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Volume 12

Series Editors
George R. Sell Hans Weinberger

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IMA

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Computational Fluid Dynamics and Reacting Gas Flows

With 124 Illustrations, 2 in Full Color

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FOREWORD

This IMA Volume in Mathematics and its Applications

COMPUTATIONAL FLUID DYNAMICS AND REACTING GAS FLOWS

is in part the proceedings of a workshop which was an integral part of the 1986-87 IMA program on SCIENTIFIC COMPUTATION. We are grateful to the Scientific Committee: Bjorn Engquist (Chairman), Roland Glowinski, Mitchell Luskin and Andrew Majda for planning and implementing an exciting and stimulating year-long program. We especially thank the Workshop Organizers, Bjorn Engquist, Mitchell Luskin and Andrew Majda, for organizing a workshop which brought together many of the leading researchers in the area of computational fluid dynamics.

George R. Sell

Hans Weinberger

PREFACE

Computational fluid dynamics has always been of central importance in scientific computing. It is also a field which clearly displays the essential theme of interaction between mathematics, physics, and computer science. Therefore, it was natural for the first workshop of the 1986-87 program on scientific computing at the Institute for Mathematics and Its Applications to concentrate on computational fluid dynamics. In the workshop, more traditional fields were mixed with fields of emerging importance such as reacting gas flows and non-Newtonian flows. The workshop was marked by a high level of interaction and discussion among researchers representing varied "schools of thought" and countries.

This volume contains 15 papers that were presented at the workshop on computational fluid dynamics and reacting gas flows during September, 1986. Numerical problems connected with weather prediction are presented in a paper by H.-O. Kreiss and G. Browning. Recent progress in vortex methods for incompressible flows is described in papers by J. T. Beale and P.-A. Raviart, G. Cottet, and S. Mas-Gallic, and new finite element techniques for compressible and incompressible fluid flow are given and analyzed by C. Johnson. O. Pironneau and F. Hecht have contributed a paper on the necessity and limitations of turbulence modeling for the numerical solution of the Navier-Stokes equations, and new computational research in aerodynamical fluid dynamics is given in the papers by E. Krause and A. Rizzi and E. Murman.

The field of reacting gas flows is represented by papers by A. Kapila and P.L. Jackson, J.H.S. Lee, J. Nunziato and M. Baer, E. Oran, A. Majda and V. Roytburd, and J. Sethian; and the field of non-Newtonian flows is represented by D. Joseph and D. Malkus and M. Webster. G. Baker has contributed a paper on the instabilities of free surface flows.

Let us point out that research in computational fluid dynamics was also presented at other workshops during the program of the year on scientific computing at the IMA, in particular during the mini-symposium on numerical simulation in oil recovery. Proceedings of these workshops appear in the same series.

The conference committee would like to thank the directors of the IMA, Professors H. Weinberger, G. Sell, and W. Miller, and the staff of the IMA, Mr. R. Copeland, Mrs. P. Kurth, Mrs. C. McAree, and Mrs. M. Saunders for their assistance in arranging the workshop. Special thanks are due to Mrs. K. Smith and Mrs. P. Brick for their preparation of the manuscripts. We gratefully acknowledge the support of the National Science Foundation and the Cray Research Foundation.

Conference Committee: B. Engquist, M. Luskin, and A. Majda.