Turbulence

The course will focus on the fundamental aspects of fluid mechanics, notably at high Reynolds numbers, when Turbulence is important. This will be a course in turbulence *theory*. The goal is to obtain a precise physical and mathematical understanding of turbulent phenomena (i.e. experiments!) based on the fluid equation of motion. This is not a course on modelling of turbulence, which is the focus of many excellent texts, e.g. Pope, Tennekes & Lumley. The subject is dealt with using tools from dynamical systems and statistical mechanics. A more general purpose is to provide a basic knowledge of these phenomena as they can be view as paradigmatic for nonlinear physics.

The following aspects will be discussed in detail:

(i) Foundation of Macroscopic Hydrodynamics

(ii) Conservation Laws in Incompressible Navier-Stokes

(iii)Large-scale dynamics and Energy cascade

(iv)Phenomenology à la Kolmogoroff

(v) Intermittency and Anomalous scaling, with a discussion on Large Deviations.

Moreover, some present researches in turbulence will be briefly presented in the form of seminars. Possible subjects will be: Wave-Turbulence; Turbulent Convection; Micro-swimmers dynamics; Transition to Turbulence; Inertial particles; MHD.

The exam will be either a written exam or a seminar concerning a subject related to turbulent research.

References

- Tennekes, H. and Lumley, J. H., A first course in turbulence, The MIT Press, 1972.
- Monin, A. and Yaglom, A., Statistical Mechanics of Fluids 1975.
- Pope, S. B., Turbulent flows, Cambridge University Press, 2000.
- Frisch, U., Turbulence, Cambridge University Press, 1995.
- Bohr T., Jensen, M., Paladin, G. and Vulpiani, A. Dynamical systems approach to Turbulence, Cambridge University Press, 1998.