CPP 10: Wetting, Micro and Nanofluidics

Time: Monday 15:00–16:15 Location: ZEU 114

CPP 10.1 Mon 15:00 ZEU 114

Capillary focusing: New Breakup Regimes in Step-Emulsification — •Michael Hein[1], Shahriar Afkhami[2], Lou Kondic[2], and Ralf Seemann[1] — [1]Experimental Physics, Saarland University — [2]Department of Mathematical Sciences, New Jersey Institute of Technology

Droplet based microfluidics has become very popular, both in research and application. But despite of a large number of studies on the droplet breakup, the physics behind this mechanism is only poorly understood. We present experimental research on the formation of droplets in a particular step-geometry by the breakup of a liquid filament. This non-equilibrium process arises from the interplay between flow properties and interfacial instabilities when the filament is suddenly released from a quasi 2d confinement at a topographic step. In particular we investigate the transition between two breakup mechanisms: the 'step-regime' where small droplets are generated just at the step and the 'jet-regime', where larger droplets are formed at some distance after the step. We provide experimental evidence that the breakup mechanism can be controlled by tuning the Capillary number and the channel geometry, which is supported by numerical simulations using the volume-of-fluid method. Interestingly, we observe new breakup mechanisms appearing during the transition from the 'step-' to the 'jet-regime' for large aspect ratios of the liquid filament.

CPP 10.2 Mon 15:15 ZEU 114

Layer erosion by crossflow: in-situ detection using microfluidics and GISAXS — Gerd Herzog[1], Matthias Schwartzkopf[1], Berit Heidmann[1], Shun Yu[1], Frans de Jong[2], Michael Schlüter[2], Volker Körstgens[3], Peter Müller-Buschbaum[3], and •Stephan V. Roth[1] — [1]DESY, Notkestr. 85, D-22607 Hamburg, Germany — [2]Institute of Multiphase Flows, Hamburg University of Technology, Eißendorfer Str. 38, D-21073 Hamburg, Germany — [3]TU München, Physik-Department, LS Funktionelle Materialien, James-Franck-Str. 1, D-85748 Garching, Germany

The process of inorganic coating (scaling) and fouling of organic matter under crossflow conditions is very important in many technical applications, e.g. membrane modules, heat exchangers, coatings for surfaces (airplanes, automobiles, ships), windows, textiles, etc. Despite this fact, the physical process of scaling and fouling as well as the reduction of scaling and fouling under crossflow conditions is not well understood because the molecular interaction forces between particles and surface are difficult to estimate and the shear stresses that act at the particles are difficult to describe. Therefore we use microbeam grazing incidence small-angle X-ray scattering (μGISAXS) to investigate the dynamic deposition and erosion behavior of particles at surfaces. Polymeric colloids on a glass plate have been detected in a microfluidic cell by means of μGISAXS under water crossflow conditions. Depending on the choice of colloidal layer (surface functionalization), the time series of the measurements show a significant reduction of colloids on the surface and thereby image the erosion process quantitatively.

CPP 10.3 Mon 15:30 ZEU 114

Relaxation and Intermediate Asymptotics of a Surface Perturbation in a Viscous Film — •Oliver Bäumchen[1], Michael Benzaquen[2], Thomas Salez[2], Joshua D. McGraw[3], Matilda Backholm[4], Paul Fowler[4], Elie Raphaël[2], and Kari Dalnoki-Veress[4] — [1]Max Planck Institute for Dynamics & Self-Organization, 37077 Göttingen, Germany — [2]Laboratoire de Physico-Chimie Theorique, UMR CNRS Gulliver 7083, ESPCI, Paris, France — [3]Department of Experimental Physics, Saarland University, 66123 Saarbrücken, Germany — [4]Department of Physics and Astronomy and the Brockhouse Institute for Materials Research, McMaster University, Hamilton, Canada

The surface of a thin liquid film with non-constant curvature flattens as a result of capillary forces. While this levelling process is driven by local curvature gradients, the global boundary conditions greatly influence the dynamics. Here, we study the evolution of rectangular trenches in a polystyrene nanofilm. We report on full agreement between theory and experiments for the capillary-driven flow and resulting time dependent height profiles, a crossover in the power law dependence of the viscous energy dissipation as a function of time as the trench evolution transitions from two noninteracting to interacting steps, and the convergence of the profiles to a universal self-similar attractor that is given by the Green's function of the linear operator describing the dimensionless linearized thin film equation.

O. Bäumchen et al., *Phys. Rev. E* **88**, 035001 (2013).

CPP 10.4 Mon 15:45 ZEU 114

The Rayleigh-Plateau Instability on a Fiber Revisited - Influence of the Hydrodynamic Boundary Condition — •Sabrina Haefner[1,4], Oliver Bäumchen[2,4], Michael Benzaquen[3], Thomas Salez[3], Robert Peters[4], Joshua McGraw[1], Elie Raphaël[3], Karin Jacobs[1], and Kari Dalnoki-Veress[3,4] — [1]Saarland University, Experimental Physics, 66041 Saarbrücken, Germany — [2]Max Planck Institute for Dynamics & Self-Organization, 37077 Göttingen, Germany — [3]Laboratoire de Physico-Chimie Théorique, UMR CNRS Guliver 7083, ESPCI, Paris, France — [4]McMaster University, Department of Physics and Astronomy, Hamilton L8S4M1, Canada

The Rayleigh-Plateau Instability (RPI) of a liquid column underlies a variety of hydrodynamic phenomena that can be observed in everyday life. In the classical case of a free liquid column, linear perturbation theory predicts characteristic rise-times and wavelengths. However, the description of a liquid layer on a fiber requires the consideration of the solid/liquid interface in addition to the free interface. In this study, we revisit the RPI of a viscous liquid layer on a solid fiber by varying the hydrodynamic boundary condition at the fiber/liquid interface. The rise of the amplitudes of the surface undulations is precisely tracked and the growth rate of the instability is determined for the different slip boundary conditions and compared to the theoretical models.

CPP 10.5 Mon 16:00 ZEU 114

Following structural changes in nanoparticle films under laminar flow conditions with in-situ SAXS microfluidics — •Volker Körstgens[1], Martine Philipp[1], David Magerl[1], Martin A. Niedermeier[1], Johannes Schlipf[1], Lin Song[1], Gonzalo Santoro[2], Vasyl Haramus[3], Stephan V. Roth[2], and Peter Müller-Buschbaum[1] — [1]TU München, Physik-Department, LS Funktionelle Materialien, James-Franck-Str. 1, 85748 Garching — [2]DESY, Notkestr. 85, 22603 Hamburg — [3]Helmholtz-Zentrum Geesthacht: Zentrum für Material- und Küstenforschung GmbH, 21502 Geesthacht

Microfluidic processes which are accompanied with structural changes at the solid-liquid interface are monitored with in-situ small angle x-ray scattering (SAXS) using a micro-focused x-ray beam. Changes of the nanostructure of a film of nanospheres dispersed in a matrix of sodium alginate of algal origin and its cross-linked analogue are followed during flow of water through a microfluidic channel. The study includes the investigation in transmission through the channel walls (SAXS) as well as in grazing incidence addressing the nanoparticle films on the substrate (GISAXS). Structural changes caused by the laminar flow in the microfluidic channel are traced and demonstrate the possibilities of both complementary in-situ SAXS techniques.

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