DY 34: Fluid Dynamics and Turbulence II

Time: Thursday 14:00–16:15 Location: ZEU 255

Topical Talk DY 34.1 Thu 14:00 ZEU 255

Dynamics of particles in turbulent flow: size matters —
•Holger Homann[1,2], Jérémie Bec[1], and Rainer Grauer[2] — [1]Laboratoire Cassiopée, OCA, Nice, France — [2]Theoretische Physik I, Ruhr-Universität Bochum

This presentation aims at a detailed understanding of the dynamical properties of finite-size particles transported by a turbulent flow. The statistics of these particles is of great importance in many engineering and environmental problems. Up to now mostly simple models are used which on the one hand consider those particles as point-like objects and one the other hand neglect their back-reaction on the carrier-flow (passive particles). Experiments have recently shown the limits of such models. We are going beyond these simple models by means of direct numerical simulations of particles larger than the small-scale structures in high Reynolds number turbulence. The combination of a standard pseudo-spectral and a penalty technique allows us to precisely control the carrier-flow and to impose the no-slip boundary condition at the surface of the particles. A selection of questions we are going to discuss: What is the range of validity of the point-models? How is turbulence modified in the vicinity of a particle? How to build a finite-size model?

DY 34.2 Thu 14:30 ZEU 255

Pressure boundary conditions for multiphase lattice-Boltzmann simulations —
•Ariel Narváez[1] and Jens Harting[1,2] — [1]Departament of Applied Physics, TU Eindhoven, P.O. Box 513. NL-5600MB Eindhoven, The Netherlands — [2]Institut für Computerphysik, Universität Stuttgart, 70569 Stuttgart

For a broad range of applications of multiphase fluid systems, the lattice-Boltzmann (LB) method together with the Shan&Chen (SC) model [1] has been successfully applied. A number of boundary conditions are available to be provided for such simulations, i.e., periodic, no-slip and wettability boundary conditions on solid surfaces. Even though, numerous applications require pressure or flux boundary conditions, an implementation of those together with the SC model has not been presented so far. We developed an implementation of the well known D3Q19 LB method integrating the SC model for multiphase flows together with Zou&He [2] on-site boundary conditions. To demonstrate the applicability of the method we show results of simulations of capillary flow and of a flow focussing device.

[1] X. Shan and H. Chen. Phys. Rev. E, 47:1815-1820 (1993)
[2] Q. Zou and X. He. Phys. Fluids., 9:1591-1598 (1997)

DY 34.3 Thu 14:45 ZEU 255

LES using Lattice Boltzmann Methods —
•Georg Eitel-Amor, Matthias Meinke, and Wolfgang Schröder — Aerodynamisches Institut, RWTH Aachen University, Aachen

Over the last two decades the Lattice Boltzmann Method (LBM) has received a growing interest due to its efficient handling of complex geometries and its parallel scalability. The LB approach is based on the Boltzmann equation and describes macroscopic quantities using a simplified model of microscopic kinetics. The present work focuses on the application of LBM to large-eddy simulations (LES) of wall-bounded turbulent flows on hierarchically refined meshes. The single-relaxation time model, the multiple-relaxation time model, and the cascaded LBM have been analyzed concerning their stability and numerical dissipation. Besides the standard Smagorinsky technique, a dynamic eddy-viscosity model has been introduced and both techniques are validated for different flow regimes.

DY 34.4 Thu 15:00 ZEU 255

Dynamical model for the formation of patterned deposits at receding contact lines —
•Uwe Thiele, Lubor Frastia, and Andrew J. Archer — Department of Mathematical Sciences, Loughborough University, Loughborough, Leicestershire, LE11 3TU, UK

We describe the formation of deposition patterns that are observed in many different experiments where a three-phase contact line of a volatile nanoparticle suspension or polymer solution recedes [1]. A dynamical model based on a long-wave approximation predicts the deposition of irregular and regular line patterns due to self-organised pinning-depinning cycles corresponding to a stick-slip motion of the contact line [2]. We analyze how the line pattern properties depend on the evaporation rate and solute concentration.

[1] R. D. Deegan et.al, Nature 389, 827 (1997); G. Berteloot et. al, Phys. Rev. E (2010), submitted; H. Yabu and M. Shimomura, Adv. Funct. Mater. 15, 575 (2005); J. Xu et al., Phys. Rev. Lett. 96, 066104 (2006); S. W. Hong, J. F. Xia, and Z.Q. Lin, Adv. Mater. 19, 1413 (2007); H. Bodiguel, F. Doumenc, and B. Guerrier, Langmuir 26, 10758 (2010).
[2] L. Frastia, A. J. Archer and U. Thiele, submitted (2010), at arxiv: http://arxiv.org/abs/1008.4334v1

DY 34.5 Thu 15:15 ZEU 255

Sound scattering on irrotational vortices —
•Piotr Marecki — Uni Duisburg-Essen

In the talk I will discuss the current status of the problem of sound scattering on typical vortex lines in superfluids. I will use hydrodynamical approximation, in which sound will be regarded as small (test) perturbation of a given background flow. I will use the acoustic-spacetime approach, which quite directly leads to the central issues of the problem. Curiously, this classical subject has deep connections to other important problems of theoretical physics, including: Bohm-Aharonov scattering, spectral analysis of systems with singular potentials, and behavior of classical/quantum fields in rotating spacetimes. Despite many efforts over the last 130 years, in the opinion of the author, the subject cannot be regarded as closed, and new important advances continue to be made. In particular, I will draw attention to the issues of boundary conditions at the vortex core and at infinity, and to the consequences of various (mathematically allowed) choices for the physical scattering characteristics.

DY 34.6 Thu 15:30 ZEU 255

Vortex-dipole chaos solves last enigma of classical physics: turbulence. —
•Helmut Baumert — IAMARIS, Bei den Mühren 69 A, 20457 Hamburg

The talk sketches a statistical quasi-particle approach to idealized fluid turbulence at asymptotically high Reynolds numbers, based on an ensemble of dipole vortex tubes realized in geometrically non-trivial forms like rings etc. In a cross sectional area through a vortex tangle, taken locally orthogonal through each individual tube, the dipoles are moving with the classical dipole velocity. The effective vortex radius is related with Prandtl's classical mixing length.

A quasi-particle is dressed, embedded in a cloud of others. Its energy is finite. It performs a local quasi-2D dipole chaos, reminding of real gases. Collisions between stable quasi-particles lead either to scattering (turbulent diffusion) or to particle annihilation (formation of unstable couples as stationary dissipative patches via the "devil's gear" of Herrmann, 1990, down to a scale of size zero).

This geometrization allows to derive equations of turbulent motions and of fundamental constants like von Karman's or two Kolmogorov spectral constants - in agreement with observations. In particular, it allows a better understanding of stratified flows (collapsing turbulence, whitecapping of internal gravity waves).

This work relates to Department of the Navy Grant N62909-10-1-7050 issued by Office of Naval Research Global. The talk will be given in German.

DY 34.7 Thu 15:45 ZEU 255

Stochastic modeling of lift dynamics under turbulent conditions —
•Muhammad Ramzan Luhur, Patrick Milan, Jörge Schneemann, Matthias Wächter, and Joachim Peinke — ForWind, Centre for Wind Energy Research, University of Oldenburg, D-26111, Germany.

This paper presents stochastic modeling of the lift dynamics of an airfoil placed in turbulent inflows. The measurements were taken in the closed wind tunnel of the University of Oldenburg, for an airfoil FX 79-W-151A. The turbulent flows were generated using different grids including a fractal one, installed in front of the wind tunnel test section nozzle. The measurements were performed by two methods i.e. using force sensors and wall pressure sensors. The force sensors were installed at the two ends of an airfoil in the flap-wise direction and the pressure sensors at the test section walls.

For the stochastic modeling of the lift dynamics, force measurements with the fractal grid are used here because the force sensors give better results than the pressure sensors. The modeling of the lift coefficient is based on measurement time series of lift coefficient. This is done using a first-order stochastic differential equation called the Langevin equation. The results are optimized using a chi-square test on the probability distribution functions. The modeled time series and their probability distribution functions show good agreement with the actual measurement. The model is being developed with the aim to integrate it into a general wind energy converter model.

DY 34.8 Thu 16:00 ZEU 255

Generation of homogeneous shear turbulence by using an active grid — •Erwin Renken, Pascal Knebel, and Michael Hölling — Carl von Ossietzky Universität Oldenburg

We generate a shear turbulence by using an active grid in a wind tunnel. This shear turbulence is homogeneous, so it has a constant gradient of the mean velocity. The active grid consist of rods with small flaps, where some rods are in horizontal and some in vertical direction. Each rod is connected to a step motor, and can rotate in a specified way. We are using a protocol which describe the time-dependent angle of each axis. We use the horizontal axis primary for a default blockage diterming the gradient, and the vertical to generate homogeneous turbulence by moving the flaps. With this approach we aim to remodel specific properties of the atmospheric layer.