DY 12 Fluid Dynamics II

Zeit: Freitag 14:30–15:15 Raum: TU H3010

DY 12.1 Fr 14:30 TU H3010

Stretch-flow of thin layers of Newtonian liquids: Fingering patterns and lifting forces — •Anke Lindner[1], Didi Derks[2], and Michael Shelley[3] — [1]PMMH, Ecole Supérieure de Physique et de Chimie Industrielles, 10, rue Vauquelin, 75231 Paris Cedex 05, France — [2]Soft Condensed Matter, Debye Institute, Utrecht University, Princetonplein 5, 3584 CC Utrecht, The Netherlands — [3]Applied Math Lab, Courant Institute, New York University, New York City, NY 10012, USA

We study the stretch flow of a thin layer of Newtonian liquid constrained between two circular plates. The evolution of the interface of the originally circular bubble is studied when lifting one of the plates at a constant velocity and the observed pattern is related to the measured lifting force. By comparing experimental results to numerical simulations using a Darcy's law model we can account for the fully non-linear evolution of the observed fingering pattern. One observes an initial destabilization of the interface by growth of air fingers due to a Saffman Taylor like instability and then a coarsening of the pattern towards a circular interface until complete debonding of the two plates occurs. Numerical simulations reveal that when relating the observed patterns to the lifting force not only the number of fingers but also the amplitude of the fingering growth has to be taken into account. This is in agreement with the experimental observations.

DY 12.2 Fr 14:45 TU H3010

Thin liquid films on a slightly inclined heated plate: From Cahn-Hilliard to Kuramoto-Sivashinsky behaviour — •Uwe Thiele[1] and Edgar Knobloch[2] — [1]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, D-01187 Dresden, Germany — [2]Department of Physics, University of California, Berkeley CA 94720, USA

After formulating the basic mathematical problem for a thin liquid film on a uniformly heated substrate we discuss the stationary solutions in the case of a horizontal substrate. These are time-independent and of two types: continuous solutions with thickness bounded away from zero, and discontinuous solutions consisting of drops separated by dry spots. We describe a construction that generates all such solutions and illustrate it with explicit examples. We then discuss how the solution landscape collapses once the substrate is inclined. The solutions are now devoid of dry spots and all slide down the substrate. These states are obtained by solving a nonlinear eigenvalue problem, and their stability properties can be mapped out by solving an additional linear eigenvalue problem. The results shed light on the multiplicity of states accessible to systems of this type and on the possible transitions among them.

[1] U. Thiele and E. Knobloch, *Physica D*, **190**, 213–248 (2004).

DY 12.3 Fr 15:00 TU H3010

Integral equations for simple fluids in a general reference functional approach — •Martin Oettel — Max–Planck–Institut für Metallforschung, Heisenbergstr. 3, D–70569 Stuttgart, Germany

The integral equations for the correlation functions of an inhomogeneous fluid mixture are derived using a functional Taylor expansion of the free energy around an inhomogeneous equilibrium distribution. The system of equations is closed by the introduction of a reference functional for the correlations beyond second order in the density difference from the equilibrium distribution. Explicit expressions are obtained for energies required to insert particles of the fluid mixture into the inhomogeneous system. The approach is illustrated by the determination of the equation of state of a simple, truncated Lennard–Jones fluid and the analysis of the behavior of this fluid near a hard wall. The wall–fluid integral equation exhibits complete drying and the corresponding coexisting densities are in good agreement with those obtained from the standard (Maxwell) construction applied to the bulk fluid. Self–consistency of the approach is examined by analyzing the virial/compressibility routes to the equation of state and the Gibbs–Duhem relation for the bulk fluid, and the contact density sum rule and the Gibbs adsorption equation for the hard wall problem.

[1] M. Oettel, cond-mat/0410185.