

DY 2: Colloids and Complex Fluids I (joint Session BP/CPP/DY, organized by BP)

Joint session with CPP and DY organized by BP.

Time: Monday 9:30–11:00

Location: H45

DY 2.1 Mon 9:30 H45

Intracellular microfluidics to probe the role of hydrodynamic flows in embryonic cell polarization — MATTHÄUS MITTASCH¹, •PETER GROSS², STEPHAN GRILL², and MORITZ KREYSING¹ — ¹MPI-CBG, Dresden, Germany — ²Biotechnology Center, TU Dresden, Dresden, Germany

A hallmark of embryogenesis is the development of spatial structure. This process is orchestrated by gene regulatory networks coupled to physical transport mechanisms. Particularly, it was suggested that the polarization of the egg cell of the nematode worm *Caenorhabditis elegans*, prior to asymmetric cell division, relies on interaction of two protein networks (PAR proteins) coupled to active cortical flows. However, it remains a challenge to perturb intracellular fluid mechanics to demonstrate the causal role of hydrodynamic flows in embryogenesis. Towards this end, we exploited thermo-viscous pumping (Weinert & Braun, *J. appl. Phys.* 2008) in order to dynamically control hydrodynamic flows inside of living embryos. Specifically, well-defined flow patterns were generated on sub- and cellular length-scales with velocities exceeding wild-type flows significantly, without affecting the biological integrity of the embryo. By application of externally-induced flows we depleted membrane-bound PAR proteins locally, suggesting that hydrodynamic flows are essential to load PAR proteins at the posterior pole. Furthermore, we perform rescue experiments in a non-polarizing embryo, by which the omitted wild-type flow will be applied externally to test if the PAR polarity can be restored artificially.

DY 2.2 Mon 9:45 H45

Phase behavior of dense lysozyme solutions — •JULIAN SCHULZE¹, JOHANNES MÖLLER², MICHAEL PAULUS¹, JULIA NASE¹, METIN TOLAN¹, and ROLAND WINTER³ — ¹Fakultät Physik/Delta, Technische Universität Dortmund, 44221 Dortmund, Germany — ²ESRF - The European Synchrotron, 38043 Grenoble, France — ³Fakultät für Chemie und Chemische Biologie, Technische Universität Dortmund, 44221 Dortmund, Germany

In previous studies, small-angle X-ray scattering (SAXS) in combination with liquid-state theoretical approaches and DLVO theory was used to study the intermolecular interaction potential $V(r)$ of lysozyme solutions under the influence of varying environmental conditions such as protein concentration c , temperature T , and pressure p . While the repulsive Coulomb term of the DLVO potential remains almost constant as a function of p , the depth of the attractive part, $J(p)$, exhibits a non-monotonic p -dependence with a minimum at about 2 kbar at constant T . Adding 0.5 M NaCl leads to more prominent short range interactions, especially at high c and low T , and the homogeneous protein solution becomes turbid due to formation of a metastable liquid-liquid phase separation (LLPS) region, where lysozyme forms small droplets of high concentration within the more dilute liquid phase. At elevated pressures, this l-l phase separation is suppressed, but due to the non-monotonic behavior of $J(p)$, a further pressure increase leads to a re-entrant LLPS regime. In this contribution, we will discuss the phase behavior of lysozyme as a function of c , p , and T .

DY 2.3 Mon 10:00 H45

Demixing and Ripening in Gradient Systems — •CHRISTOPH WEBER¹, CHIU FAN LEE² und FRANK JÜLICHER¹ — ¹Max Planck Institute for the Physics of Complex Systems, Dresden — ²Department of Bioengineering, Imperial College, London

Ostwald ripening in homogeneous mixtures is described by the Lifshitz-Slyozov theory. It captures the phenomenon of smaller droplets that shrink, while larger ones grow. This process is driven by a difference in the Laplace pressures between the drops. Recently, liquid-like drops have been reported in living cells, which ripen in a gradient of a regulating protein component. This protein is known to affect the phase separation properties along the gradient such that drops dissolve at one and grow at the opposite side of the cell. An open question is how an inhomogeneous background affects the ripening law in contrast to the homogeneous Lifshitz-Slyozov theory.

To this end we analytically derived the corresponding growth law using a mean field theory. We find that there is a gradient of supersaturation that leads to a drift and an inhomogeneous growth of drops.

The latter gives rise to a dissolution boundary that moves through the system leaving droplets only at one side of the system.

Using our mean field approach to describe the interactions between multiple drops we discover that a larger gradient of supersaturation not necessarily implies a faster ripening. Instead, droplets can be spatially sorted in size leading an arrest of the ripening dynamics for large times until homogeneous Ostwald-ripening sets in again.

DY 2.4 Mon 10:15 H45

New analysis method for passive microrheology — •KENGO NISHI¹, MARIA L. KILFOIL², CHRISTOPH F. SCHMIDT¹, and FRED C. MACKINTOSH³ — ¹Georg-August-Universität Göttingen, Göttingen, Germany — ²University of Massachusetts, Amherst, USA — ³Vrije Universiteit, Amsterdam, Netherland

Passive microrheology is an experimental technique used to measure the mechanical response of materials from the fluctuations of micron-sized beads embedded in the medium. Microrheology is well suited to study rheological properties of materials that are difficult to obtain in larger amounts and also of materials inside of single cells. In one common approach, one uses the fluctuation-dissipation theorem to obtain the imaginary part of the material response function from the power spectral density of bead displacement fluctuations, while the real part of the response function is calculated using a Kramers-Kronig integral. The high-frequency cut-off of this integral strongly affects the real part of the response function in the high frequency region. Here, we discuss how to obtain more accurate values of the real part of the response function by an alternative method using autocorrelation functions.

DY 2.5 Mon 10:30 H45

How to regulate droplet position in a heterogeneous chemical environment? — •SAMUEL KRÜGER^{1,2}, CHRISTOPH A. WEBER¹, JENS-UWE SOMMER^{2,3}, and FRANK JÜLICHER¹ — ¹Max Planck Institute for the Physics of Complex Systems, Dresden — ²Leibniz Institute of Polymer Research Dresden e.V., Dresden — ³Technische Universität Dresden, Institute of Theoretical Physics, Dresden, Germany

Cells contain chemical components that are not separated from the cytoplasm by a membrane. An example are P-granules in the *C. elegans* embryo. They are liquid-like structures, that form droplets. They consist of RNA and proteins that are segregated spontaneously from the cytoplasm and are known to play a role in the specification of germ cells. During asymmetric cell division, P granules are segregated to one side of the cell. This segregation is guided by a spatial concentration gradient of the protein Mex-5. We simplify the multicomponent nature of the cytoplasm with a ternary model: The P granule material, the solvent (cytoplasm), and a regulator corresponding to Mex-5. Using this model we aim to understand the physical principles controlling the droplet position in a simplified scenario, where an external potential establishes the regulator gradient. We use the Flory-Huggins mean field theory and calculate the equilibrium solutions by minimizing the free energy functional. There are two equilibrium states. Droplets either localize at high external potential or low external potential. Changing the interaction between the regulator and the solvent we find that the free energy exhibits a kink indicating that the transition between both states being a discontinuous phase transition.

DY 2.6 Mon 10:45 H45

Finding descriptive features for the characterization of the coarsening dynamics of three dimensional foams — •JONAS DITTMANN¹, ANJA EGGERT², MARTINA LAMBERTUS¹, JANNIKA DOMBROWSKI³, ALEXANDER RACK⁴, and SIMON ZABLER^{1,2} — ¹Lehrstuhl für Röntgenmikroskopie, Fakultät für Physik und Astronomie, Universität Würzburg, Germany — ²Fraunhofer EZRT, Fürth, Germany — ³Wissenschaftszentrum Weihenstephan, Technische Universität München, Germany — ⁴European Synchrotron Radiation Facility (ESRF), Grenoble, France

Understanding the coarsening behavior of foams is essential for their deliberate design. The coarsening theories by Lifshitz, Slyozov and Wagner (LSW) as well as Glazier provide concise coarsening models with descriptive parameters that may enable systematic studies on the effects of different foam constituents.

Wet polydisperse beta-Lactoglobulin foam was imaged by fast synchrotron micro computed tomography over a period of 15 minutes in intervals of 2 to 5 minutes. The growth behavior of about 2×10^5 pores is individually observed and statistically analyzed as a function of pore radius as well as number of neighboring pores.

The three-dimensional analog of von Neumann's law by Glazier is

confirmed as a fitting empirical description of the mean coarsening behavior, whereby the critical number of neighbors discriminating between shrinkage and growth is found to be 13.2 ± 5.5 . Qualitative features of LSW theory are observed as well: the pore's growth rate increases with their size and a critical radius can be identified.