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# Book Reviews

## *Numerical Methods for Wave Propagation*

Edited by E. F. Toro and J. F. Clarke, Kluwer Academic Publishers, Dordrecht, The Netherlands, 1998, 396 pp., $170.00

This book contains 14 papers selected from contributions to the International Workshop on Numerical Methods for Wave Propagation Phenomena held at Manchester Metropolitan University in 1995. Although a wide variety of different applications and numerical methods are discussed, there is an emphasis on conservation laws and the use of Godunov-type methods. High-resolution methods of this type are based on solving Riemann problems and then applying limiters to second-order correction terms to eliminate nonphysical oscillations. These methods have proved extremely effective in solving nonlinear hyperbolic equations in the presence of shock waves or other discontinuities in the solution. Several papers contain novel applications or new developments in this methodology.

One of the pioneers in this field was the late Amiran Harten, of Tel-Aviv University, who developed the notion of a total variation diminishing (TVD) method, among his many other contributions. He was scheduled to speak in this workshop before his untimely death. Instead, the conference proceedings include the First Harten Memorial Lecture, which was delivered by Philip Roe. This lecture, "New Applications of Upwinding," gives an overview of some applications beyond the Euler equations where these upwind methods are beginning to play a role. It includes discussions of extended thermodynamics, magnetohydrodynamics, and the development of an upwind leapfrog method with applications to acoustics.

The papers in this book are all quite substantial and well written. Most are about 20 pages long and contain enough detail on interesting problems to be well worth reading. This volume is much more satisfying than many conference proceedings in this respect.

A rather diverse array of topics is covered, making it difficult to describe each one within reasonable space constraints. However, the titles are fairly descriptive and are listed here, with the authors, to evoke the flavor of the proceedings: Multidimensional Upwinding with Grid Adaptation (M. J. Baines and M. E. Hubbard), Wave Propagation in Saturated Rigid Porous Media—Numerical Simulation and Comparison with Experiments (G. Ben-Dor, A. Levy, and S. Sorek), Unsplit WAF-Type Schemes for Three-Dimensional Hyperbolic Conservation Laws (S. J. Billet and E. F. Toro), Semi-Implicit Methods for Free-Surface Environmental Flows (L. Bonaventura and V. Casulli), On Applications of High-Resolution Shock Capturing Methods to Unsteady Flows (D. M. Causon, D. M. Ingram, and G. Yang), Wave Propagation Phenomena in the Theory of Sedimentation: Mathematical Theory of Gravitational Solid-Liquid Separation Processes (F. Concha and R. Bürger), Difference Approximations of Acoustic and Elastic Wave Equations (D. B. Duncan), Approximate Riemann Solvers for Fluid Flow with Material Interfaces (M. F. Göz and C. D. Munz), Formulation of the ECMWF Forecast Model (M. Hortal), A Level-Set Capturing Scheme for Compressible Interfaces (S. Karni), An Entropy Diminishing Criterion for Hyperbolic Conservation Laws (P. G. LeFloch), High-Resolution Methods for Relativistic Fluid Dynamics (J. M. Marti), and Primitive, Conservative, and Adaptive Schemes for Hyperbolic Conservation Laws (E. F. Toro).

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## *Fundamentals of Computational Fluid Dynamics*

Patrick J. Roache, Hermosa Publishers, Las Lunas, NM, 1998, 648 pp., $75.00

In the author's words, the stated purposes of the book are 1) "... to build upon, and indeed preserve, the original 1972 textbook *Computational Fluid Dynamics* (Roache, 1972) as much as possible ...," and 2) to add a selection of more recent material "... based both on my opinion of its importance, keeping '*Fundamentals* ...' in mind, and especially on my own experience and contributions." These two purposes constitute Parts 1 and 2, respectively, of the book.

The original textbook has been well received by the computational fluid dynamics community for its lucid exposition of fundamental concepts and algorithms. The original material focused on incompressible and compressible finite difference/volume algorithms up to the early 1970s and included an extensive (indeed, encyclopedic) bibliography of over 1100 references. Because the original text is well known to the computational fluid dynamics community, this review focuses on the enhancements and additions.

In Part 1 of the book, the original textbook *Computational Fluid Dynamics* is "expanded, yet essentially reproduced ...." The expansion to Part 1 is very modest. The revised bibliography for Part 1 contains approximately 1400 references, of which more than 80% predate the 1972 publication date of the original book. Of the remaining references from 1972 and later, nearly one fourth are the author's papers (as first author or coauthor). A total of 56 problems for Part 1 are provided at the end of the book, but fewer than 10% of them are new. The section on Riemann solvers constitutes one page despite their overwhelming popularity in modern compressible finite difference and finite volume codes. The section on "Plots and Motion Pictures" includes only one new figure (in addition to the color contour plot on the cover) and reproduces 10 figures from the original edition (including the now obsolete dot-matrix plots of streamlines). No example of modern three-dimensional flowfield visualization results obtainable from commercial software (e.g., TECPLOT, AVS) is presented.

Part 2 of the book comprises, in effect, a partial anthology of the author's works. The chapters are based mostly on reprints and/or rewriting of the author's prior publications. The exceptions are Chapter 8 ("Finite Element vs Finite Difference Methods," 4 pp.), Chapter 10 ("Multigrid Solvers," 16 pp.), and Chapter 14 ("Solution Adaptive Grids and Time Steps," 11 pp.), representing about one fifth of the total material in Part 2. The remaining chapters are reprints or rewriting of published papers or sections of books by the author. A wide range of topics is covered, including, for example, "Operation Count for Direct Gaussian Elimination," "Nonlinear Flux Limiters Applied to Groundwater Contaminant Transport," and "A Sixth-Order Accurate Direct Solver for Poisson and Helmholtz Equations in Polar Coordinates." Particularly noteworthy are the chapters on "Verification of Codes and Calculations" and "The Grid Convergence Index," which have been adapted from the author's previous publications; however, there is an admitted, but unnecessary, overlap in these chapters. There is a single exercise for the reader in Part 2 at the end of the book.

In summary, the book faithfully presents the now classic *Computational Fluid Dynamics* with minor updates as Part 1. The collection of papers in Part 2 varies widely in topic, reflecting the author's tastes, but does not constitute an integrated presentation of material for computational fluid dynamics.

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