DY 25: Fluid dynamics I

Time: Thursday 11:30–13:00 Location: MA 001

DY 25.1 Thu 11:30 MA 001

Highly resolved measurements of temperature fluctuations in turbulent flows — •Achim Kittel and Florian Heidemann — Energy and Semiconductor Research Laboratory, University of Oldenburg,

We present high frequency, highly spatially resolved temperature measurement taken with a sub-micrometer thermocouple developed in our group gained from two different experimental setups. The first setup is a water free-jet in water. Here a heated water jet is injected into a cold basin. The presented measurements are taken at high injection velocities and, therefore, the temperature has no impact on the flow — it can be considered as a passive scalar. The temperature fluctuations are taken at different positions and analyzed with different methods. With our sensor we are able to resolve temperature fluctuations up to 30kHz under these conditions. The changes on characteristic features of the inertial range are investigated under variation of the sensors position. The second experiment is a large scale convection experiment — the barrel of Ilmenau. Here the mean temperature and the temperature fluctuations are measured as a function in distance to the cooling plate at the top lid of the experiment. We achieved a special resolution of a micrometer in separation from the lid. The results are discussed by means of finite element simulation.

DY 25.2 Thu 11:45 MA 001

Spiral vortices in perturbed circular Couette flow — •Jan Abshagen — Institute of Experimental and Applied Physics, University of Kiel, 24098 Kiel, Germany

Circular Couette flow is well-known for its centrifugal instability that results in the formation of either Taylor or spiral vortices depending on the rate of differential rotation of the two cylinders that confine the viscous fluid in radial direction. Due to the presence of axial end plates as often used in experimental systems the circular Couette profile is deformed. This results in a secondary circulation, the so-called Ekman vortices. The role of axial end plates for the onset of Taylor vortices in the 'classical' Taylor-Couette setup with non-rotating outer cylinder has been studied in depth and recently finite-length effects have been found at the onset of spiral vortices in counter-rotating Taylor-Couette flow. Here, the role of the secondary circulation for the appearance and the properties of spiral vortices in perturbed circular Couette flow is investigated. Focus is given to the case of co-rotating cylinders which has been considered so far as a prototype for the appearance of Taylor vortices due to centrifugal instability.

DY 25.3 Thu 12:00 MA 001

Complexity in small aspect ratio Taylor-Couette flow — •Ole Staack, Matti Heise, Jan Abshagen, and Gerd Pfister — Institute of Experimental and Applied Physics, Kiel, Germany

Taylor-Couette flow, i.e. a viscous fluid in the gap between two concentric rotating cylinders, is one of the classical hydrodynamic systems for investigating bifurcation events and nonlinear dynamics. For small aspect ratios the multiplicity of steady solutions is small. However, complex dynamical behavior, that appears abruptly from time dependent flow, can be observed at higher Reynolds numbers. Our present study is focused on the origin of this complexity. Therefore the underlying bifurcation structure has been investigated in an extended parameter space, unfolded by the rotation of the rigid end plates.

A rich diversity of time dependent modes and mode coupling has been observed. One example is a rotating wave with an azimuthal wave number $m = 2$ rotating either in the same or the opposite azimuthal direction to the rotating inner cylinder. This direction reversion scenario includes frequency locking between the rotating wave and the stationary as well as the slowly rotating 'imperfect' end plates.

DY 25.4 Thu 12:15 MA 001

The Wake of a Magnetic Obstacle — Evgeny Votyakov and •Egbert Zienicke — Institut für Physik, Technische Universität Ilmenau, 98684 Ilmenau, Germany

When a liquid metal moves relative to a localized magnetic field — a magnetic obstacle — the induced eddy currents produce a Lorentz force retarding the flow according to Lenz's rule and, moreover, creating vorticity. Whereas the flow pattern around a mechanical obstacle, such as for example a circular cylinder, is well documented the structure of the wake of a magnetic obstacle is poorly understood even in the seemingly simple steady state.

We demonstrate [1] that the stationary flow pattern is considerably more complex than in the wake behind an ordinary body. The steady flow is shown to undergo two bifurcations (rather than one) and to involve up to six (rather than just two) vortices. We find that the first bifurcation leads to the formation of a pair of vortices within the region of magnetic field that we call *inner magnetic vortices*, whereas a second bifurcation gives rise to a pair of *attached vortices* that are linked to the inner vortices by *connecting vortices*.

[1] E.V. Votyakov, Yu. Kolesnikov, O. Andreev, E. Zienicke, A. Thess, Phys. Rev. Lett. **98** (2007) 144504.

Invited Talk DY 25.5 Thu 12:30 MA 001

State space properties of linearly stable flows - How does flow in a pipe become turbulent? — •Tobias M. Schneider — Fachbereich Physik, Philipps-Universität Marburg, D-35032 Marburg, Germany

According to most textbooks flow down a straight circular pipe becomes turbulent near a Reynolds number of 2000. However, despite research since 1883 when Reynolds performed his famous experiments, details of the transition mechanism are still not completely understood. This has primarily to do with the absence of a linear instability of the laminar profile for any flow rate, thus making the transition fundamentally different from the ones in the well studied cases of fluids heated from below (Rayleigh-Benard) or between rotating cylinders (Taylor-Couette). The transition in pipe flow is not mediated by any intermediate simple states but rather jumps to a complex flow state immediately. The flow rates at which the onset of transition has been observed vary over a wide range, and there are indications that the turbulent state is not permanent but can decay spontaneously. All these observations are compatible with the formation of a strange chaotic saddle in the system's state space. We will summarize evidence for the existence of this saddle, discuss the properties of the turbulent state and analyze the 'edge of chaos' that separates laminar and turbulent dynamics.