

Preface

The problem of turbulence and coherent structures is of key importance in many fields of science and engineering. It is an area which is vigorously researched across a diverse range of disciplines such as theoretical physics, oceanography, atmospheric science, magnetically confined plasma, nonlinear optics, etc. Modern studies in turbulence and coherent structures are based on a variety of theoretical concepts, numerical simulation techniques and experimental methods, which cannot be reviewed effectively by a single expert. The main goal of these lecture notes is to introduce state-of-the-art turbulence research in a variety of approaches (theoretical, numerical simulations and experiments) and applications (fluids, plasmas, geophysics, nonlinear optical media) by several experts.

This book is based on the lectures delivered at the 19th Canberra International Physics Summer School held at the Australian National University in Canberra (Australia) from 16-20 January 2006. The Summer School was sponsored by the Australian Research Council's Complex Open Systems Research Network (COSNet).

The lecturers aimed at (1) giving a smooth introduction to a subject to readers who are not familiar with the field, while (2) reviewing the most recent advances in the area. This collection of lectures will provide a useful review for both postgraduate students and researchers new to the advancements in this field, as well as specialists seeking to expand their knowledge across different areas of turbulence research.

The material covered in this book includes introductions to the theory of developed turbulence (G. Falkovich) and statistical and renormalization methods (D. McComb). The role of turbulence in ocean energy balance is addressed in a review by H. Dijkstra. A comprehensive introduction to the complex area of the theory of turbulence in plasma (J. Krommes) is complemented by a review of experimental methods in plasma turbulence (M. Shats and H. Xia). An introduction to the main ideas and modern capabilities of numerical simulation of turbulence is given by J. Jimenez.

Experimental methods in fluid turbulence studies are illustrated in the lectures by J. Soria describing the particle image velocimetry. Finally, the relatively new field of the physics of vortex flows in optical fields is reviewed by A. Desyatnikov.

The Summer School in Canberra was accompanied by a workshop on the same topic. The Workshop Proceedings (editors J. Denier and J. Fredrikson) will also be published by World Scientific under the same title as these Lecture Notes (“Turbulence and Coherent Structures in Fluids, Plasmas and Nonlinear Media”). References in this book to the Workshop papers are given as “I. Jones, Workshop Proceedings”.

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