DY 57: Posters - Turbulence

Time: Thursday 17:00–19:30 Location: P1A

DY 57.1 Thu 17:00 P1A

Inclined-layer convection in fluids with small Prandtl number — •Oliver Zier, Werner Pesch, and Walter Zimmermann — Theoretische Physik I, Universität Bayreuth, 95440 Bayreuth, Germany

The onset of thermal convection is strongly modified, if the fluid layer is not perpendicular to gravity and inclined by an angle [1]. In this case the system becomes anisotropic and the basic state is characterized by a cubic shear flow profile. In addition an intricate competition between an buoyancy-driven and a shear-flow driven pattern-forming instability mechanism takes place. The shear-flow driven instability prevails in the case of a small Prandtl number P, on which we focus in this work.

For a finite inclination angle transverse rolls form at threshold with their axes perpendicular to gravity. The secondary instabilities of the rolls with increasing Rayleigh number depend on the inclination angle and are characterized by spatially periodic perturbations along their roll axes. Here we focus on the regime of small inclination angle, where both instabilities compete. As a result, we find in full simulations complex 'heteroclinic orbits' where the system switches periodically between the two pattern types.

[1] P. Subramanian, O. Brausch, E. Bodenschatz, K. Daniels, T. Schneider, W. Pesch, J. Fluid. Mech. **794**, 719 (2016)

DY 57.2 Thu 17:00 P1A

Experimental modeling of gas-liquid horizontal jet flows — •Oleksii Barybin — Donetsk National University, 600-Richchya Str., 21, Vinnytsia, 21021, Ukraine

The behavior of gas-liquid turbulent two-phase jets has been substantially studied over many years, due to their fundamental importance in many multiphase systems. Understanding jet performance is crucial for modeling many effects of practical importance. I discuss some specific non-equilibrium processes in two-phase horizontal jets (dispersion of bubbles, development stages, etc.) as well as possibility to apply single-phase buoyant flow models in order to determine geometrical characteristics of the aeration zone in jet aerators. It has been found that for the high initial gas content above 30% the bubbles dispersion is within 2 mm and thus, the device can be considered middle-size bubbled. Growth of the initial gas content in the gas-liquid jet above 30-35% results in the formation of very large bubbles with diameter above 5 cm. I have compared the proposed and experimentally verified physical model of the horizontal gas-liquid jet with those for buoyant single-phase jets with low (less than 10 %) gas content, obtained an additional stage of the process development, the stage of a single-phase flow with a residual fluid movement without bubbles, and defined specific similarity number.

DY 57.3 Thu 17:00 P1A

Modeling drying mixture droplets on porous substrates — •Christian Diddens[1], Hans Kuerten[1,2], Cees van der Geld[1], and Herman Wijshoff[1,3] — [1]Eindhoven University of Technology, The Netherlands — [2]University of Twente, The Netherlands — [3]Océ Technologies B.V., Venlo, The Netherlands

Inspired by the typical composition of water-based inks in inkjet printing processes, we have developed a numerical model for the drying of sessile multi-component droplets on porous substrates. Due to different volatilities of the components, a composition gradient is induced in the droplet. Since the physical properties of the liquid, i.e. the mass density, viscosity, surface tension and the mutual diffusion coefficient, depend on the local fluid composition and the local temperature, the flow in the droplet is governed by a complicated spatio-temporal interplay of preferential evaporation, evaporative cooling, solutal and thermal Marangoni flow and absorption of liquid into the pores of the substrate. It is shown how preferential evaporation can drastically influence the absorption speed. Furthermore, colloidal particles and their deposition to the substrate are taken into account, which allows to predict resulting deposition patterns as function on the initial mixture composition.

DY 57.4 Thu 17:00 P1A

Quantum-like approach for a wave-particle system in fluid mechanics — •Remy Dubertrand, Maxime Hubert, Peter Schlagheck, Nicolas Vandewalle, Thierry Bastin, and John Martin — IPNAS CESAM Université de Liège, Liège, Belgium

A droplet bouncing on a vibrating bath can mimic, close to the Faraday instability threshold, a wave-particle system called a walker, see the pioneering experiment in [1]. It reported the observation of a diffraction pattern in a single slit geometry. This wave-like phenomenon can be linked to the coupling of the droplet with the associated bath surface wave. Yet a quantitative model in the presence of boundaries represents a highly difficult question while recent experiments have reported clear effects of the geometry [2, 3].

Here we present a simple model inspired from quantum mechanics for a walker in an arbitrary geometry [4]. We propose to describe its trajectory via a Green function approach. In the case of a single-slit geometry, our model is analytically and explicitly solvable, and reproduces some of the features observed experimentally.

[1] Y. Couder, and E. Fort, Phys. Rev. Lett. **97** 154101 (2006)
[2] J. W. M. Bush, Ann. Rev. Fluid Mech. **47** 269 (2015)
[3] B. Filoux, M. Hubert, N. Vandewalle, Phys. Rev. E **92** 041004(R) (2015)
[4] R. Dubertrand et al., New J. Phys. **18** 113037 (2016)

DY 57.5 Thu 17:00 P1A

Forced oscillations of droplets confined to a stripe — •Martin Brinkmann and Ralf Seemann — Experimentalphysik, Universtität des Saarlands, 66123 Saarbrücken

Sessile droplets confined to a stripe of finite length display a multistability of static shapes above a certain critical liquid volume and stripe length [1,2]. Close to the bifurcation point the energy barrier separating an elongated filamentous morphology from a localized, droplet-like conformation can be resolved using the distance of the center of mass to the substrate as a 'reaction' coordinate. To study the oscillation dynamics of droplets on a stripe in response to vertical vibrations close to the bifurcation point, we propose a fluid mechanical model that is build on small amplitude oscillations around equilibrium shapes under the constraint of a fixed center of mass distance. Numerical computations of the effective mass matrix and spring constants describing the shape oscillations around these constrained equilibria as a function of their center of mass coordinate allow us to describe the temporal evolution of the droplet shape by a coupled system of non-linear equations. Numerical integrations of this low dimensional system comprising a number of 'fast' oscillation amplitudes and the 'slow' center of mass coordinate reveal a rich spectrum of dynamic phenomena, including a fluid mechanical analog to Kapizas pendulum.

[1] M. Brinkmann and R. Lipowsky, J. Appl. Phys. **92**: 4296 (2002)
[2] D. Ferraro, C. Semprebon, T. Toth, E. Locatelli, M. Pierno, G. Mistura, and M. Brinkmann Langmuir **28**: 13919 (2012)

DY 57.6 Thu 17:00 P1A

The effect of planetary rotation on early Earth differentiation — •Christian Maas and Ulrich Hansen — Institute for Geophysics, University of Münster, Münster, Germany

Most geophysical systems, e.g. atmospheres and planetary interiors, are crucially influenced by planetary rotation. One of the few systems where it is reasonable to exclude rotation as well as inertia is today's Earth mantle due to its high viscosity. However, during the early evolution of the Earth the mantle was probably largely affected by rotation. About 4.5 billion years ago the proto-Earth was hit by a mars-sized impactor, which led to extensive melting of the early mantle. After the impact the planet was covered by a global layer of molten mantle material with a thickness of about 1000-3000 km. This molten layer is called magma ocean. It is characterized by turbulent convection, high temperatures and pressures and a small magma viscosity. The existence of such a magma ocean is of key importance for the differentiation and chemical evolution of the Earth. It sets the initial conditions for plate tectonics and the habitability on Earth.

After the impact the magma ocean cools and starts to crystallize. Due to asmall magma viscosity and rotation periods of 2-5 h, rotation probably had a profound effect on this crystallization.

With numerical experiments we study the dynamics of crystal settling in a vigorously convecting and strongly rotating magma ocean to gain insight into the influence of planetary rotation on magma ocean crystallization.