10:00 C 264

Self-assembly of magnetic filaments with different topologies — •Elena Pyanzina[1], Ekaterina Novak[1], Dmitry Rozhkov[1], Pedro Sanchez[2], and Sofia Kantorovich[1,2] — [1]Ural Federal University, Lenin av. 51, Ekaterinburg, 620000, Russia — [2]University of Vienna, Sensengasse 8, 1090, Wien, Austria

Semi-flexible polymer-like chains of magnetic nanoparticles permanently crosslinked with polymers (magnetic filaments) have been recently pointed as promising building blocks for the creation of sophisticated magnetoresponsive materials. Our research addresses the study of magnetic filaments with different chain conformations - simple open chains, closed rings and branched structures with "X" and "Y" junctions - inspired by the recent findings on the low temperature self-assembly of dipolar hard spheres (Kantorovich et al, PCCP, 2015). The introduction of the polymer crosslinkers to stabilise the structure of such self-assembled nanoparticle aggregates is expected to have an important impact on the properties of the system. Here we focus on low-concentration solutions, analysing in detail their self-assembly behaviour. Extensive cluster analysis allows us to compare the structures formed by these filament solutions to those observed in "conventional" magnetic fluids containing non-crosslinked nanoparticles. These results will pave the way for the development of analytical models and identify the most interesting building block candidates for the design of novel magnetoresponsive materials.

CPP 24.4 Tue 10:15 C 264

Magnetic microgels in computer simulations — •Elena Minina[1,2], Pedro Sanchez[1], Christos Likos[1], and Sofia Kantorovich[1,2] — [1]University of Vienna, Vienna, Austria — [2]Ural Federal University, Ekaterinburg, Russian Federation

In this work, we study magnetic microgels – spherical colloidal particles consisting of polymer network with embedded magnetic dipolar particles – by means of molecular dynamics computer simulations. Our main focus is concentrated on how the microgels change their shape and size depending on their internal structure and magnetic component. Microgels are initially modelled as bead-spring polymer chains randomly crosslinked into a polymer network. Changing degree of crosslinking allows us to vary microgel's internal structure. This way, we consider weekly crosslinked and highly crosslinked microgels. The fraction of magnetic particles is in the range between 0.5 to 10 per cent of the total fraction of particles comprising the polymer network. Studying such systems at different strength of dipole-dipole interactions, we estimate the change of magnetic microgel in size, self-assembly of magnetic particles and the initial magnetic susceptibility. We show that an appropriate combination of magnetic component and degree of crosslinking may offer an additional way to control.

CPP 24.5 Tue 10:30 C 264

Influence of rotating magnetic field on magnetic fluids with different viscosities — •Anastasia Storozhenko[1], Ralf Stannarius[2], Alexey Eremin[2], Torsten Trittel[2], and Igor Aref'ev[3] — [1]Southwest State University, 305040 Kursk, Russia — [2]Otto von Guericke University Magdeburg, 39016 Magdeburg, Germany — [3]Ivanovo Power Engineering University, 153003, Ivanovo, Russia

In an external rotating magnetic field, the magnetization of magnetic nanoparticles follows the field direction with a certain phase lag, which results in a macroscopic torque. We investigated experimentally the dependence of the torque density on the strength and frequency of the magnetic field, as well as on the viscosity of magnetic fluid.

The torque density increases with the square of the field strength; this can be explained by well-known expressions. At the same time, the magnetization direction changes slower than the external magnetic field due to the relaxation of magnetic nanoparticles. The dependence of the torque on frequency is thus complex and depends on the viscosity of magnetic fluid. We find a growth of the torque with rotation rate of the field, followed by a decay at higher rates. The torque maximum shifts with changing viscosity. This phenomenon can be related to the balance of Neel and Debye relaxation times.

This study was funded by DFG within SPP 1681, Project STA 425/36 and a DAAD Stipendium.

CPP 24.6 Tue 10:45 C 264

Microfludic-SANS: Rapid screening and flow processing of complex fluids — •Carlos Lopez[1], Takaichi Watanabe[2], Marco Adamo[3], Andreas Poulos[3], Anne Martel[4], Lionel Porcar[4], and Joao Cabral[3] — [1]RWTH Aachen University — [2]Okayama University — [3]Imperial College London — [4]Institut Laue Langevin

The coupling of microfluidics and small angle neutron scattering (SANS) is demonstrated. We have developed microfluidic devices with low SANS background and high pressure resistance for the investigation of flow-induced phenomena and high throughput phase mapping of soft matter.

We study the structure of model water-surfactant-oil mixtures under extensional flow and obtain scattering profiles from 50 micron wide channels, with 1 - 300 second acquisition times. The microfluidic geometry enables the variation of both flow type and magnitude, beyond traditional rheo-SANS setups, and is well-suited for complex fluids due to the commensurability of relevant time and lengthscales.

Using an online micromixer we implement a high-throughput approach, scanning in excess of 10 SANS profiles per minute for model surfactant and colloid solutions both in continuous and multiphase (droplet) flow. We show that microfluidic approaches can reduce experimental time and sample volume and considerably improve the accuracy of contrast matching experiments.

15 min. break

CPP 24.7 Tue 11:15 C 264

Biaxial Phases in binary mixtures of liquid crystals — •Robert Skutnik, Louis Lehmann, Sergej Püschel-Schlotthauer, and Martin Schoen — Stranski-Laboratorium für Physikalische und Theoretische Chemie, Technische Universität Berlin, Sekr. C7, Straße des 17. Juni 135, Berlin 10623, Germany

Liquid crystals are organic molecules of anisotropic shape exhibiting anisotropic interactions. In fact, because of their delocalized π electron system, they exhibit π-π stacking and align parallel with their neighbors. Generally speaking, liquid crystal molecules can be classified as prolate or oblate molecules where the π-π electrons are parallel and perpendicular to the molecular symmetry axis. Hence, the interaction of an oblate and prolate liquid crystal results in a perpendicular alignment with respect to their symmetry axes. We perform Monte Carlo simulations and model both species (i. e., prolate and oblate) by an anisotropic potential based on the well-known 12-6 Lennard-Jones potential which promotes a parallel alignment if both particles are of the same species and perpendicular alignment otherwise. Besides the isotropic phase, we observe the formation of a nematic phase in the presence of a biaxial isotropic phase and the formation of a biaxial nematic phase despite the otherwise uniaxial symmetry of molecules of both species.

CPP 24.8 Tue 11:30 C 264

Polar and nematic liquid crystals on curved surface — •Axel Voigt, Simon Praetorius, Michael Nestler, Ingo Nitschke, and Sebastian Reuther — TU Dresden, Institut für Wissenschaftliches Rechnen

We consider a thin film limit of a Frank-Oseen and a Landau-de Gennes model. In the limiting process we observe a continuous transition where the normal and tangential parts of the director and the Q-tensor decouple and various intrinsic and extrinsic contributions emerge. For the derived surface models, we consider an L^2-gradient flow. The resulting vector- or tensor-valued surface partial differential equations are numerically solved to demonstrate realizations of the tight coupling of elastic and bulk free energy with geometric properties. We further discuss extensions towards surface Ericksen-Leslie and Beris-Edwards models and active liquid crystals on curved surfaces.