Eur. J. Mech. B - Fluids 20 (2001) 741–747

Book reviews

S0997-7546(01)01138-4/BRV

Intermittency in Turbulent Flows edited by J.C. Vassilicos (Cambridge University Press, UK, 2000, 276 pp.) £45.00, US$ 74.95 hardcover. ISBN 0 521 79221 5

The book is a collection of contributions to the Workshop "Intermittency in Turbulent Flows and Other Dynamical Systems" that was held at the Isaac Newton Institute for Mathematical Sciences in Cambridge, June 1999. Intermittency refers to localization of fluctuations in time and/or space. It is a fundamental feature of turbulence in fluids, as revealed by experiments and numerical simulations. It is also believed to be the outcome of a large class of non-linear systems which includes the Navier–Stokes equations. Since the seminal works by Kolmogorov about scaling laws of turbulent structures in fluids, intermittency has motivated a large body of work by mathematicians and physicists, which aims at characterizing universal properties, if any, of this phenomenon.

It is the main quality of this book to draw a picture of present efforts devoted to this difficult interdisciplinary topic. The result lacks unity and looks 'fractal', but this reflects how difficult it is to fill the gap between low order systems and Navier–Stokes turbulence and how difficult it is to transcend the 'legacy' of the great Kolmogorov.

The book contains sixteen papers covering key subjects related to intermittency, such as routes to chaos in dynamical systems ("Sil'nikov chaos in Fluid flows" by Mullin, Juel and Peacock), phase turbulence ("Phase turbulence and heteroclinic cycles" by Busse, Brausch, Jaleski and Pesch), singularity formation in Euler flows ("An ODE approach for the enstrophy of a class of 3D Euler flows" by Ohkitani), regularity of the Navier–Stokes equations ("Scale separation and regularity of the Navier–Stokes equations" by Doering and Gibbon, where an interesting discussion about scale separation and its relation to moments of the energy spectrum may be found) and scaling laws in fully developed turbulence.

Scaling laws in developed turbulence is a classical subject covered by six contributions. The latter are mainly based on recent experimental results. The paper "Vorticity statistics in the 2D enstrophy cascade and tracer dispersion in the Batchelor regime" by Jullien, Castiglione, Paret and Tabeling brings a valuable experimental validation of equilibrium laws in 2D turbulence inferred from theory. Other papers concern 3D flows. They introduce the reader to an exhaustive list of the different concepts and models proposed to characterize the statistical properties of turbulent velocity fields and their scale dependence. This comprises the characterization of the similarity properties of the high order velocity structure functions ("Non-homogeneous scalings in boundary layer turbulence" by Ciliberto, Lévèque and Chavarria), their relationship with the fractal structure of turbulence ("Turbulent wakes of 3D fractal grids" (!) by Queiros-Conde and Vassilicos) or with cascade models ("Scaling and structure in isotropic turbulence" by Jimenez, Moisy, Tabeling and Willaime). These articles are a good illustration of the various post-processing methods that can be applied to one point longitudinal velocity signal in order to scrutinize fine turbulence properties. As stressed by Jimenez et al., a limit has certainly be attained using structure functions and this is one of the assets of this book to show this limit. Other alternatives are followed by considering more dynamically significant objects. This is done in two articles: "Statistical geometry and Lagrangian dynamics in turbulence" by Chertkov, Pumir and Shraiman and "Flow structure visualization by a low-pressure vortex" by Kida, Miura and Adachi.

A common criticism towards this community is that it focuses on ideal 'infinite' Reynolds number and isotropic turbulence, leaving aside 'real word' flows which are known to be anisotropic to a large extend. Interestingly, the book prescrits several experimental indications that the cascade properties and intermittency should be related by a way or another to the mean shear (paper by Cililberto et al. cited above and "On the origin of intermittency in real turbulent flows" by Khomyanski and Tsinober). One of the conclusions given by the editor in its introduction is that "we must be prepared to do away with the concept of universal turbulence...". This sounds like the status of the turbulence modeling community which has abandoned any desire for a universal turbulence model after several decades of great efforts. On the same line of thinking, the first article of the book is a contribution by Blossey and Lumley on "Control of intermittency in near-wall turbulent flows". This article describes ongoing works on drag reduction by means of control in a closed-loop of the near wall intermittent busting process using low order proper orthogonal decomposition (POD). This is a challenging topic in the field of applied fluid mechanics but it sharply departs from the spirit of the whole. Opening the book with such a topic is felt as an indication that cross-fertilization of ideas coming from all domains in the field of turbulence is becoming crucial to be able to go ahead.

It is in this spirit that I will recommend, finally, the reading of this book to people involved in the field of turbulence research, both physicists and modelers. It describes an interesting body of recent research results that draw bounds to our sparse knowledge about turbulence theory. Its reading may motivate, hopefully, novel research ideas which are strongly needed in the domain of turbulent flows.

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S0997-7546(01)01143-8/BRV

Lattice Gas Hydrodynamics by Jean-Pierre Rivet, Jean Pierre Boon (Cambridge University Press (Cambridge Non-linear Science Series), UK, 2001, 289 pp.) £60.00, US$ 95.00 hardcover. ISBN 0 521 41944 1

When the lattice gas cellular automaton was introduced as an entirely new and simple way to compute hydrodynamic flows in the mid-1980s, it gave rise both to an intense research activity and a whole cascade of related models. The present book deals with the basic theory of these models.

As the lattice gas automaton models the physical fluid as a collection of discrete, interacting particles it has both hydrodynamic average properties and fluctuations. This is a key focus in the book. Along with the hydrodynamic continuum limit the book describes how the fluctuations that arise in lattice gases have physical characteristics.

This excellent book systematically develops lattice gas theory, starting from the microscopic evolution equations and properties of the underlying lattice. In this way the reader is introduced not only to the theory of a particular model, but to the whole hierarchy of models that emerge from the basic ideas of conservation laws and lattice symmetries. These models range from the original anisotropic lattice gases to thermal- and multi-species lattice gases.