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REVIEWS

Annual Review of Fluid Mechanics, Volume 3. Edited by M. VAN DYKE, W. G. VINCENTI and J. V. WEHAUSEN. Annual Reviews, Inc., 1971. 406 pp. $10.00.

In recognizing how timely and desirable was the entry in 1969 of Annual Reviews Inc. into the field of fluid mechanics, and in welcoming their production both in that year and in 1970 of a volume of some 16 authoritative survey articles, each covering some particularly interesting part of the subject, reviewers in this Journal and elsewhere have only expressed doubts concerning the possibility of continuing on an annual basis the same standards regarding excellence of the articles, authoritative stature of the authors and timely interest of the topics covered. Now in 1971, therefore, it is a particular pleasure to be able to report that volume 3 has been more than successful in maintaining the standards of its predecessors in all of these respects.

This volume begins like them with an historical article of a particularly interesting kind: reminiscences by Adolf Busemann of how compressible aerodynamics came into being in the nineteen-thirties. To learn of the background to the writing of Dr Busemann's article in the *Handbuch der Experimentalphysik* is particularly interesting to those of us for whom that article was the first indispensable introduction to this enormous subject.

The application of fluid mechanics in biology is pursued with great effect in three articles. M. Y. Jaffrin and A. H. Shapiro review the mechanics of peristaltic pumping, with its particular importance for the physiology of the ureter, and show how well developed is our current understanding of the flow patterns involved. Y. C. Fung and B. W. Zweifach review the mechanics of the microcirculation, admirably relating the fluid-mechanical aspects to the anatomy and physiology. R. G. Cox and S. G. Mason give a general survey of flow of suspensions through tubes, and bring out the implications of this extensive body of knowledge for blood flow problems, while emphasizing also many chemical-engineering applications.

In this volume, two outstanding articles are by distinguished Soviet authors. V. P. Korobeinikov reviews the gasdynamics of explosions in an unbounded atmosphere in a thorough manner, including the perturbing effects of stratification and of magnetic fields, and also including the case of detonation waves. V. V. Mikhailov, V. Ya. Neiland and V. V. Sychev give an equally excellent and comprehensive survey of the strong interaction problem for viscous hypersonic flows.

Gasdynamics of very high-speed motions dominates also two other reviews in the volume. W. G. Vincenti and S. C. Traugott survey the coupling of radiative transfer and gas motion: the bulk of the work described relates to strong-shock structure and steady flows typical of re-entry bodies, but the authors include also an interesting section on the effect of radiative transfer on

atmospheric dynamics. H. W. Friedman, L. M. Linson, R. M. Patrick and H. E. Petschek cover the current state of knowledge on collisionless shocks in plasmas, going into considerable detail both regarding the dissipation mechanisms which the authors themselves did much to clarify and regarding the application to the magnetospheric bow shock.

Classical magnetohydrodynamics is represented by a survey of theoretical and experimental knowledge of flows at high Hartmann number. J. C. R. Hunt and J. A. Shercliff show in their review that the nature of duct flows under these conditions is now very well understood and that the sometimes bizarre predictions of theory are well confirmed experimentally. Classical laminar flame theory is reviewed by F. A. Williams in an equally authoritative survey.

A welcome new feature in volume 3 is a review article confined to the exposition of a body of experimental technique. W. W. Willmarth reviews a subject in which his work is internationally famous: the measurement of unsteady pressures and forces. A very wide range of different approaches to that important problem is covered in this article.

Experimental data dominate also W. M. Rohsenow's comprehensive review of boiling phenomena, which includes a very full correlation of heat-transfer data in various conditions (nucleate boiling, film boiling, forced-convection boiling, etc.). Other papers notable for encyclopaedic coverage of a vast preceding literature are the review of motion of floating bodies by J. V. Wehausen which describes motions periodic in time, transient motions and motions in irregular waves, and that of the continuum mechanics of visco-elastic fluids by R. S. Rivlin and K. N. Sawyers, with its thorough coverage of an enormous range of different constitutive equations and their various implications.

Last but not least, two distinctly difficult but particularly important branches of non-linear fluid mechanics theory are reviewed by authors who have most notably contributed to each. W. D. Hayes gives an elegant and economical account of the theory for calculating strengths of supersonic booms generated by aircraft flying at given speed and altitude under given atmospheric conditions, including recent material on interaction of the basic N-wave with low-level turbulence. J. T. Stuart reviews the nonlinear theory of hydrodynamic stability which in the hands of many research workers including primarily the author himself has already made so much progress towards bridging the gap between experimental data on transition and the linear stability theory.

To sum up, the editors of volume 3 (M. D. Van Dyke, W. G. Vincenti and J. V. Wehausen) are particularly to be congratulated on having put together a body of review articles of quite exceptional interest to workers in fluid mechanics. Lewis Caroll's Bellman explained "What I tell you three times is true", and on this basis the proposition that the *Annual Review of Fluid Mechanics* can each year be made so outstanding that all workers in the field regard the series as completely indispensable may now be regarded as proved.

JAMES LIGHTHILL

Übersichtsbeiträge zur Gasdynamik. Edited by E. LEITER and J. ZIEREP. Springer-Verlag, 1971. 386 pp. DM 142.

Modern Optical Methods in Gas Dynamic Research. Edited by D. S. DOSANJH. Plenum Press, 1971. 295 pp. $14.50.

The 60th birthday of Professor Klaus Oswatitsch was marked by a Symposium in Vienna in March 1970 during which ten of his former and present colleagues presented papers. Extended versions of these papers have been edited by Leiter and Zierep. They are all surveys rather than original research papers and vary greatly in scope and length. The book opens with a short survey of the contributions of Oswatitsch to gasdynamics and a list of his publications.

E. Leiter gives a comprehensive review of "Nonlinear propagation phenomena" in steady and unsteady flow, concentrating on isentropic flow but with brief references to magnetogasdynamics, radiation and relaxation. W. Gretler's paper on "The application of direct and indirect methods in the theory of subsonic flows" deals with the now classical methods and their recent extensions. J. Zierep in his survey of "Theory and experiment on transonic flows" deals in turn with sonic, slightly subsonic and slightly supersonic flows, giving theory as well as experimental techniques and results. W. Schneider's "Hypersonic flows" have mostly constant gamma, but there is some discussion of viscous effects. The article is so short that it can give no more than a broad outline. The same is true for the even shorter contribution by I. Teipel on "Numerical methods for the calculation of unsteady compressible flows". F. Bartlmä surveys the field of "Detonation processes" in gases, concentrating on the gasdynamics aspects.

In a comprehensive article on "Gas flows with thermodynamic relaxation" G. Romberg treats both the macroscopic thermodynamics and the gas kinetics of relaxation, with examples drawn from nozzle flows, body flows and wave propagation. Interesting are the discussions of the analogy between relaxation and dusty gas flows, and of the limitations of the analytical method of characteristics. Similarly, I. L. Ryhming in "Some recent advances in radiation gasdynamics" looks at both microscopic and macroscopic aspects for both monatomic and molecular gases. This is the only paper written in English. D. Rues adds to the rapidly growing literature on "The solar wind and the magnetosphere", and finally M. Fiebig gives a brief survey of "Plasma wind tunnels".

All the papers are readable and useful introductions for students but vary greatly in depth. Personally I found the two longest articles by Leiter and by Romberg most attractive, containing much material useful to those actively engaged in research. All articles are well documented with a large number of references. It is obvious, however, that the material to be included under any one heading is very much a matter for personal choice and that many headings are so broad that there can be no question of giving a really comprehensive coverage. An article in *Annual Reviews of Fluid Mechanics*, volume 2, by Lick was entitled "Nonlinear wave propagation in fluids" and the article by Leiter on "Nichtlineare Ausbreitungsvorgänge" might be expected to cover similar ground. The two articles together quote some 200 references, but only *six* are

common to both. Similarly, one might expect the Annual Reviews paper by Rich & Treanor on "Vibrational relaxation in gasdynamic flows" to have something in common with Romberg's article on "Gasströmungen mit thermodynamischer Relaxation", but again one finds that of a total of some 200 references only *four* are common to both and of those only *one* is a research paper.

The presentation and printing of the Oswatitsch volume are of the usual immaculate Springer standard.

Modern Optical Methods in Gas Dynamic Research is a collection of 15 papers presented at an International Symposium held at Syracuse University in May 1970; the authors are in fact all from North America. Three broad areas are covered: spectroscopy, refractive-index methods, and laser applications.

The opening paper surveys recent work on shock-tube spectroscopy and is essentially concerned with measurements of equilibrium spectral properties of gases. It is followed by a paper on non-equilibrium flow radiation and briefer notes on temperature errors in plasma diagnostics and impurity measurements in the expansion tube. The first paper on refractive-index methods briefly surveys the classical methods and through a review of the atomic dipole theory of dispersion leads into a discussion of the use of refractive studies in new areas such as spectral interferometry, f-number measurements, population inversions and nonlinear refractivity. Two further papers discuss Hook interferometry. The second half of the volume is devoted to the various uses of lasers, with two papers on laser light sources for refractive-index techniques, one on plasma analysis by light scattering, two on laser-generation of flows, two on tunable lasers, and a final paper on the CS_2/O_2 combustion laser.

This collection of papers gives a well-balanced account of the present state of this important field of research, and should be of interest both to active workers and new students. It is impossible to pick out individual papers for detailed comments. Suffice it to say that the collection succeeds in conveying the enormous impact of recent laser developments on experimental methods. Not only have they given us light sources of exceptional purity and intensity, but they have also recently been developed into useful devices for producing gas flows and gas samples.

The book is neatly and clearly reproduced from typescript.

N. H. JOHANNESEN

Aerodynamic Characteristics of Atmospheric Boundary Layers. By ERICH J. PLATE. U.S. Atomic Energy Commission, 1971. 190 pp. $3.00.

The atmospheric boundary layer has for a long time been a subject of applied meteorological interest in respect to problems of dispersion of pollutants and the effects of wind gusts on structures. It has recently begun to attract interest, in its own right as it were, from dynamical meteorologists who are concerned with formulating the action of the boundary layer in the atmospheric transfer of heat, momentum and water vapour. There has also been an increase in the

attention given to the prospect of physically modelling the atmospheric boundary layer in a wind tunnel. The latter aspect has been a particular interest of the author of the publication issued under the above title in the U.S. Atomic Energy Commission series of critical reviews. The author describes his work as a report which is intended to summarize the present state of knowledge of the mean-flow conditions, without, however, any coverage of the turbulent fluctuations. The publication is divided into four chapters dealing with neutrally stratified flow over uniform terrain, thermally stratified flow, free convection and the effects of changes in boundary properties.

It is noteworthy that Professor Plate chooses to introduce the logarithmic velocity profile for neutral flow as a deduction from the matching of recent dimensionally predicted asymptotic forms for the profiles in the outer and inner regions of the layer. On this basis the law apparently does not require the stress to be independent of height, as does the Monin–Obukhov similarity argument. This is a particularly interesting point in view of the vertical extent over which a close approach to the logarithmic form is sometimes observed, though the new argument does not itself provide any indication of this extent. Also, in connexion with this law there has just recently been a questioning of the value of 0·4 for von Kármán's constant, and it is therefore slightly disappointing that the basis for this long-standing value is given only six lines on p. 23 of the present summary. For stratified flow the now famous Monin–Obukhov length is introduced as a quantity in the flux Richardson number for near-neutral flow, in which terms it is recognized as effectively the height at which the mechanical and thermal productions of turbulent energy are equal. This physical identification has much merit but it is, nevertheless, surprising that so little of the exposition is given over to the similarity arguments which have gained such a prominent place over the last fifteen years. The important problem of the final stage of interaction at the boundary would seem to deserve rather more attention (for example, the work of Chamberlain is given only the briefest reference) especially in a work which is principally from an aerodynamic standpoint.

The foregoing are examples of features which may be a little unexpected to some readers but, overall, this aerodynamic view has a content which will be both informative to the reader with general interests in fluid flow and stimulating or even provocative to the atmospheric physicist concerned specially with the flow structure and its effects in the lower atmosphere. There are clearly many challenging problems remaining, and Professor Plate offers at various parts of his summary suggestions for elucidation of these in numerical and wind-tunnel studies. The difficulties of making and interpreting full-scale measurements are formidable but no doubt these will continue to be faced (more equably than suggested by the misprint 'convulsions' for 'conclusions' near the bottom of p. vii). Finally, the production of the summary is generally of a high quality and can be recommmended as good value for a price which is modest by present standards.

F. Pasquill