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Institute for Mathematics and Its Applications

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Computational Fluid Dynamics and Reacting Gas Flows

With 124 Illustrations, 2 in Full Color



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CONTENTS

Foreword	ix
Preface	xi
Two-frequency Rayleigh-Taylor and Richtmyer-Meshkov Instabilities	1
G.R. Baker	
On the Accuracy of Vortex Methods at Large Times	19
J. Thomas Beale	
Numerical Problems Connected with Weather Prediction.....	33
G. Browning and Heinz-Otto Kreiss	
Vortex Methods for the Incompressible Euler and Navier-Stokes Equations	47
G.H. Cottet, S. Mas-Gallic, P.A. Raviart	
On the Numerical Simulation of Turbulent Flows around Vehicles	69
F. Hecht and O. Pironneau	
Streamline Diffusion Finite Element Methods for Incompressible and Compressible Fluid Flow.....	87
Claes Johnson	
Hyperbolicity, Change of Type, Wave Speeds and Related Matters	107
D.D. Joseph	
Dynamics of Hot-Spot Evolution in a Reactive, Compressible Flow.....	123
A.K. Kapila and T.L. Jackson	
Numerical Prediction of Internal Flows	151
Egon Krause	
On the Universal Role of Turbulence in the Propagation of Deflagrations and Detonations	169
John H.S. Lee	
Numerical Modeling of the Initiation of Reacting Shock Waves	195
Andrew Majda and Victor Roytburd	
On the Accuracy of Finite Element and Finite Difference Predictions of Non-Newtonian Slot Pressures for a Maxwell Fluid	219
David S. Malkus and Michael F. Webster	
Flame Propagation and Growth to Detonation in Multiphase Flows	257
J.W. Nunziato and M.R. Baer	
Computations of Compressible Reactive Flows	291
Elaine S. Oran	
Computation of Flows Containing Edge Vortices	307
Arthur Rizzi, and Earll M. Murman	
Large Eddy Interaction with Propagating Flames	333
J.A. Sethian	

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-Galic, 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.