J. Fluid Mech. (1979), *vol.* 91, *part* 3, *pp.* 598–600
Printed in Great Britain

REVIEWS

Progress in Numerical Fluid Dynamics. Edited by H. J. WIRZ. Lecture Notes in Physics 41. Springer, 1975, 476 pp.

Proceedings of the Fifth International Conference on Numerical Methods in Fluid Dynamics. Edited by A. I. VAN DE VOOREN and P. J. ZANDBERGEN. Lecture Notes in Physics 59. Springer, 1976. 459 pp. $15.20.

The Springer series *Lecture Notes in Physics* has, as its aim, the publication of new developments in physical research and teaching, including reports of meetings and lecture notes. These volumes are examples of the two types of publication.

The first book contains the texts of lectures delivered at the 1974 Lecture Series held at the von Kármán Institute for Fluid Dynamics near Brussels. The lecture series, an annual event, provides an opportunity for detailed reports to be made on a few areas of active development in the field of computational fluid dynamics.

The contributions to this volume vary greatly in length (from 8 to 147 pages); in purpose (from the presentation of new discoveries to the review of a whole field of activity); and in topic (two- and three-dimensional transonic flows, the incompressible and compressible Navier–Stokes equations, boundary layers, the finite element method, numerical stability and the use of hybrid computers in numerical fluid dynamics). Three of them are major surveys.

Cheng's 'Critical Review of Numerical Solution of Navier–Stokes Equations' is worthy of study by both tyro and expert. While following a text-book approach to the topic – and producing a very readable account in the process – he draws attention to the various pitfalls which face the practitioner, and emphasizes that a solution should not only look right (i.e. not contain tell-tale instabilities): it is a good idea for it to be right, as well.

Kutler surveys finite difference 'shock capturing' methods for the computation of three-dimensional, inviscid supersonic flows. The other contribution which provides a survey of an extensive area of work is from Bailey on the computation of two- and three-dimensional steady transonic flows by relaxation methods.

The other papers, on the topics mentioned above and each an important document, are devoted to more specialized areas and may be of more interest to the established researcher than the student. Mueller's comparison of numerical and physical experiments on several viscous separated flows complements Cheng's remarks on the need for verification of accuracy and is worthy of special attention.

The second book contains the papers presented at Enschede, in The Netherlands, in 1976. There were two invited one-hour lectures from J. L. Lions (on methods for the solution of free surface problems which are connected to the calculus of variations) and S. A. Orszag (on the direct solution of the Navier–Stokes equations for turbulent and transition flows); four invited half-hour lectures: from O. R. Burggraf (on a boundary layer approach to the study of supersonic flow over a flat plate on which a compression ramp is mounted), M. G. Hall (reviewing methods for transonic flows, cf. Bailey above), W. Loeve (on panel methods and finite difference methods for wing-body combinations at subsonic speeds) and G. Schmid (on some finite

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element methods); and 53 short contributions on topics ranging from motion induced by suspensions of swimming micro-organisms to the flow around arbitrarily shaped objects such as rocks.

The papers cover such a wide range of topics that they defy any attempt at a useful categorization. There are several papers each on transonic flow problems, on novel co-ordinate systems, on problems in or related to biofluid mechanics, on questions of stability and on the finite element method, and one or two papers on each of a host of other topics. In half a dozen pages or less, so little detail can be given that the short contributions do not much more than define a problem and solution method and present one or two results. It is sometimes doubtful that they contain significant new material. The bulk of this book can best be regarded as a catalogue of work in progress in numerical fluid dynamics – and, of course, an incomplete one at that. The texts of the invited lectures are another matter, and provide valuable reports on progress in their respective topic areas.

G. DE VAHL DAVIS

Numerical Methods in Fluid Dynamics. By MAURICE HOLT. Springer, 1977. 253 pp. $31.70.

This book is directed to graduate students and research workers interested in the numerical solution of problems of fluid dynamics, primarily those arising in high speed flow. The first part describes techniques originating in the method of characteristics for the solution of unsteady nonlinear wave interaction and other problems in inviscid gas dynamics. The second part, slightly more than half the book, discusses several methods which have the common objective of removing the need for finite difference approximations in one or more directions by the use of polynomial or other approximations, and which are applied to a variety of steady flow problems.

The introductory chapter includes a description of the standard method of characteristics and a rapid survey of the ideas of finite difference methods. In Chapter 2 the Godunov schemes are presented. The solution region is imagined to be filled with cells within which the unknowns (velocity, density, pressure and energy) are uniform but across the boundaries of which they are discontinuous. The future behaviour of the unknowns is determined as if the cell boundaries are diaphragms which break down. Problems such as supersonic flow past a sphere and various reentry body configurations, wave formation on the sides of electrodes in a dense plasma and the bursting of a dam have been solved successfully.

The essential feature of the BVLR method (the name comes from the initials of the four Russians who developed it) is the replacement of finite difference approximations along characteristics by equivalent conditions along co-ordinate directions. Initially developed for purely supersonic flow, the method has since been extended to mixed (subsonic, transonic and supersonic) flow problems. Chapter 4 describes both uses of the method. It has been applied extensively to flow over a supersonic yawed cone and to the blunt body problem.

The next chapter contains a short description of each of several methods of characteristics for solving three-dimensional problems in gas dynamics, in particular the bicharacteristics method and the near characteristics method.

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Chapter 5 presents the method of integral relations, usually ascribed to Dorodnitsyn, to the development and use of which Holt has himself contributed extensively. The flow field is divided into a number of strips parallel to the body surface, across each of which the equations of motion are integrated. The integration is made possible by assuming that the integrands can be represented within each strip by suitable interpolation formulae. The integrated equations are ordinary or lower order partial differential equations in the unknowns on the strip boundaries. The method can be used for both inviscid and viscous flow. It has been used extensively for the mixed subsonic-supersonic flow around a blunt body in a supersonic stream, for transonic flow in nozzles, for wake flows and for a wide range of laminar boundary flows in two and three dimensions.

The final chapter describes Telenin's method and the method of lines. The main difference between these two methods and that of integral relations is that the equations of motion, incorporating interpolating functions to find derivatives in one direction, are solved in their original form without performing an integration. The main difference of these methods from each other is that the method of lines uses local polynomial fitting rather than fitting over the whole co-ordinate range. Again, Holt has been an active contributor to this work.

It is a cause for reflexion that each of the four new methods described was invented by Russian workers; they have, however, been very widely used and developed, especially by Holt and his co-workers.

Like many texts, this book is based on a university lecture course – there are references to other sets of lecture notes, and worked solutions prepared by students – and the selection of topics is more limited than might otherwise be expected in a text with such a general title; the choice no doubt reflects the interests of the lecturer and his students.

The book is well arranged, logically presented and well illustrated. It contains several FORTRAN programs with which students could experiment to gain confidence in the methods. It does not contain an overall author index, which is a minor irritation (references are given at the end of each chapter); and there are no suggested problems for students, which some will miss. However, this is not likely to be a 'do it yourself' book (many students would welcome expansion of some of the sections) and assignments can be introduced in class. It is a *practical* book, with emphasis on methods and their implementation. It is an excellent text for the fruitful research area it covers, and is highly recommended.

G. DE VAHL DAVIS and R. D. ARCHER