BP 27: Posters: Complex Fluids and Soft Matter

Time: Tuesday 14:00–16:00 Location: Poster A

BP 27.1 Tue 14:00 Poster A

Flux simulations of anisotropic particles in different geometries using lattice Boltzmann method — •Lukas Schrack and Stephan Gekle — Biofluid Simulation and Modeling, Universität Bayreuth

Experiments by Trebbin et al. [1] have shown that anisotropic particles align perpendicular to the flow direction after passing through constricted parts of narrow microchannels.

In order to gain additional insight into the microscopic orientation distribution of such particles, we simulate the flow of rod-like colloids within a restrictive geometry which contains a narrowing section. We use the lattice Boltzmann method as implemented in the software package ESPResSo [2]. We have expanded this software package by integrating cylinders with variable diameter and bifurcations to the alternatives of possible geometries.

Our simulations are performed at low Reynolds numbers and since the alignment process is likely to be a collective phenomena, a large amount of rods is investigated. Each of them consists of single point particles, bonded to each other by a harmonic potential. Stability of the alignment process is of particular interest.

[1] M. Trebbin et al., *PNAS* **110**, 17 (2013)

[2] A. Arnold et al., *Meshfree Methods for Partial Differential Equations VI, Lecture Notes in Computational Science and Engineering* **89**, 1 23 (2013), Springer

BP 27.2 Tue 14:00 Poster A

Nonlinear Dynamics Model Of Epithelial Tissue — •Wei-Lung Lo and Hsuan-Yi Chen — Department of Physics, Nation Central University, Jhongli, 32001, Taiwan.

In spite of recent experimental and theoretical advances in the study of the homeostasis of biological tissues, not much is known about the relaxation dynamics of a tissue toward its homeostasis state. In this work we propose a theoretical model to study this problem. The tissue is composed of stem cells and terminal differentiated cells (TDs). The stem cells divide at a rate r*s and TD cells undergo apoptosis at a rate rd. The self-renewal probability of a stem cell after cell division is assumed to be P*(N*_D) , a function of the total number of TD cells. Our model shows that a biological tissue could allow the existence of multiple steady states. The relation between the steady state properties of the tissue and the corresponding biomolecular processes is addressed. Furthermore, the stability of the homeostasis for a stratified epithelium is studied. We show that the relaxation rate of a tissue towards its homeostasis state is controlled by (i) viscous flow induced by tissue surface tension (ii) adjusted cell proliferation rate (iii) coupling between cell proliferation and flow field in the tissue. The question of how tissue competition affects the relaxation of tissue around a homeostasis state is addressed.

BP 27.3 Tue 14:00 Poster A

Extended X-ray absorption fine structure investigation of aqueous salt solutions under high pressure — •Karin Julius[1], Christian Sternemann[1], Michael Paulus[1], Thomas Büning[1], Karin Esch[1], Julian Schulze[1], Patrick Degen[2], Ralph Wagner[3], and Metin Tolan[1] — [1]Fakultät Physik / Delta, TU Dortmund, 44221 Dortmund, Germany — [2]Ruhr-Universität Bochum, Lehrstuhl für Physikalische Chemie, 44780 Bochum, Germany — [3]Fachbereich C Physik, Bergische Universität Wuppertal, Gaußstr. 20, 42097 Wuppertal, Germany

The study of the structural impact that water (de)stabilizing agents have upon the bulk solvent medium under high hydrostatic pressure can give comprehensive insight to the stabilization or destabilization of proteins in solution. We use extended X-ray absorption fine structure (EXAFS) analysis in order to investigate the influence of pressures up to 5 kbar on the local water network around Rb^+ and Y^{3+} in 0.1 M salt solutions of RbCl and YCl_3. The EXAFS measurements have been performed at beamline BL8 of DELTA (Dortmund) with a high pressure cell in vicinity of the Rb and the Y K-edge. Within the limits of the experiment, the spectra show evidence that the first hydration shells around Rb^+ and Y^{3+} are not influenced by the pressure increase while the surrounding bulk water gets compressed. MD-simulations of the salt solutions in a pressure range from 50 to 5000 bar were performed to discuss the experimental results.

BP 27.4 Tue 14:00 Poster A

Micropipette force sensors for biomechanics and soft matter adhesion studies — •Marcin M. Makowski and Oliver Baeumchen — Max Planck Institute for Dynamics and Self-Organization (MPIDS), 37077 Goettingen, Germany

The precise determination of acting forces is fundamentally important for the characterization of mechanical properties of soft matter and biological processes, e.g. cell-cell and cell-substrate interactions. Optical or magnetic tweezers as well as AFM force probes can provide quantitative information on the interactions of objects such as e.g. single molecules and bacteria. However, these techniques are very much limited to objects within a certain force and size range. Inspired by the work of Colbert et al. (EPJE 30, 117, 2009), we developed a micropipette deflection technique which is capable of quantifying forces down to the pN level (and up to mN) of objects of the size of μm (and up to mm), that are attached via a small negative pressure within the micropipette. As it is purely based on optical high-resolution (and eventually high-speed) imaging involving image cross-correlation analysis, the technique additionally allows for quantitative force-shape correlations and, e.g. in adhesion and friction studies, a direct access to the area of contact. Here, we present force spectroscopy measurements of vesicle adhesion on hydrophilic and hydrophobic substrates, based on micropipette force sensors.

BP 27.5 Tue 14:00 Poster A

Probing the inhomogeneity of intracellular fluids with fluorescence lifetime imaging — •Olivia Stiehl and Matthias Weiss — University of Bayreuth, Bayreuth, Deutschland

Cellular fluids are crowded with a plethora of macromolecules, supramolecular complexes, and organelles. These fluids can therefore be expected to display a spatial inhomogeneity on small length scales, i.e. a coexistence of spatially varying environments. So far, the local diffusional mobility of tracer particles has been exploited frequently as a measure for such inhomogeneities. Here, we report on a different approach that is based on local changes of the photophysics of a tracer dye. In particular, we have used fluorescence lifetime imaging microscopy (FLIM) to quantify local variations in the photophysics of DASPMI in the cytoplasm of living cells. Due to shortened lifetimes in regions of lower viscosity, this method allowed us to explore local properties of the cytoplasm without a need to interprete complex diffusion data. Our results suggest that the cytoplasm's properties are altered in response to changes in the cells' substrate and alterations in intracellular traffic.

BP 27.6 Tue 14:00 Poster A

Microscopic structure of supercooled water studied by x-ray Compton scattering and x-ray Raman scattering — •Juri Nyrow[1], Felix Lehmkühler[2], Mikko Hakala[3], Thomas Büning[1], Ingo Steinke[2], Christoph J. Sahle[4], Karin Julius[1], Agnieszka Poulain[4], Ali Al-Zein[4], Thomas Buslaps[4], Metin Tolan[1] und Christian Sternemann[1] — [1]Fakultät Physik/DELTA, TU Dortmund, GE-44221 Dortmund — [2]Deutsches Elektronen-Synchrotron DESY, GE-22607 Hamburg — [3]Department of Physics, University of Helsinki, FI-00014 Helsinki — [4]ESRF, FR-38043 Grenoble Cedex 9

The microscopic structure of water at ambient and in supercooled conditions is controversially discussed, e.g. with respect to a mixture of low and high density water phases [1]. Recently, x-ray absorption and diffraction studies reported an increasing contribution of tetrahedrally coordinated low density water on cost of a highly disturbed hydrogen bonding network at supercooled conditions [2,3]. We investigated changes of the molecular structure in supercooled water for temperatures down to 255 K by x-ray Compton scattering and x-ray Raman scattering. The results indicate a strengthening of the tetrahedral hydrogen bond network, accompanied by a shortening of the intramolecular OH bond length upon supercooling. These findings will be discussed using structural models with different local bonding configurations [4].

[1] C. Huang et al. PNAS 106, 15214 (2009).
[2] J. A. Sellberg et al. J. Chem. Phys. 141, 034507 (2014).
[3] J. A. Sellberg et al. Nature 510 (7505), 381-384 (2014).

[4] M. Hakala et al. Phys. Rev. B 73, 035432 (2006).

BP 27.7 Tue 14:00 Poster A

The role of detailed balance in chemically active droplets
— •Rabea Seyboldt[1], David Zwicker[1,2], and Frank Jülicher[1] — [1]Max-Planck Institut für Physik komplexer Systeme, Dresden — [2]School of Engineering and Applied Science, Harvard University, Cambridge, MA

Liquid systems that undergo phase separation coarsen with time. One mechanism for coarsening is Ostwald ripening, where large droplets grow at the expense of smaller ones by diffusive fluxes. We are interested in situations in which Ostwald ripening is suppressed due to chemical reactions. We consider a system consisting of three chemical components in which reactions occur between the components. Reaction rates in general obey local detailed balance conditions. We focus on the case where two of the components phase-separate while the third component does not participate in phase separation but represents a reservoir that provides chemical free energy to the system. In this case, the system can be effectively described as a two component phase-separating system with broken detailed balance. In this case, many droplets can coexist with a stable stationary droplet size. Thus chemical reactions can suppress Ostwald ripening and stabilize active suspensions. Our work could be relevant to phase separation in biological cells where liquid-like structures such as centrosomes and germ granules coexist in the cytoplasm in presence of chemical reactions.

BP 27.8 Tue 14:00 Poster A

The mechanical properties of early Drosophila embryos measured by high-speed video microrheology
— •Alok Daniel Wessel and Christoph F. Schmidt — Drittes Physikalisches Institut, Georg-August-Universität Göttingen

In early development, Drosophila melanogaster embryos form a syncytium, i.e. multiplying nuclei are not yet separated by cell membranes, but are interconnected by cytoskeletal polymer networks consisting of actin and microtubules. Between division cycles 9 and 13, nuclei and cytoskeleton form a 2D cortical layer. To probe the mechanical properties and dynamics of this self-organizing "pre-tissue", we measured shear moduli in the embryo by high-speed video microrheology. We recorded position fluctuations of injected micron-sized fluorescent beads with kHz sampling frequencies and characterized the viscoelasticity of the embryo in different locations. Between nuclear layer and yolk the cytoplasm was homogeneous and viscously-dominated, with a viscosity three orders of magnitude higher than that of water. Within the nuclear layer we found an increase of the elastic and viscous moduli consistent with an increased microtubule density. Drug-interference experiments showed that microtubules contribute to the measured viscoelasticity inside the embryo whereas actin only plays a minor role. Myosin inhibition had only minor effects on the probe particle's fluctuation. Measurements at different stages of the nuclear division cycle showed little variation, besides at anphase where we observe directed motion.