DY 27: Fluid Dynamics and Turbulence

Time: Thursday 9:30–11:30 Location: H48

DY 27.1 Thu 9:30 H48

Formation of Kinneyia via shear-induced instabilities in microbial mats — Katherine Thomas[1], Stephan Herminghaus[1], Hubertus Porada[2], and •Lucas Goehring[1] — [1]Max-Planck-Institut für Dynamik und Selbstorganisation, Göttingen, Germany — [2]Univeristy Göttingen, Goewissenschaftliches Zentrum, Göttingen, Germany

Kinneyia are microbially mediated sedimentary fossils with clearly defined ripple structures. They are generally found in areas that were formally littoral habitats and covered by microbial mats. To date there has been no conclusive explanation as to the processes involved in the formation of these fossils. Microbial mats behave like viscoelastic fluids. We propose that the key mechanism involved in the formation of Kinneyia is a Kelvin-Helmholtz instability induced in a viscoelastic film under flowing water. A ripple corrugation spontaneously forms in the film and grows in amplitude over time. Theoretical predictions show that the ripple instability has a wavelength proportional to the thickness of the film. Experiments carried out using viscoelastic films confirm this prediction. The ripple pattern that forms has a wavelength roughly three times the thickness of the film. Laboratory-analogue Kinneyia were formed via the sedimentation of glass beads, which preferentially deposit in the troughs of the ripples. Well-ordered patterns form, with both honeycomb-like and parallel ridges being observed, depending on the flow speed. These patterns correspond well with those found in Kinneyia fossils, with similar morphologies, wavelengths and amplitudes being observed.

DY 27.2 Thu 9:45 H48

Burgers turbulence from the functional renormalisation group: universal properties of momentum dependent correlation functions — •Steven Mathey, Thomas Gasenzer, and Jan Martin Pawlowski — ITP, Philosophenweg 16, 69120 Heidelberg

The stochastic Burgers' equation is studied as a toy model for Navier-Stokes turbulence. Non perturbative scaling of a randomly stirred fluid in a stationary state is investigated with the functional renormalisation group. We make a truncation with a very general, momentum dependent, two points correlation function and write a fixed point condition which is to be solved recursively. We extract scaling exponents that agree with a similar work on the KPZ equation.

DY 27.3 Thu 10:00 H48

Dynamical scaling of the critical velocity for the onset of turbulence in oscillatory superflows — •Wilfried Schoepe[1] and Risto Hänninen[2] — [1]Universität Regensburg — [2]Aalto University Helsinki

The critical velocity for the onset of turbulence in oscillatory superflows v_c is universal and scales as $\sqrt{\kappa\omega}$, where κ is the circulation quantum of the superfluid vortices and ω is the oscillation frequency. This behavior was observed experimentally and can be derived theoretically in various ways, e.g., from dimensional considerations, from the superfluid Reynolds number $R_s = (vl)/\kappa$ (where v is the flow velocity and l is a characteristic length scale), and rigorously by means of dynamical scaling of the equations of motion of vortex dynamics.

DY 27.4 Thu 10:15 H48

Permeability of porous materials determined from the Euler characteristic — •Christian Scholz[1], Frank Wirner[1], Jan Götz[2], Ulrich Rüde[2], Gerd E. Schröder-Turk[3], Klaus Mecke[3], and Clemens Bechinger[1,4] — [1]2. Physikalisches Institut, Universität Stuttgart, 70569 Stuttgart, Germany — [2]Lehrstuhl für Systemsimulation, Friedrich-Alexander Universität Erlangen-Nürnberg, 91058 Erlangen, Germany — [3]Institut für Theoretische Physik, Friedrich-Alexander Universität Erlangen-Nürnberg, 91058 Erlangen, Germany — [4]Max-Planck-Institut für Intelligente Systeme, Heisenbergstraße 3, 70569 Stuttgart, Germany

We present measurements and lattice Boltzmann simulations of the permeability of quasi two-dimensional porous structures of randomly placed overlapping monodisperse circular and elliptical grains. We demonstrate that the permeability can be determined from the Euler characteristic of the fluid phase. The resulting expression is independent of the percolation threshold and shows a good agreement with our data over a wide range of porosities. Our results suggest that the permeability depends explicitly on the overlapping probability of grains rather than their shape (Scholz et al., PRL 2012, in press).

15 min. break

DY 27.5 Thu 10:45 H48

Drag coefficient measurements of spheres with different surface patterns — •Daniel Strutz, Hendrik Heisselmann, Joachim Peinke, and Michael Hölling — ForWind - Center for Wind Energy Research, Institute of Physics, University of Oldenburg, Germany

Precise drag force measurements of bluff bodies are an under-estimated challenge and in particular drag coefficients of bodies with rough surface structure are not very well documented in literature. In our contribution, we present a new setup for measurements of the acting drag forces on spheres and other bluff bodies. The examined bodies are attached to a slim supporting rod, which is held by thin steel wires in a cubical rigid frame, and the resulting velocity-dependent forces are measured by means of strain gauges. Besides a detailed description of the achieved experimental setup, we will present results from force measurements using smooth spheres and a sphere with a dimpled surface pattern. Measurements were performed for a Reynolds number range of 2,700 up to 230,000 under laminar inflow conditions as well as in turbulent flows generated by a classical grid. An overview of the calculated drag coefficients will be given for different sphere types and in turbulent flow. The obtained results will be compared to those documented in literature.

DY 27.6 Thu 11:00 H48

Droplet impact on free-standing smectic liquid crystalline films — •Sarah Dölle[1], Thomas John[1,2], and Ralf Stannarius[1] — [1]Department of Nonlinear Phenomena, Faculty of Science, University of Magdeburg, PB 4120, 39016 Magdeburg, Germany — [2]Department of Experimental Physics, Faculty of Science, University of Saarland, 66123 Saarbrücken, Germany

Liquid droplet impact on solid and liquid surfaces, including wetting phenomena and splashing behavior have been in the focus of scientific interest since decades. Experimental and theoretical work so far dealt basically with droplets hitting wet solid substrates, dry solid substrates or deep liquid pools. Mostly, the diameters of the droplets were chosen in the millimeter range. With the development of inkjet printing, however, a strong interest in the impact behavior of picoliter droplets emerged. So far, only few investigations have been carried out on droplet collisions with free-standing liquid films. We present a study on the impact of aqueous droplets with a diameter of about 50 microns on freely suspended, smectic liquid crystalline films. Because of the small dimensions of the droplets, the Weber and Ohnesorge numbers, that describe the ratios of inertial, viscous and surface tension related forces, are smaller than one. In this regime, capillary forces prevail over kinetic effects and viscous forces. Smectic liquid crystals are favorable materials to generate free-standing films. Due to their layered molecule structure, these films remain stable even if the thickness is as low as two molecular layers. The impact process was resolved via high-speed imaging, using rates up to 180000 frames per second.

DY 27.7 Thu 11:15 H48

Thermal convection in thin soap films — Markus Abel[1,2], Luca Biferale[3,4], •Henning Krüsemann[5], and Mauro Sbragaglia[3,4] — [1]LEMTA UdL, Nancy, France — [2]Ambrosys GmbH, Potsdam, Germany — [3]University of Rome, Tor Vergata, Italy — [4]INFN, Rome, Italy — [5]University of Potsdam, Germany

In recently published experiments it was shown that turbulent convection in a vertically suspended foam film with a nanometer thickness speeds up thinning enormously. The effects that govern the resulting turbulent flows have not been described theoretically, so far. At the nanoscale,mesoscopic and microscopic forces start to play a role, which are unimportant for thicker films.

The presented work concerns a theory for the dynamics of a vertically oriented foam film, including external forcing, in particular thermal effects. The aim is to describe convection in vertical foam films. A closed two-dimensional model for the fluid flow is derived, considering capillary effects, as well as van-der-Waals interaction between the

amphiphile surfactants and other forces.

The resulting equations are simulated using a Lattice Boltzmann scheme, which was specially developed for this case. An outline of the development of this model is given and some results considering the analysis of the flow are presented.