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REVIEWS

Turbulence. 2nd edition. By J. O. HINZE. McGraw-Hill, 1975. 790 pp. £19.40.

The first edition of the well-known book by Hinze appeared in 1959 (and was reviewed in this Journal, vol. 10, 1961, pp. 319–320). At that time there were no elementary books on the mechanics of turbulence; in fact, only two excellent, but rather special, monographs by Batchelor (1953) and Townsend (1956) were devoted to turbulence problems before the publication of Hinze's book. As a consequence the first edition of the book served two important purposes. It was widely used as a text-book on turbulence for students of different specialities, although it was not fully satisfactory in this role because it was too thick and too much attention was paid to the questions directly related to chemical engineering processes. It was also used as a valuable reference book for research workers in various fields where turbulence flows played an important role, although it fitted satisfactorily only the demands of chemical engineers. Nevertheless, the detailed and rather clear presentations of the material made the book very popular among the turbulence community (in particular, it was translated into Russian as early as 1963).

The book continues to be popular now; this can be seen from a large number of references to it in many recent journals and books. Hence it is clear that a new edition of the book would be very useful. However the preparation of a new edition is not easy. Many research papers have been published since the appearance of the first edition of the book, and these papers have substantially changed our view of all parts of the mechanics of turbulence. At least three not too big text-books on turbulence have also been published, namely, the books by Tennekes and Lumley (1972), Reynolds (1974) and a German book by Rotta (1972); see the reviews of these books in vol. 58, 1973, 816–819, vol. 70, 1975, 414–416, and vol. 63, 1974, 826–829 of this journal. Several special monographs were also published during this period including the very big two-volumed work of Monin and Yaglom (MIT Press, 1971 and 1975) which can be used as a reference book. It is clear that the second edition of Hinze's book had to reflect the modern development of mechanics of turbulence and to differ considerably from the first one. However there are several possible ways of revising a book, and authors have to choose one of them. The most radical way to do it is to rewrite the whole text or at least a considerable part of it (this way was selected, e.g. by Townsend in the course of preparation of the second edition of his book). The other possibility is to preserve the whole (or almost the whole) text of the first edition, but to augment it by many insertions devoted to the modern development of the subject. Prof. Hinze has chosen the second way (except in chapter 2 of the book). He especially underlines in the preface to the second edition that this book is just an elementary introduction and that the experimental data included in the text must serve as illustrations rather than showing most recent and accurate measurements. After this he preserves the overwhelming part of the text of the first edition and almost all the figures, but he supplements the book by much new material which increases the size of the book by approximately 40 %; the number of the references is also greatly increased in the new edition.

Chapter 2 undergoes the most radical changes; in fact, it has been almost entirely rewritten. The new chapter 2 is devoted mostly to hot-wire anemometry as the old one was; but the main attention is paid here to the constant-temperature method and not to the constant-current method which was the more important before 1959. Chapter 2 now includes also the description of some new instruments such as laser anemometers. However the neglect of all non-engineering applications of the mechanics of turbulence is reflected in the fact that the book does not mention sonic anemometers which are now the most widely used instruments for the study of atmospheric turbulence.

Much more attention is paid in the new edition to the transition from laminar to turbulent flow conditions. The chapter on isotropic turbulence now contains more examples of the closure hypothesis (although there are many other hypotheses which are not mentioned at all). It also contains much more experimental data (almost entirely lacking in 1959) which illustrate the Kolmogorov theory of locally isotropic turbulence. (It is curious to note that both Hinze and Townsend include in the second editions of their books the data of A. L. Kistler and T. Vrebalovich from vol. 26, 1966, 37–48 of this journal, which are exceptional in many respects and which are considered as erroneous by many people including the present reviewer.) A few remarks are added in the new edition relating to the refinement of the Kolmogorov theory taking into account fluctuations in dissipation rate. Chapter 4 on homogeneous shear-flow turbulence in the first edition seemed to be quite uninteresting and formal (this fact was mentioned in the review by L. S. Kovasznay published in this journal and the author admitted himself at the beginning of the chapter that "homogeneous shear-flow turbulence is unattainable and may be considered as a hypothetical case"). However during the last few years W. G. Rose and F. H. Champagne, V. G. Harris and S. Corrsin have shown that this type of turbulence can be modelled rather satisfactorily in a wind-tunnel. The author has used this recent development to enrich chapter 4 with experimental data and has made it much more interesting.

There are many other additions to the second edition of Hinze's book, but it is unnecessary to mention all of them. Perhaps it is just worth mentioning that the author's approach to the revision of the book has left some minor parts of it still out of date. For instance, great attention paid to the wholly outdated Heisenberg hypothesis, and even the important Kolmogorov constant is regularly expressed in terms of the quite uninteresting Heisenberg constant. The '$-\frac{5}{3}$ law' for the temperature spectrum is also derived with the aid of the modified Heisenberg hypothesis; this derivation does not seem the best in 1975. I think also that it is hardly appropriate to give the theory of locally isotropic turbulence as part of the more special theory of fully isotropic turbulence. The attention paid by the author to similarity and dimensional considerations seems insufficient for 1975. All these critical remarks are however not too important. The new edition has preserved the elementary and very clear presentation which has made the first edition so popular and widely used; it is reasonable to suppose therefore that the second edition of the book will be very useful too. Of course Hinze's huge 1975 book is absolutely unsuitable as a text-book for the beginner and it is not a good reference book either. There is, however, a very wide gap between elementary text-books and highly specialized and condensed reference books reflecting the modern development of the subject. I am sure that there are many readers interested just in the books which are in the middle of this gap. Prof. Hinze's book may be recommended to them.

A. M. Yaglom

Molecular Gas Dynamics. By G. A. BIRD. Oxford University Press, 1976. 289 pp. £12.00.

This book is a treatise on certain aspects of rarefied gas dynamics and may, as the author puts it, be divided into an introductory text, a handbook on the direct-simulation Monte Carlo method, and a research monograph on nonlinear transition regime flows.

The classical kinetic theory of gases is developed from scratch and is based from the outset on the principle that the gas is not necessarily in equilibrium. Simple interaction potentials are introduced and binary elastic collisions are discussed. The Boltzmann equation is derived and the Chapman–Enskog perturbations are introduced as well as boundary conditions and reference states. The introductory text, which makes up half the book, concludes with a chapter on collisionless flow which has sections on one-dimensional flows, free-molecule aerodynamics, thermophoresis, and the Rayleigh problem. The test particle Monte Carlo method is introduced and applied to the circular tube flux problem. This first half of the book is suitable for engineering and science graduates and contains a considerable number of exercises.

The rest of the book centres on the use of the direct simulation Monte Carlo method for the numerical calculation of flows with large perturbations. Throughout, this method is discussed in the context of other available analytic and experimental methods. The various examples considered are illustrated by details of the computational techniques and a number of FORTRAN programs are given as appendices. The topics are discussed in order of increasing complexity: one-dimensional flows of a monatomic gas, including shock wave structure, heat transfer, multi-dimensional flows, and flows of gas mixtures. These cases are all treated for molecules without internal energy modes. At the present state of the art these can only be introduced with greatly simplified molecular models. Mentioned are the rough-sphere model and the author's own energy-sink model. The final chapter discusses chemically reacting flows and the possibilities of treating them by simulation methods, and the author concludes with some observations on the relative merits of experiments, theoretical analysis, and simulation methods.

This book appears to fulfil its purpose admirably and will be a valuable addition to the library of anybody interested in rarefied gas dynamics.

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