DY 16: Fluid dynamics and turbulence II

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

Topical Talk DY 16.1 Wed 10:00 MA 144

Pepsi®–or ☹ interfacial instabilities between magnetic/non-magnetic liquids — •Reinhard Richter — Experimentalphysik 5, Universität Bayreuth

Turn a can upside down and lift the pull-tab! The heavier liquid will start to leave the vessel through the small orifice, whereas air tries to enter it from below. This unstable condition is known as Rayleigh-Taylor instability. For magnetic beverages it may become *stable* by applying a rotating magnetic field, oriented parallel to the flat interface [1]. We present a first experimental confirmation [2] of this prediction and measure the shape of the interface for different magnetic fields utilizing radioscopy [3].

On the contrary, a magnetic liquid layer will become *unstable* if the field is oriented normally to the interface, and a critical field strength is surpassed. The resulting Rosensweig instability is measured in a highly viscous ferrofluid via a sequence of magnetic pulses. This allows us to catch the phase space dynamics, and to reconstruct the underlying fully nonlinear equation of motion of the pattern amplitude [4]. When exploring the control parameter-phase space, localized states are uncovered next to the unstable branch of the bifurcation diagram.

[1] D. Rannacher and A. Engel, Phys. Rev. E **75**, 016311 (2007). [2] A. Poehlmann, Diplomarbeit, Universität Bayreuth (2011). [3] R. Richter and J. Bläsing, Rev. Sci. Instrum. **72**, 1729 (2001). [4] C. Gollwitzer, I. Rehberg, and R. Richter, New J. Phys. **12**, 093037 (2010).

DY 16.2 Wed 10:30 MA 144

Identifying Heat Transport Processes in Turbulent Rayleigh-Bénard Convection via a PDF Equation Approach — •Johannes Lülff[1], Richard J.A.M. Stevens[2], Michael Wilczek[1], Rudolf Friedrich[1], and Detlef Lohse[2] — [1]Institute for Theoretical Physics, University of Münster, Wilhelm-Klemm-Straße 9, 48149 Münster, Germany — [2]Department of Science and Technology and J. M. Burgers Center for Fluid Dynamics, University of Twente, PO Box 217, 7500 AE Enschede, The Netherlands

Rayleigh-Bénard convection, i.e. the convection of a fluid enclosed between two plates that is driven by a temperature gradient, is the idealized setup of a phenomenon ubiquitous in nature and technical applications. Of special interest for this system are the statistics of turbulent temperature fluctuations, which we are investigating for a fluid enclosed in a cylindrical vessel.

To this end, we derive an exact evolution equation for the probability density function (PDF) of temperature from first principles. Appearing unclosed terms are expressed as conditional averages of velocities and heat diffusion, which are estimated from direct numerical simulations.

Our theoretical framework allows to connect these statistical quantities to the dynamics of Rayleigh-Bénard convection, giving deeper insights into the temperature statistics and transport mechanisms in different regions of the fluid volume, i.e. in the boundary layers, the bulk and the sidewall regions.

DY 16.3 Wed 10:45 MA 144

Rotor model for the inverse cascade of two-dimensional turbulence — •Benjamin Motz and Rudolf Friedrich — Institute for Theoretical Physics, University of Münster, Wilhelm-Klemm-Str. 9, D-48149 Münster

We investigate dynamical aspects of the inverse cascade, a central phenomenon of two-dimensional turbulence. Kirchhoff's point vortex model for fluid motion is extended by gluing together two equally-signed point vortices to one rotor. This allows to include the effects of shear, still permitting to analyze the flow in terms of a dynamical system. Our theoretical studies are supported by numerical results of the rotor model. The results are compared to direct numerical simulations of homogeneous isotropic turbulence.

DY 16.4 Wed 11:00 MA 144

Gaussian vortex approximation to the instanton equations of two-dimensional turbulence — •Kolja Kleineberg and Rudolf Friedrich — Institute for Theoretical Physics, University of Münster, Germany

We investigate two dimensional turbulence within the instanton formalism. The instanton formalism determines the most probable field in a stochastic classical field theory starting from the Martin-Siggia-Rose path integral. To this end, we derive a history dependent equation for the Langrangian velocity and vorticity field using a point vortex approach. A variational ansatz using elliptical vortices leads to a set of evolution equations for the positions and the shapes of the vortices. We discuss the relationship of this dynamical system to the inverse cascade process of two-dimensional turbulence.

DY 16.5 Wed 11:15 MA 144

Modeling of bacterial turbulence — •Sebastian Heidenreich[1], Henricus H. Wensink[2], Knut Drescher[3], and Jörn Dunkel[3] — [1]Physikalisch Technische Bundesanstalt Berlin, Germany — [2]Heinrich-Heine-Universität Düseldorf, Germany — [3]University of Cambridge, UK

From large scale atmospheric plasma instabilities to small scale bacterial turbulence, irregular flow motion appears in very different fluid systems. The investigation of system independent universal properties give a deep insight into the character of turbulence. In particular, the study of bacterial turbulence may lead to a better understanding of both the collective behavior of active soft matter and universal properties of turbulence. In the presentation, for the description of self-sustained bacterial turbulence continuum equations are introduced and numerical solutions are discussed. For the characterization of turbulence statistical quantities as structure functions, energy scalings and velocity distributions are derived. The results are in a good agreement with experimental data of bacillus subtilis and self-propelled hard rods molecular dynamics simulations.

DY 16.6 Wed 11:30 MA 144

Experimentelle Untersuchung des turbulenten Strömungsnachlaufs eines fraktalen Gitters mittels PIV — •André Fuchs, Christian Strüwing, Hannes Hochstein, Joachim Peinke und Gerd Gülker — ForWind - Center for Wind Energy Research, Institute of Physics, University of Oldenburg

Die genaue Beschreibung von Turbulenzen ist aufgrund des komplexen und chaotischen Strömungsverhaltens eines der großen ungelösten Probleme der Wissenschaft. Aus diesem Grund besitzt die experimentelle Untersuchung in dieser Forschungsrichtung eine hohe Relevanz. Zur Erzeugung einer turbulenten Luftströmung werden in realen Strömungsanalysen im Windkanal derzeit vermehrt sogenannte fraktale Gitter eingesetzt. Forschungsergebnisse, die aus Analysen mittels der Hitzdrahtanemometrie resultieren, zeigen dabei, dass sich der Strömungsnachlauf und die sich ausbildenden Strukturen hinter einem fraktalen Gitter, deutlich von dem Nachlauf hinter einem klassischen Gitter unterscheiden. So steigt im Fall eines fraktalen Gitters zunächst die Turbulenzintensität im Nachlauf stromabwärts weiter an und besitzt ein Maximum in einer gitterspezifischen Entfernung. Im Gegensatz dazu nimmt die Turbulenzintensität hinter einem klassischen Gitter kontinuierlich ab. In der experimentellen Untersuchung dieser Strömungsprozesse mittels des Particle Image Velocimetry Messverfahren (PIV) konnte dieses Verhalten bestätigt werden. Im Vortrag werden die Ergebnisse dieser Analyse vorgestellt und mit numerischen CFD Simulationen (Computational Fluid Dynamics) des turbulenten Nachlaufs eines fraktalen Gitters verglichen.

DY 16.7 Wed 11:45 MA 144

Investigations of cavity noise generation on a cylinder — •Tim Homeyer[1], Nils Kirrkamm[1], Christopher Haut[3], Manfred Schultz-von Glahn[2], Gerrit Kampers[1], Joachim Peinke[1], Volker Mellert[3], and Gerd Gülker[1] — [1]ForWind - Center for Wind Energy Research, Institute of Physics, University of Oldenburg — [2]ITAP - Institut für Technische und Angewandte Physik GmbH, Oldenburg — [3]Acoustics, Institute of Physics, University of Oldenburg

Cavity noise generation was under investigation in various studies and is today of particular interest for e.g. the aeronautical and automotive industry. The boundary layer plays a major role in the characterization of the flow in and around the cavity. In this work a small overflowed cavity on a cylinder at flow velocity ramps up to 45 m/s is under investigation. It turns out, that the standard cavity noise theory is not

applicable for this particular setup.
Acoustical, PIV, smoke and Hot-Wire measurements were performed. A sudden transition of the circulating flow (drag crisis) at the expected Reynolds number lead to vorticies flow over the cavity. The onset of the acoustic radiation of the cavity is simultaneous with this transition and shows a strong hysteresis. CFD simulations with OpenFoam are performed to investigate the three-dimensional flow instabilities. All results indicate that the Kelvin-Helmholtz instabilities are the reason for the acoustic noise generated by the cavity.
In this presentation measurements and simulations will be presented and discussed.