CPP 57: Complex Fluids and Colloids, Micelles and Vesicles II (joint session CPP/DY)

Time: Friday 9:30–13:00   Location: MER 02

Invited Talk   CPP 57.1   Fri 9:30   MER 02
Chiral transport of active and passive colloids — •Anke
Lindner[1], Andreas Zöttl[2], Olivia du Roure[1], Eric Clement[1],
Francesca Tesser[1], and Guangying Jing[3] — [1]PMMH-ESPCI, 10,
rue Vauquelin, 75011 Paris, France — [2]Faculty of Physics, University
of Vienna, Kolingasse 14-16, 1090 Wien, Austria — [3]School of Physics,
Northwest University, Xi'an, 710127, China

Chirality-induced effects are at the origin of bacterial rheotaxis and
particle drift in shear flows. Here we investigate such effects using
a combination between experiments and theoretical modeling for two
systems: E-coli bacteria and 3D printed micro-particles.

The micro-particles consist of a spherical head and a helical tail of
different pitch and handedness. We investigate the chirality-induced
reorientation dynamics using microfluidics and observe asymmetric ori-
entation bistability perpendicular to the flow direction. We quan-
titatively explain our findings through a theoretical model without
adjustable parameters considering particle elongation, chirality and
head-heaviness, in very good agreement with experiments.

We then present a study of the transport of motile bacteria in shear
flows. Experimentally, we obtain with high accuracy and for a large
range of flow rates, the spatially resolved velocity and orientation dis-
tributions. They are in excellent agreement with the simulations of
a kinematic model accounting for stochastic and microhydrodynamic
properties and flagella chirality. In contrast to the micro-printed par-
ticles Brownian rotational noise plays a crucial role in bacterial rheo-
tactic drift.

CPP 57.2   Fri 10:00   MER 02
Active and driven colloids interacting with vesicles —
•Antonio Stocco, Vaibhav Sharma, Florent Fessler, and Car-
los Marques — Institut Charles Sadron, CNRS University of Stras-
bourg

When a colloid is close to a lipid giant vesicle, the interaction between
the Brownian particle and the fluctuating soft membrane affects not
only the particle motion but also the membrane properties. The mem-
brane may change its shape to accommodate the particle and partial or
complete engulfment may occur as a function of the energy of adhesion,
membrane tension and bending. Furthermore, the interaction between
a micrometric solid particle and a giant vesicle membrane may lead to
complex dynamics when the system is driven out of equilibrium. Here,
we report our efforts with self-propelled Janus colloids and with bare
colloids under optical trapping to mimic complex dynamics such as
particle endocytosis, the motion of a self-propelled particle confined to
a spherical membrane, or the physics of particle engulfment by a mem-
brane. In a wide range of experimental conditions, we have observed
that a self-propelled Janus colloid is able to perform orbital motion
around a giant vesicle remaining in a non-engulfment state. Still, the
active particle is able to impart a force of the order of 0.01 pN on the
vesicle, which is however too small to trigger particle engulfment. By
applying external forces in the 1-100 pN range, we were able to observe
engulfment of bare and Janus colloids by a giant vesicle.

CPP 57.3   Fri 10:15   MER 02
**Universal Casimir interaction and its relevance for col-
loidal and biophysical systems** — •Tanja Schoger[1], Benjamin
Spreng[2], Gert-Ludwig Ingold[1], Paulo A. Maia Neto[3], and
Serge Reynaud[4] — [1]Universität Augsburg, Germany — [2]University
of California at Davis, USA — [3]Universidade Federal do Rio de
Janeiro, Brazil — [4]Laboratoire Kastler Brossel, France

Colloidal systems and biophysical interfaces involve electrolytic envi-
ronments where the Debye screening is extremely efficient. Therefore,
it was thought that the interaction induced by electromagnetic fluc-
tuations could not give rise to long-range forces in such systems. It
has now been shown and experimentally verified [1] that the contribu-
tion to the Casimir force or retarded van der Waals force induced by
low-frequency transverse magnetic fluctuations is not screened. There
thus exists a contribution to the long-range interaction between two
objects in an electrolyte two orders of magnitude larger than previously
thought at distances as small as one hundred nanometres.

For two dielectric microspheres in salted water at room tempera-
ture, the force becomes universal for sufficiently large distances, in
that it depends solely on the geometrical parameters and not on di-

electric functions. While in general, a significant numerical effort is
required to determine the Casimir interaction [2], we have also derived
approximate simple expressions [3] accurate enough for most practical
applications. - [1] L. B. Pires et al., Phys. Rev. Res. 3 033037, (2021);
[2] B. Spreng et al. J. Chem. Phys. 153, 024115 (2020); [3] T. Schoger
et al., Phys. Rev. Lett. 128, 230602 (2022)

CPP 57.4   Fri 10:30   MER 02
**Interparticle forces between real cement surfaces across aque-
ous and non-aqueous solvents** — •Simon Becker and Regine
von Klitzing — Soft Matter at Interfaces, TU Darmstadt, 64289
Darmstadt, Germany

Concrete and cement are highly abundant construction materials.
Therefore, their flow behavior in early stages of processing is of great
interest. By using chemical admixtures such as superplasticizers (e.g.
polycarboxylate ethers - PCEs) their rheological performance can be
enhanced. The rheology is governed by the forces between the particles
and the forces between particles and the liquid phase.

The aim of this work is to map the force between cement surfaces
across an electrolyte via colloidal probe atomic force microscopy (CP-
AFM). Since cement hydrates in aqueous solutions the surface changes
with time. The challenge is to disentangle different effects like hydra-
tion and roughness of the cement surfaces on the interaction. To pre-
vent hydration of the cement the force measurements are conducted in
ethanol solutions. For comparison the force measurements are carried
out between two silica particles, between cement and silica as well as
between cement and cement.

Furthermore, the time dependence of the cement surface due to hy-
dration in water is mapped using tapping mode AFM. Moreover, the
hydration time dependent interparticle force between cement surfaces
is investigated in aqueous electrolyte solution with and without PCE
to approach application related conditions.

CPP 57.5   Fri 10:45   MER 02
**Structure and interaction of surface charged polymeric mi-
celles** — Lingsam Tea, Lutz Willner, •Jörg Stellbrink, and
Stephan Förster — JCNS-1, Forschungszentrum Jülich, 52425
Jülich, Germany

Soft colloids are ubiquitous in synthetic and biological matter and dis-
play macroscopically interesting structural and dynamical properties
resulting from its hybrid microscopic structure. We established mi-
celles formed by amphiphilic block copolymers as an easy and elegant
model system to tailor colloidal softness [1].

In the present work, we introduce surface charges on n-alkyl-PEO-
OH micelles resulting in electrostatic interactions in addition to the
inherently present steric repulsion. These charges are precisely imple-
mented by oxidation of only the terminal hydroxy group of the PEO
block into a carboxy group. We studied intra- and interparticle struc-
ture by SANS over a broad range of concentrations, pH and ionic
strength and demonstrate that the micellar form factor remains the
same independent of the number of charges. However, in contrast to
neutral micelles, the charged micelles typically reveal structure factor
contributions even at very dilute concentration, arising from the here
dominating long-range electrostatic repulsion. Structure factors in the
liquid state are analyzed using competing effective interaction poten-
tials. By increasing the concentration a liquid to crystal transition
is observed for all systems, but for charged micelles at a much lower
concentration compared to the uncharged micelles.
[1] S. Gupta et al., Nanoscale, 7 (2015) 13924.

CPP 57.6   Fri 11:00   MER 02
**Structure and dynamics of concentrated suspensions of
PMMA-PDMS core-shell particles** — •Joel Diaz Maier, Paul
Tümmler, and Joachim Wagner — Institut für Chemie, Universität
Rostock, 18051 Rostock, Germany

Sterically stabilized polymer particles with silicone based stabilizers
find increasing interest as a novel colloidal model system with hard-
sphere interactions. In this contribution, the largely unknown behavior
of concentrated suspensions of PMMA-PDMS core-shell particles was
investigated over a wide range of volume fractions employing static
and dynamic light scattering experiments. Static structure factors ex-
tracted from scattered intensities are analyzed using integral equation

theory. The wavevector-dependent short-time diffusion of the systems can be accurately described using $\delta\gamma$-expansion, based on interpolated experimental structure factors as a direct input. All investigated structural and dynamical properties closely follow theoretical predictions for hard-sphere systems, proving the suitability of these colloidal particles as an easily accessible model system for hard spheres.

15 min. break

CPP 57.7 Fri 11:30 MER 02

Inverse ISAsomes in biocompatible oils - formulation and characterisation — ●Florian Trummer[1], Otto Glatter[2], and Angela Chemelli[2] — [1]Universität Stuttgart, Institut für Physikalische Chemie, Pfaffenwaldring 55, 70569 Stuttgart, Deutschland — [2]Technische Universität Graz, Institut für Anorganische Chemie, Stremayrgasse 9, 8010 Graz, Österreich

In contrast to their more common counterparts in aqueous solutions, inverse ISAsomes (internally self-assembled somes/particles) are formulated as kinetically stabilised dispersions of hydrophilic, lyotropic liquid-crystalline phases in non-polar oils. This contribution reports on their formation in bio-compatible oils and their structural characterisation with Small Angle X-Ray Scattering (SAXS), Dynamic Light Scattering (DLS) and optical microscopy [1]. By using these methods, we were able to demonstrate the presence of inverse hexosomes, inverse micellar cubosomes (Fd3m) and an inverse emulsified microemulsion in squalane with a polyethylene glycol (PEG) alkyl ether as the primary surfactant forming the internal self-assembled phase, which was stabilised by hydrophobised silica nanoparticles. Furthermore, an emulsified L_1-phase and inverse hexosomes were formed in triolein with the triblock-copolymer Pluronic P94 as the primary surfactant. In this case, stabilisation was achieved with a molecular stabiliser of type PEG-dipolyhydroxystearate. Finally, triolein was replaced with olive oil which also led to the successful formation of inverse hexosomes.

[1] Trummer, F., Glatter, O. & Chemelli, A. *Nanomaterials* **12**, 1133 (2022)

CPP 57.8 Fri 11:45 MER 02

Anomalous Screening Behavior of Nanometer-Sized Ions — ●Thomas Tilger and Regine von Klitzing — Department of Physics, Technische Universität Darmstadt, Darmstadt, 64289, Germany

Natural colloidal dispersions have accompanied mankind in the form of blood or milk ever since. Besides this, artificial systems have gained a significant importance for our daily life during the last decades.

Therefore, it is of special interest to gain an understanding of which interparticle forces govern the stability of colloidal dispersions and how this stability can be tailored. The DLVO theory is a powerful framework to describe these interactions. While this description provides a good agreement with experimental data for small 1:1 electrolytes, larger deviations emerge for ions of higher valency and of larger dimensions. For a detailed examination of these border cases, we directly measure the forces between colloidal silica particles in aqueous electrolyte solutions containing nanometer-sized ions by the colloidal probe AFM (atomic force microscopy) technique.

Two different types of nano-ions were chosen as model systems, Keggin ions (silicotungstic acid, STA, a 1:4 system) and Terpyridine-Nickel-complexes with variable charge. Their electrostatic screening behavior reveals significant deviations between the calculated and measured ionic strengths, which indicates some unexpected phenomena.

CPP 57.9 Fri 12:00 MER 02

Charged, screened-charged and hard-sphere fluids studied by confocal microsopy, analytical theory and simulation. — Sahana Kale, Martin Oettel, and ●Hans Joachim Schöpe — Universität Tübingen, Institut für angewandte Physik, Auf der Morgenstelle 10, 72076 Tübingen

We present a joint experimental and theoretical study investigating the fluid structure in direct and reciprocal space of PMMA particles dispersed in various solvents. Using decaline and CHB alone the structure can be well-described using PB-RMSA-Theory for monodisperse systems. Upon adding TBAB we observe that the surface charge can't be screened entirely. To model the fluid structure we use Monte Carlo simulations for a polydisperse hard core Yukawa System. Thus we get meaningful data for the effective charge and salt concentration. The results indicate behavior that is significantly different from HS. Surprisingly the situation is fundamentally different for particles dispersed

in a mixture of decaline and TCE. Here all measured observables follow polydisperse Percus-Yevick theory.

CPP 57.10 Fri 12:15 MER 02

Bicontinuous Microemulsion in Porous Materials — ●Margarethe Dahl[1], René Haverkamp[2], Larissa Doll[1], Thomas Hellweg[2], and Stefan Wellert[1] — [1]Institut für Chemie, Technische Universität Berlin, Germany — [2]Physikalische und Biophysikalische Chemie, Universität Bielefeld, Germany

While the bulk phase behavior of microemulsions has been intensively studied, the influence of a geometrical confinement has been widely neglected. Understanding the influence of geometrical restrictions yields both, fundamental insights and importance for applications, e.g. decontamination and enhanced oil recovery. In our study, controlled-pore silica glasses (CPGs) serve as confining matrices for bicontinuous microemulsions. Effects of the pore network and surface chemistry on phase behavior and structure of a model microemulsion are studied by using various CPGs with pore diameter between $75 - 1000$ Å and ternary bicontinuous microemulsions (water/octane/$C_{10}E_4$). The naturally hydrophilic surfaces of the CPGs were hydrophobically modified to analyze the influence of the surface polarity. We use imaging techniques (cryo-SEM), small angle scattering (SANS, SAXS) with measurements of the advancing contact angles inside the hydrophilic and hydrophobically modified pores (Washburn approach) to explore the microemulsion phase structure in bulk and inside the pores. In this talk, the results of these combined experiments will be presented and discussed.

CPP 57.11 Fri 12:30 MER 02

Diffusion and thermodiffusion of polymers in mixed solvents — ●Daniel Sommermann, Jannik Kantelhardt, and Werner Köhler — Physikalisches Institut, Universität Bayreuth, Germany

We present experiments on diffusion and thermodiffusion of polymers in mixed solvents. So far, most works on thermodiffusion have dealt with binary systems or ternary mixtures of small molecules. Binary samples with polymers in solvents have been studied over both a broad concentration and polymer molar mass range. Only a few very recent experiments measured polymers in a binary solvent. In this work, samples made of polystyrene ($M_w = 4880\,g/mol$), toluene and cyclohexane have been analysed using multi-color optical beam deflection (OBD) and supporting single-color thermal diffusion forced Rayleigh scattering (TDFRS). While binary mixtures are readily characterized by one diffusion and one thermodiffusion coefficient, the number of coefficients increases to four plus two for ternaries. The measured signals show three well separated modes that can be assigned to the thermal diffusivity and the two eigenvalues of the mass diffusion matrix. We are particularly interested in the question, to what extent the dynamics of the large entity, the polymer, is coupled to the solvent-solvent dynamics, both with respect to diffusion and thermodiffusion. A first analysis supports the picture of an effective solvent whose internal dynamics is decoupled from the one of the polymer.

CPP 57.12 Fri 12:45 MER 02

Dynamic susceptibility of magnetic nanoplatelet suspensions — ●Margaret Rosenberg[1], Sofia S. Kantorovich[1], and Philip J. Camp[2] — [1]Department of Physics, University of Vienna, Vienna, 1090, Austria — [2]School of Chemistry, The University of Edinburgh, David Brewster Road, Edinburgh EH9 3FJ, UK

Particle anisometry and anisotropy provide valuable control parameters to alter the self-assembly, and thermodynamic, rheological, and phase behaviour, of colloidal suspensions. This work is concerned with the dynamic magnetic susceptibility (DMS) of a ferrofluid with platelet-shaped anisotropic particles, which have a fixed out-of-plane dipole moment providing additional, magnetic anisometry. Such a colloidal suspensions is of particular interest as, above a threshold concentration, it exhibits a ferromagnetic nematic phase. Recent experimental work [1] has shown that the DMS spectrum exhibits multiple dynamical modes, suggesting that there might be clusters of particles with distinct rotational timescales. Using Brownian dynamics simulations, we explore the effects of varying nanoparticle concentration - and therefore microstructure - on the DMS, and explain the gap in relaxation times, and changes in the spectrum, that are observed experimentally.

[1] M. Küster et al., "Magnetic dynamics in suspensions of ferrimagnetic platelets", Journal of Molecular Liquids, Vol. 360, (2022), 119484