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International Mini-Workshop on

Multi-Component Soft and Complex Fluids

International Center for Condensed Matter Physics (ICCMP),
University of Brasilia (UnB), Brasilia-DF, Brazil, July 15-16, 2013

The scope of the workshop:

Scientific talks and posters on flow and dynamics of soft and complex multi-component fluids, for example in porous systems, in biological systems, electrohydrodynamic flows and flow of magnetic nano-fluids. The relation between macroscopic flow patterns and underlying structures will be in focus. The topics are in particular relevant for energy related applications such as oil-recovery, pharmaceutical designs, design and processing of stronger and lighter materials, etc.

Invited speakers:

Heloisa Bordallo (NBI-Univ. Copenhagen, Denmark)
Jerome Depeyrot (UnB-Brasilia, Brazil)
Azarmidokht Gholamipour-Shirazi (UNICAMP-Campinas, Brazil)
Elisabeth Lindbo Hansen (NTNU-Trondheim, Norway)
Yves Meheust (Univ. Rennes 1, France)
Kleber Carlos Mundim (UnB-Brasilia, Brazil)
Zbigniew Rozynek (NTNU-Trondheim, Norway)

Organizing committee:

Jon Otto Fossum (Chair) (NTNU-Trondheim, Norway)
Geraldo José da Silva (ICCMP-UnB, Brazil)
Tarcísio Marciano da Rocha Filho (ICCMP-UnB, Brazil)

Practical information to participants:

The workshop will take place at International Center for Condensed Matter Physics (ICCMP), University of Brasilia (UnB), Brasilia-DF, Brazil, July 15-16, 2013.

For further information about the workshop, and for submission of contributions, contact
Geraldo Jose da Silva: geraldo@fis.unb.br
Registration deadline for submission of contributed poster abstracts is July 13, 2013.
Submission should include title + coauthors/affiliations + ½ page abstract.

The Abstracts of the Workshop:

Time	Monday – 15 July 2013	Title of the presentations
15:20 – 16:00	Yves Méheust	**Mixing and reaction kinetics in porous media: an experimental pore scale quantification**
16:00 – 16:40	Elizabeth Hansen	**Orientational order in a glass of charged platelets with a concentration gradient.**
17:10 – 17:50	Heloisa Bordallo	**Neutrons: the key to understanding hydrogen bonds and improving our quality of life.** Can neutrons really help us live longer and get home faster?
17:50 – 18:30	Jerome Depeyrot	**Core-Shell Ferrite Nanoparticles for Magnetic Liquids and Nanodrugs**
	Tuesday – 16 July 2013	.
09:30 – 10:10	Zbigniew Rozynek	**Clay-based active eye pupil-like structure.**
10:10 – 10:50	Azarmidokht Gholamipourshirazi	**Miniature Science: A “microfluidical” approach.**
11:20 – 12:00	Kleber Mundim	**Are Natural Phenomena Really Exponential Decay?** **Beyond Arrhenius Theory**

MEHEUST:

Mixing and reaction kinetics in porous media: an experimental pore scale quantification.

Pietro de Anna(1,2), Joaquin Jimenez-Martinez(1), Hervé Tabuteau(3),
Régis Turuban(1), Tanguy Le Borgne(1), Morgane Derrien(1), and Yves Méheust

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We propose a new experimental set up to characterize mixing and reactive transport in porous media with a high spatial resolution, at the pore scale. The analogous porous medium consists in a Hele-Shaw cell containing a single layer of cylindrical solid grains built by soft lithography. On the one hand, the measurement of the local, intra-pore, conservative concentration field is done using a fluorescent tracer. On the other hand, considering a fast bimolecular advection-dispersion reaction $A + B \rightarrow C$ occurring as A displaces B, we quantify the reaction kinetics from the spatially-resolved measurement of the pore scale reaction rate, using a chemiluminescent reaction. The setup provides a dynamical measurement of the local concentration field over 3 orders of magnitude and allows investigating a wide range of Péclet and Damköhler numbers by varying the flow rate within the cell and the local reaction rate. We use it to study the kinetics of the reaction front between A and B. While the advection-dispersion (Fickian) theory, applied at the continuum scale, predicts a scaling of the cumulative mass of product C as, the experiments exhibit two distinct regimes in which the produced mass evolves faster than the Fickian behavior. In both regimes the front reaction kinetics is controlled by the geometry of the mixing interface between the reactants. Initially, the invading solute is organized in stretched lamellae and the reaction is limited by mass transfer across the lamella boundaries. At longer times the front evolves into a second regime where lamellae coalesce and form a mixing zone whose temporal evolution controls the reaction kinetics. In this second regime, the produced mass of C is directly proportional to the volume of the mixing zone defined from conservative species. This interesting property is indeed verified from a comparison of the reactive and conservative data. Hence, for both regimes, the direct measurement of the spatial distribution of the pore scale reaction rate and conservative component concentration is shown to be crucial to providing an explanation to the departure from the Fickian scaling as well as quantifying the basic mechanisms that govern the mixing and reaction dynamics at the pore scale.

HANSEN:

Orientational order in a glass of charged platelets with a concentration gradient

Elisabeth Lindbo Hansen, Sara Jabbari-Farouji, Henrik Mauroy, Tomas S. Plivelic,
Daniel Bonn, and Jon Otto Fossum

Colloidal dispersions of anisometric particles can display dynamical arrest and ordering involving both translational and rotational degrees of freedom. We show that orientational order can develop in glassy colloidal dispersions of charged platelets when a concentration gradient is imposed through solvent evaporation. Our model system of Laponite (LRD) platelets in deionized water has been extensively studied for its ergodic to non-ergodic transitions, and the existence of an underlying isotropic-nematic phase transition has been a subject of debate. We use small-angle x-ray scattering, dynamical light scattering and birefringence to show that the orientational order we observe does not result from an underlying, uniquely determined equilibrium state with orientational order, but from plastic deformation of the colloidal glass.

BORDALO:

Neutrons: the key to understanding hydrogen bonds and improving our qualityof life.

Can neutrons really help us live longer and get home faster?

Heloisa N. Bordallo

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Hydrogen bonds are ubiquitous to our bodies and the world around us. Although most hydrogen bonds exhibit weak attractive forces, with a binding strength about one tenth of a normal covalent bond, they are very important, for without them our daily lives would be impossible. If we could see inside ourselves at the molecular level we would observe a marvelous display of chemical reactions taking place, keeping the body healthy. When a foreign drug enters our inner world, it can interfere with these reactions via mechanisms common to solution chemistry including hydrogen bonding, dipole-dipole interactions, charge-transfer and covalent bonding with (unpredictably) beneficial, benign or catastrophic consequences. Clearly, understanding the structure of a drug in terms of its hydrogen bonds and their interaction with our body chemistry is vital to the challenge of designing new and improved therapeutic drugs. In our physical (outer) world, hydrogen bonds are just as important. Without them, for instance, cement would crumble and it would not be possible to use this magic material in such diverse applications as moulding into different shapes and sizes to build skyscrapers, bridges, superhighways and houses, or to repair our teeth and keeping them healthy.

In this lecture I will show that Inelastic Neutron Scattering and DFT calculations are powerful instruments for probing matter. Together, they make it possible to follow and understand many problems related to hydrogen bond interactions between molecules in physics, chemistry and biology.

DEPEYROT:

CORE-SHELL FERRITE NANOPARTICLES FOR MAGNETIC LIQUIDS AND NANODRUGS

J. DEPEYROT

Complex Fluids Group - Instituto de Física

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Magnetic nanoparticles (NPs) display remarkable properties, which are not present in bulk materials. At the nanometre scale, the observed magnetic properties can be intrinsic, when arising from finite-size and surface effects in individual particles, or can stem from a collective behavior caused by interparticle interactions. These abilities make them interesting systems for fundamental physics as well as prospective for biomedical and technological applications. In particular, the superparamagnetic response may be advantageous for the conversion of electromagnetic energy into heat in magnetic hyperthermia treatment. In such a biomedical application there is still a need to augment the conversion efficiency, and for this purpose it has been proposed to employ the exchange coupling between a magnetically hard core and a magnetically soft shell. The results are optimistic and evidence that the specific loss power can be increased by an order of magnitude with respect to conventional iron-oxide NPs, with a therapeutic efficiency superior to that of a common anticancer treatment. A detailed study of the properties of core/shell magnetic NPs dispersible in living tissues, currently synthesized at GFC-UnB, will be presented.

ZBIGNIEW:

Clay-based active eye pupil-like structure.

Zbigniew Rozynek,[1#] Paul Dommersnes,[1,2] Alexander Mikkelsen,[1] Rene Castberg[3] and
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Keywords: clay mineral, structuring, electric field, colloids, pupil-like behaviour

In my talk I will show that electrohydrodynamic and electro-rheological effects in leaky-dielectric liquid drops can be used to structure and dynamically control colloidal particle assemblies at drop surfaces, including electric-field-assisted convective assembly of jammed colloidal "ribbons" and electro-rheological colloidal chains confined to a two-dimensional surface. Understanding of the aforementioned phenomena enables creation of a "pupil-like" structure that can be actively controlled, i.e. extracts and contracts as electric field strength changes. This work was recently published in [1]. It also serves as a basis for fabricating different colloidal shells, including Janus shell and patchy shells.

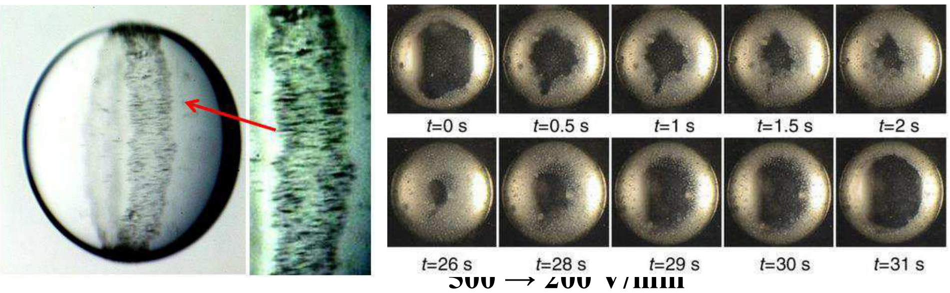

Figure 1. Ribbon formed on the droplet surface (left). Contraction and expansion of a pupil-like colloidal shell (right).

References:

[1] Dommersnes, P., Rozynek, Z., Mikkelsen, A., Castberg, R., Kjerstad, K., Hersvik, K., Fossum, J.O. (2013) Active structuring of colloidal armour on liquid drops. (2013) Nat. Commun. **4,** 2066.

AZARMIDOKT:

Minature Science: A “microfluidical” approach

Azarmidokht Gholamipour-Shirazi

This presentation covers

1- Introduction to microfluidics, the reasons that we need it, its brief history.
2- A brief look into microfabrication techniques.
3- The hydrodynamics principals that govern microfluidics.
4- A brief look into the micromixing.

MUNDIM:

Are Natural Phenomena Really Exponential Decay?

Beyond Arrhenius Theory

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Keywords: Supercooled Liquids, d-Arrhenius model.

In the current scientific literature many experiments across a range of fields present non-Arrhenius behavior, such as diffusion, electrical conductivity, rate reaction in chemistry and biology processes, super conductivity, nonlinear resistors and various transport phenomena in materials science. In the light of existing problems in this subject, our main objective, in this talk, is to propose an approach to describe temperature-dependence for the diffusion activation energy, as well as non-Arrhenius diffusivity in supercooled liquids near glass transition temperature, as well as in reaction rate process, in ionic liquid conductivity, food control process and proton transfer in chemical reaction. Furthermore, the present study provides new insights into the deviations from linearity in many non-Arrhenius phenomena, such as VTF and non-exponential processes.

The linearity in empirical Arrhenius plots ($log\, K \times \frac{1}{T}$) can be enforced because the number and accuracy of experimental data points are usually not too high. Also, in most situations involving physical and chemical ion transport processes, the accessible range of the 1/T variable is small. Currently, the improvement in experimental techniques to study reaction mechanism and transport phenomena has allowed measurements to be made with high accuracy and in a wide range of temperatures. In these cases, the obtained results clearly indicate a nonlinear variation between the activation energy and temperature. On the other hand, the diffusion barrier or activation energy is usually assumed constant, and there are no well-defined models that enable a correct characterization of these phenomena. In particular, for the transport mechanism in general, there is increasing evidence from a variety of recent studies on the temperature dependence of diffusivity processes that points to the need to account for deviations from the Arrhenius mechanism. Our focus on these questions is to propose a new approach, based on a generalization of Tolman´s activation energy definition, which provides a possible insight into the observed deviations from linearity and a tool for extrapolating observations beyond the experimentally accessible range in the case of transport phenomena.

References:

[1] Aquilanti, V., Mundim, K. C., Elango, M., Kleijn, S. & Kasai, T. Temperature dependence of chemical and biophysical rate processes: Phenomenological approach to deviations from Arrhenius law. CHEMICAL PHYSICS LETTERS 498, 209-213 (2010).]

[2] Smith, R. S. & Kay, B. D. Breaking Through the Glass Ceiling: Recent Experimental Approaches to Probe the Properties of Supercooled Liquids near the Glass Transition. THE JOURNAL OF PHYSICAL CHEMISTRY LETTERS 3, 6 (2012).

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