Advances in investigating turbulence

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H. H. Fernholz and H. E. Fiedler (editors). *Advances in Turbulence: Proceedings of the Second European Turbulence Conference. Berlin. August 30–September 2, 1988.* Springer-Verlag, Berlin; Heidelberg, 1989, 522 pp.

The Second European Conference on Turbulence took place in the Technical University of Berlin under the direction of the conference co-chairmen V. Frisch (Níce, France), J. C. R. Hunt (Cambridge, England), E. Krause (Aachen), M. Landahl (Stockholm), A. M. Obukhov (Moscow), and G. Ooms (Amsterdam). 165 scientists from 18 countries took part in it; most of their reports are presented in the present volume.

Practically all the directions of modern research on turbulence are represented to varying degrees in this volume, which is divided by subject into nine parts and includes a total of 74 papers by the authors of the reports.

The first part of the volume consists of four papers devoted to the questions of stability and of transition to turbulence. Numerical modeling of the propagation process for a turbulent spot due to rapid growth of wave modes and their disruption in a plane Poiseuille flow (D. S. Henningson), an analysis of the experimental data of the velocity field of turbulent spots compared with the numerical results for the flow in a plane channel (B.G.B. Klingmann *et al.*) and in a slightly heated laminar boundary layer (M. Sokolov *et al.*), where an interconnection of the growth of turbulent spots with an increase of the number of structural elements in a spot was noted, are presented here. In addition, the main characteristics of explosion phenomena of turbulent flows in regions near walls are considered here (W. Kozlowski), and the symmetry of the processes interconnected with the discrete stages of transition to turbulence and with laws of similarity corresponding to Feigenbaum universality is recognized.

Seven papers devoted to general and coherent structures, and also to vortex dynamics, are presented in the second part. In particular, the influence of coherent structures on the relative enhancement of turbulent heat transfer in comparison with turbulent momentum transfer (M. Favre-Marinet *et al.*) is discussed here, and the stages of the transition from laminar to turbulent flow that are interconnected with the sequence of vortex merging effects (C. M. Ho *et al.*) are considered; the process of merging two coplanar vortex rings and the evolution of an elliptical vortex ring in an unbounded region are modeled numerically (K. Ishii *et al.*). Experimental and numerical investigations of three-dimensional vortex dynamics in a wake behind a two-dimensional body at intermediate Reynolds numbers (J. C. Lasheras *et al.*) when, besides von Karman vortices, three-dimensional dipolar type (consisting of vortex pairs of different signs whose axes are inclined to the plane of the wake) vortex structures, and also numerical modeling of the spontaneous formation of large-scale structures due to the reverse cascading of energy over the spectrum in anisotropic three-dimensional turbulent flows (H. Scholl, P. L. Sulem, Z. S. She, and U. Frisch) are also presented in this part of the volume.

Seven papers in which free shear flows are considered are also put in the third part of the symposium. In particular, the statistical properties of a vortex field in a plane, two-flow, turbulent mixing layer are investigated (J. L. Balint *et al.*); these are relatively poorly known in comparison with the experimental data about individual vortices in such flows. With the exception of A. A. Townsend's general theory paper, the other papers of this part of the symposium are also devoted to experimental investigations of the formation of spiral coherent structure in a free jet (J. W. Elsner *et al.*), of the role of pressure fluctuations in producing isotropy (J. Groth *et al.*), of intermittency (R. C. Haw *et al.*), etc.

Unlike the third part, experimental investigations of flows bounded by walls, including flows above an obstacle (G. Dimaczek *et al.*), of the development of disturbances in a boundary layer during longitudinal oscillations of a wall (H. Flotke *et al.*), the direct measurement of vorticity and of the longitudinal velocity gradient in the direction perpendicular to the wall in sections of accelerated flow near the wall (M. Randolph *et al.*), and of streams of bubbles which make turbulence near walls visible (M. Souhar) are examined (in six papers) in the fourth part of the volume, and also an analysis is given of the limited applicability of the traditional concept of turbulent viscosity in complicated turbulent shear flows (M. D. Zhou).

Eleven papers on the investigation of turbulent diffusion in a stratified fluid (M. Larcheveque), and also diffusion with several thermal or chemical sources present (A. Picart *et al.*), including also those which allow for the simultaneous influence of molecular and stratification effects on the evolution of the fluctuations of a concentration field (K. Oduyemi *et al.*) are included in the fifth part of the volume. The concept is formulated of phase turbulence of slightly non-linear convective modes for nearly critical Rayleigh number values during rotation of a fluid layer (F. H. Busse), and heat transfer by the thermal conditions in a convective boundary layer (V. Schumann *et al.*) and the cross spectra of large-scale vortices in a stably stratified boundary layer of the atmosphere from the data of observations in the Antarctic (S. D. Mobbs and J. M. Rees) are also analyzed.

Eleven papers that are devoted to the development of experimental methods and techniques for investigating turbulent structures near walls (P. H. Alfredsson *et al.*), including methods for optical visualization of flows by means of laser interferometry (J. M. Bessem *et al.*) and for recording the wakes of particles or bubbles in turbulent flows (R. J. Perkins and J. C. R. Hunt) are collected in the sixth part of the volume.

The seventh part, consisting of 16 papers, is mainly devoted to the development of numerical methods, both for direct calculations on an electronic computer and also by using methods of large-scale vortices and of a different type of closure hypotheses. In particular, a new strategy for modeling the hydrodynamics of "grid" gases of particles is formulated in the paper by U. Frisch; this is used both for the finite difference approximation of the equations of hydrodynamics and also in the method of discrete vortices.

Papers (9 of them) connected with questions of controlling turbulent flows are concentrated in the eighth part of the volume. Here the main attention is paid to the problem of reducing slowing-down of the fluid due to the use of grooved sections of streamline surfaces, in particular, in connection with "bursts" of vorticity near walls during the interaction of dipole type vortex structures (Kwing-So Choi and R. Johnson).

The ninth part consists of three papers of an applied nature, in particular, of investigating the role of turbulence in industrial processes, also including those for the transfer of chemically interacting impurities (G. Ooms *et al.*).

The addresses of the authors of the papers are given at the end of the volume. The volume is well designed and illustrated (392 illustrations). An acquaintance with it may be useful for a wide circle of specialists in the fields of physical and geophysical hydrodynamics and aerodynamics.

Translated by Frederick R. West