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Book Review

Mathematical Models of Fluiddynamics: Modelling, Theory, Basic Numerical Facts - An Introduction

Rainer Ansorge

Weinheim, WILEY-VCH GmbH & Co. KgaA 2003, 187pp., EUR 89.00
ISBN 3-527-40397-3

Mathematical modeling as a kind of investigations is nowadays practiced in every scientific branch. Dedicated to fluid dynamics the author demonstrates how mathematical modeling is applied in order to transform a problem from outside mathematics to a mathematical one. The book title means: mathematics meets fluid dynamics. Therefore, in the preface the author says that it can help to understand the text more easily if the reader has basic knowledge of linear algebra, calculus, partial differential equations, numerical analysis, theory of complex functions and functional analysis.

The book is organized in seven chapters. In every chapter the mathematical instruments are applied in context to fluid flow phenomena: Chap. 1 (38 pages) is about ideal fluids and deals mainly with the derivation of conservation equations for mass, momentum and energy. Among others potential flows and dynamic buoyancy are considered. Chap. 2 (18 p.) treats weak solutions in order to considerably extend the set of admissible solutions, even to discontinuous solutions. Examples are shallow water equations, shock waves and others. In Chap. 3 (27 p.) the entropy conditions are derived in order to select physically reasonable solutions out of the large amount of weak solutions. With view to the later numerical part, Chap. 4 (5 p.) considers the Riemann problem (an initial value problem with piecewise constant initial data) in conjunction with the finite difference method. For real fluids (Chap. 5, 31 p.) the Navier-Stokes equations are introduced and some phenomena as Hagen-Poiseuille flow, boundary layers and the stability of laminar flows are investigated. Chap. 6 (16 p.) demonstrates existence proofs for entropy solutions by means of discretization procedures while Chap. 7 (29 p.) touches already the area of computational fluid dynamics: the three widely used numerical discretization methods (Finite Element Method, Finite Volume Method, Finite Difference Method) are explained shortly from their basic idea. Additionally, convergence and stability aspects are described.

Concluding, the book combines the large mathematical areas of fluid flow equations, solution theory and numerical procedures in one volume. This features is the major strength of the book and it might be interesting and beneficial for both students and experts investigating fluid flows with mathematical tools or for those who wish to enter this field. Concerning the terminology, the book by R. Ansorge seems to be intended for mathematicians only. Also the title reveals that the book belongs to the branch of "Mathematical Fluid Dynamics" (MFD) which needs to be distinguished from the larger field of "Computational Fluid Dynamics" (CFD), where people with very different backgrounds are engaged.

Though the book is named introduction, there is only a small amount of accompanying text, which gives the impression that the book is more likely an abstract of an introduction, with totally only 187 pages. For the amount of information provided by the book its price is rather high.

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