DY 3: Fluid dynamics I

Time: Monday 10:00–12:00 Location: MA 144

DY 3.1 Mon 10:00 MA 144

Convection in suspensions at large solutal Rayleigh numbers — •Georg Freund and Walter Zimmermann — Institute of Physics, University of Bayreuth, Germany

We present theoretical results on thermal convection in colloidal suspensions. The dynamics of the suspension is described by a continuum model for binary fluid mixtures with very small values of the Lewis-number. In recent experiments with thermo-sensitive suspensions a rather strong Soret effect has been detected, which leads at moderate temperature differences between the boundaries of the convection cell already to rather large solutal Rayleigh numbers. We give theoretical explanations for the experimentally observed oscillations using low-dimensional models and direct numerical simulations of the full balance equations.

DY 3.2 Mon 10:15 MA 144

Non-linear rheology of active soft matter — •Sebastian Heidenreich[1] and Sabine H. L. Klapp[2] — [1]Physikalisch Technische Bundesanstalt Berlin, Germany — [2]Technische Universität Berlin, Germany

From self-sustained bacterial turbulence to viscosity reduction, active soft matter show amazing non-equilibrium effects and unusual flow behavior. The flow of complex fluids is characterized by its rheological properties as, for example, shear viscosity and normal stress differences. In the presentation, we discuss the response of active particle suspensions or active gels subjected to a shear flow. Using a set of extended hydrodynamic equations we derive a variety of analytical expressions for shear viscosity and normal stress differences. Depending on the nature of activity, the system show shear-thickening and -thinning in qualitative agreement with experiments. Furthermore, predicted changes of normal stress differences are surprising and different compared with passive counterparts.

DY 3.3 Mon 10:30 MA 144

On the dynamics of dimer and trimer suspensions — •Johannes Greber and Walter Zimmermann — Uni Bayreuth, LS Theoretische Physik I

The nonlinear hydrodynamic interaction between dumbbells and longer chains of beads coupled via harmonic spring forces in suspension causes in linear shear flow a much more complex dynamics, as obtained for a single dumbbell or chain. This result is obtained with Fluid Particle Dynamics (FPD) simulations of such suspensions. The complex flow field caused by the dynamics of dumbbells and chains as well as the mixing behavior is compared with those obtained in inertial turbulence at high Reynolds numbers. The complex dumbbell dynamics shares also similarities with so called elastic turublence, observed in experiments with polymer solutions [1].

[1] A. Groisman, V. Steinberg : New J. Phys. (2004) *Elastic turbulence in curvilinear flows of polymer solutions*

DY 3.4 Mon 10:45 MA 144

Faraday wave patterns under excitation with time reversed asymmetric periodic wave forms — •Thomas John, Dirk Pietschmann, and Ralf Stannarius — Institut für Experimentelle Physik, Fakultät für Naturwissenschaften, Universität Magdeburg, Universitätsplatz 2, D-39106 Magdeburg, Germany

A vertically shaken (periodically exited) Newtonian liquid layer, called Faraday experiment, is a paradigm for pattern forming systems. We investigate experimentally and numerically the onset parameters and wavelengths of the Faraday wave pattern under excitation with temporally asymmetric waveforms. A superposition of two sine waves with a mutual phase shift is used as excitation. Certain phase shifts give the possibility to generate time reversed shapes of the waveforms, in what we focus on here. The measurements are compared with numerical calculations based on the linear stability analysis of the full set of hydrodynamic equations for Newtonian liquids. We demonstrate with a modified Mathieu-equation the astonishing fact: already a linear system can be sensitive to the direction of the asymmetric, periodic excitation in terms of different thresholds amplitudes.

DY 3.5 Mon 11:00 MA 144

Friction controlled bending sheets toward 3D-cylindrical helical tubes — •Nebojša Ćasić and Thomas M. Fischer — Institut für Experimentalphysik V, Universität Bayreuth, Bayreuth, Germany

We study the conformational transition of an ensemble of magnetic particles from linear sheets to a compact 3D-cylindrical helical tubes when subjected to an external magnetic field modulation. We measure the variation of the "pitch" of this helical tubes when they are subjected to different frequency of the magnetic field. We show that for a constant magnetic field ratio system will make a transition from synchronous to asynchronous mode.

DY 3.6 Mon 11:15 MA 144

Receding a plate from a bath: The transition from precursor films to Landau-Levich films — •Mariano Galvagno, Hender López, and Uwe Thiele — Department of Mathematical Sciences, Loughborough University, Loughborough LE11 3TU, UK

In several types of coating processes a solid substrate is removed at a controlled velocity U from a liquid bath. The shape of the liquid meniscus and the thickness of the coating layer depend on U. These dependencies have to be understood in detail for non-volatile liquids to control the deposition of such a liquid and to lay the basis for the control in more complicated cases (volatile pure liquid, solution with volatile solvent).

We study the case of non-volatile liquids employing a precursor film model that describes partial wettability with a Derjaguin (or disjoining) pressure. In particular, we focus on the relation of the deposition of (i) an ultrathin precursor film at small velocities and (ii) a macroscopic film of thickness $h \sim U^{2/3}$ (corresponding to the classical Landau-Levich film).

Depending on the plate inclination, four regimes are found for the change from case (i) to (ii). The different regimes and the transitions between them are analysed employing numerical continuation of steady states and saddle-node bifurcations and simulations in time. We discuss the relation of our results to results obtained with a slip model [J. Ziegler, J. H. Snoeijer and J. Eggers, *J. Eur. Phys. J. Special Topics* **166**, 177 (2009)].

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DY 3.7 Mon 11:30 MA 144

Development of Surface Waviness during Pulsed Electron Beam Treatment — •Renate Fetzer, Wladimir An, Georg Mueller, and Alfons Weisenburger — Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Pulsed high-current electron beams have shown their capability to improve surface properties such as hardness, wear, or corrosion resistance of metals and alloys without affecting the bulk material. The interaction of the electron beam with a metal target leads to rapid heating and cooling of the surface layer, accompanied by different phase transitions between the solid, liquid, vapor, and plasma phase. As a consequence of the treatment, however, a topographical pattern evolves on the target surface and is conserved upon re-solidification. This waviness can reach typical amplitudes in the range of tens of micrometers, which is disadvantageous for some applications.

In this work, we present a systematic study on the development of surface waviness during pulsed high-current electron beam irradiation, including time- and space-resolved diagnostics during treatment and target analysis after treatment. The experimental studies are accompanied by heat conduction simulations. Possible mechanisms of waviness evolution such as cratering due to substrate inhomogeneity and various hydrodynamic instabilities are discussed.

DY 3.8 Mon 11:45 MA 144

Impact of micrometer droplets on free-standing fluid films — •Sarah Dölle, Thomas John, Alexey Eremin, and Ralf Stannarius — Abteilung Nichtlineare Phänomene, Otto-von-Guericke-Universität Magdebrug, Deutschland

Smectic liquid crystals can form homogeneous free-standing fluid films. With a thickness on the order nanometers and lateral extensions up to several centimeters, they are unique systems to study fluid dynamics in two dimensions. Picoliter droplets of water are shot on these films with a microdispenser. Via high speed imaging, we investigate the impact of the droplets on curved and planar films, and the subsequent shape changes. Capillary forces and surface effects play the major roles for the equilibration of the droplet. Additionally, one has to take into account the elastic forces of the liquid crystal due to the molecular layer order.