DY 32: Fluid Dynamics

Time: Friday 10:15–12:30 Location: H47

DY 32.1 Fri 10:15 H47

Supersonic Air Flow due to Solid Object Impact — •Stephan Gekle[1], Ivo Peters[1], Jose Manuel Gordillo[2], Devaraj van der Meer[1], and Detlef Lohse[1] — [1]Physics of Fluids, University of Twente, The Netherlands — [2]Mecanica de Fluidos, Universidad de Sevilla, Spain

A solid object impacting on liquid creates a liquid jet due to the collapse of the impact cavity. Using visualization experiments with smoke particles and multiscale simulations we show that in addition a high-speed air-jet is pushed out of the cavity. Despite an impact velocity of only 1 m/s, this air-jet attains *supersonic* speeds already when the cavity is slightly larger than 1 mm in diameter. The structure of the air flow resembles closely that of compressible flow through a nozzle – with the key difference that here the "nozzle" is a *liquid* cavity shrinking rapidly in time.

DY 32.2 Fri 10:30 H47

Maximizing torque transmission in magneto-rheological clutches — •Hanna Lagger, Claas Bierwisch, and Michael Moseler — Fraunhofer Institut für Werkstoffmechanik IWM, Freiburg, Germany

Typical magneto-rheological fluids (MRF) consist of micron-sized magnetically permeable particles (mostly iron) dispersed in carrier oil. MRF are increasingly being considered in variety of devices such as shock absorbers, vibration insulators, brakes or clutches. The activation of an external magnetic field causes a fast and dramatic change in the apparent viscosity of the MRF contained in the clutch. Chains of magnetized particles are formed between the two inner surfaces of the clutch within a few milliseconds. The flow properties of the MRF change from liquid to solid and, thus, render large torque transmission possible.

In this study, numerical simulations based on the discrete element method (DEM) are used to model magneto-rheological clutches. Magnetic and mechanical interactions among particles and between the particles and the surface of the clutch are implemented.

For different volume fractions of the suspension, we investigate the influence of inter-particle-friction, particle-surface-friction and the external magnetic field on the torque transmission. Mechanisms that may lead to the breaking of the chains of the magnetic particles under high shear stresses are discussed.

DY 32.3 Fri 10:45 H47

Characteristics of water jet reflection on superhydrophobic surfaces in experiment and theory — •Sören Kaps[1], Rainer Adelung[1], Srdjan Milenkovic[2], and Achim Walter Hassel[2] — [1]Functional Nanomaterials, Technical Faculty, University of Kiel, Kaiserstr. 2, 24143 Kiel, Germany — [2]Institute for Chemical Technology of Inorganic Materials, Johannes Kepler University, Altenbergerstr. 69, 4040 Linz, Austria

After impinging onto superhydrophobic surfaces water jets are observed to flow along for a distance equal to several jet diameters before they are jumping off the surface under an angle that is close to or smaller than the angle of incidence. To understand this effect the reflection of water jets on different surfaces with varying jet parameters was investigated. The reflection mechanism can be described by a mathematical model which assumes the total energy of the system as constant. The speed of the conversion of kinetic energy to surface energy and vice versa can be calculated for different wetting condition parameters. Parameters included in this theory are the surface roughness, interfacial energies as well as diameter, speed, and angle of the incident water jet. Variation of these parameters shows how the characteristics of the reflection changes and where the limits of water jet reflection are.

DY 32.4 Fri 11:00 H47

Convection and Mixing in a nanometer-thin membrane — •Markus Abel[1], Michael Winkler[1], Guggi Kofod[1], Rumen Krstev[2], and Silke Stöckle[3] — [1]Universität Potsdam, Institut für Physik und Astronomie — [2]NMI Naturwissenschaftliches und Medizinisches Institut an der Universität Tübingen — [3]Max-Planck-Institut für Kolloid- und Grenzflächenforschung

We investigate experimentally the convection and resulting mixing properties in a very thin membrane positioned vertically. Due to local heating or cooling a convection pattern can be created. The convection can be followed by optical tracking of the film thickness by means of interference finges. We consider the mixing properties of the motion and the related transport of the relevant physicla quantities.

DY 32.5 Fri 11:15 H47

Oscillation dynamics of soap bubbles — Ulrike Kornek[1], Kirsten Harth[1], •Ralf Stannarius[1], Andreas Hahn[2], and Lutz Tobiska[2] — [1]Otto-von-Guericke-Universität Magdeburg, Institut für Experimentalphysik — [2]Institut für Analysis und Numerik

Oscillations of fluid spheres in fluid environment have been extensively studied since the 19^{th} century. By high-speed video imaging, we investigate oscillations of soap bubbles with radii of 1 cm and more. The gases inside and outside the bubbles contribute to the oscillations, whereas the inertia of the membrane can be neglected. Initial states are prepared by fusion of two spherical bubbles. During the experiment the bubbles float on a layer of butane. The surface tension of the soap films drives damped oscillations from the initial states into the equilibrium sphere shape.

Shapes in each image are expanded in cylinder symmetric spherical harmonics, considered as the eigenmodes of the linearised system [1]. From time dependent amplitudes of these modes we analyse the frequencies and damping constants, as well as anharmonic behavior of the modes and test the predictions of various analytical and numerical models. In addition, we solve the Navier-Stokes equations by means of a finite elements algorithm with moving boundaries and compare the results with experimental data.

[1] Sir H. Lamb, *Hydrodynamics*, Cambridge University Press (1932), p. 473 *ff.*

DY 32.6 Fri 11:30 H47

A phase field description of Rayleigh-Taylor instability with evaporation — •Rodica Borcia and Michael Bestehorn — Lehrstuhl Statistische Physik/ Nichtlineare Dynamik, Brandenburgische Technische Universität Cottbus, Germany

We investigate numerically a thin liquid film under gravity effects on the underside of a cooled horizontal plate. Initially, the flat liquid film is in equilibrium with its own vapor in the gas phase below. If the free surface of the thin film is deflected around the values where the two phases are in equilibrium, thicker parts evaporate and thinner parts condensate. In this way, evaporation/condensation could be used to stabilize the Rayleigh-Taylor instability and to obtain regular structuring of the film surface [1]. Our aim is to study the Rayleigh-Taylor instability using the phase field model. 2D computer simulations are performed in order to visualize the streamlines in each bulk phase and to achieve a better understanding of the stabilization role of evaporation.

[1] M. Bestehorn, D. Merkt, Phys. Rev. Lett. **97** (2006) 127802.

DY 32.7 Fri 11:45 H47

Contact Angle Evaluation in Phase Field Simulations — •Ion Dan Borcia, Rodica Borcia, and Michael Bestehorn — Lehrstuhl für Theoretische Physik II, Brandenburgische Technische Universität Cottbus, Germany

The phase field method is a good tool for investigating fluid systems when complicated interfaces are present. For the point of view of numerical implementation a great advantage of the method is to avoid complicated boundary conditions when the interfaces are allowed to deform. In order to describe the interfaces, gradient terms of the phase field are included in the free energy functional. A study of static and dynamic contact angles is possible by including the solid-liquid interactions into the boundary conditions on the solid substrate. Due to the fact that the phase field model works with diffuse interfaces, determination of static or dynamic contact angles is not obvious. Some solutions for this problem and preliminary results will be presented.

DY 32.8 Fri 12:00 H47

Global Solutions and Dynamics for a modified Navier-Stokes Equation — •Tobias Grafke and Rainer Grauer — Theoretische Physik I, Ruhr-Universität Bochum

One of the outstanding open problems in classical fluid dynamics is the possible existence of finite time singularities in the incompressible Navier-Stokes or Euler equations. To get further insight into the difficulties of the problem, a hydrodynamical model closely related to the Navier-Stokes equation but with a slightly modified pressure term will be presented. Existence, uniqueness and regularity of its solutions are shown. In addition to these findings numerical simulations of its turbulent behaviour were performed to confirm that this new model has dynamic properties lying inbetween Navier-Stokes and Burgers turbulence and can be described with a She-Leveque like model.

DY 32.9 Fri 12:15 H47

Stability and disintegration of liquid sheets — •Bernhard Heislbetz — DLR Lampoldshausen, Institut für Raumfahrtantriebe, D-74239 Hardthausen, Germany

The primary mechanism of liquid sheet disintegration is the growth of small disturbances on the initial flat surface of a free liquid sheet. These disturbances generate wavy structures i.e. symmetric or anti-symmetric wave modes on the surfaces of the liquid sheet which increase and cause a periodical separation of ligament structures. The disintegration mechanism itself depends on various miscellaneous hydrodynamic and geometric control parameters. Thus theoretical investigations are necessary to narrow the parameter space and give a better understanding of the influence of these parameters on the fragmentation process of the liquid sheet. Therefore we present a stability analysis for liquid sheets moving with a constant velocity through a gaseous atmosphere. The analysis includes the derivation of dispersion relations for highly viscous Newtonian and non-Newtonian fluids. The non-Newtonian fluids were modelled as power-law fluids to incorporate the rheological properties and viscosity characteristic of shear-thinning liquids. We show numerical solutions related to the wave modes and determine the most unstable growth rates and the corresponding critical wave lengths as well as the sheet breakup length of both kinds of fluids.