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BOOK REVIEWS

G. P. Galdi, J. G. Heywood, R. Rannacher (eds.): SIX LECTURES IN MATHEMATICAL FLUID MECHANICS. Advances in Mathematical Fluid Mechanics. Birkhäuser-Verlag, Basel, 2000, 304 pages. ISBN 3-7643-6414-9, price DM 138.–.

This book contains six articles composing an extension of the material from short courses given at the beginning of the International Workshop on Theoretical and Numerical Fluid Dynamics, held in Vancouver, Canada, July 27 to August 2, 1996. The topics of the articles cover important parts of the mathematical fluid mechanics.

First, a detailed history of the famous problem of existence, uniqueness and regularity of solutions to the Navier-Stokes equations for viscous incompressible fluid is given.

Secondly, spectral approximation methods and their application to the numerical solution of the Navier-Stokes equations are reviewed and the so-called domain decomposition method is introduced.

In the third article the prototypical problems of bifurcation theory are studied on the parametrized family of diferential equations $u'(t) = Au(t) + \nu Bu(t) + N(u(t))$, A, B being linear operators (B accretive in a sense), N nonlinear (bilinear) and $u(t) \in \mathbb{R}^n$ or $u(t)$ ranges in a Banach space possibly of infinite dimension ($\nu > 0$). The former can be among others applied to finite-dimensional approximations of the Navier-Stokes equations and the latter to the full Navier-Stokes problem.

The next article concerns the steady transport equation $k\sigma + \gamma \operatorname{div}(\sigma v) = H$ (k, γ constants, v a given vector field) the theory of which forms a fundamental background to many problems in fluid mechanics, in particular to subsequent thorough study of existence and uniqueness for a steady compressible viscous flow.

The volume is concluded with a presentation of finite element methods for the incompressible Navier-Stokes equations, the theory of which is important for the numerical treatment of the problem.

The choice of themes is representative, the presentation clear, concise and rigorous. The book is strongly recommended to those who wish to be rapidly introduced into the fascinating world of mathematical fluid mechanics. Specialists will find here an up to date information, otherwise spread in a numerous spectrum of journals, concentrated into one volume.

Ivan Straškraba

Peter Imkeller, Jin-Song von Storch (eds.): STOCHASTIC CLIMATE MODELS. Progress in Probability, Vol. 49. Birkhäuser-Verlag, Basel, 2001, xxvii+398 pages. ISBN 3-7643-6520-X, price EUR 109.–.

The book under review collects papers motivated by the workshop Stochastic Climate Models held in Chorin from May 31 to June 2, 1999. It opens with Preface by Klaus Hasselmann, who pioneered the use of stochastic models in climate physics more than twenty five years ago, and with the Editors' Introduction, in which a detailed description of the papers included into the proceedings is given and the basic ideas guiding the whole field of stochastic climate modelling are provided. We take the liberty of quoting extensively from this Introduction, since we find it quite telling: "One of the most important features of the

climate systems [...] is that the fluctuation of physical quantities in its different components takes place on tremendously different scales. [...] If phenomena on very different scales appear in systems described by the same set of nonlinear (partial) differential equations, the old concept of averaging enters the game. [...] This way, in the framework of normal deviations one obtains differential equations for the slow variables in which the influence of the fast ones appears as a stochastic term. [...] Therefore averaging transforms multi scale deterministic (partial) differential equations into stochastic (partial) differential equations. In his seminal paper of 1976, Hasselmann adopted this concept for the area of climate modelling to create the prototype featured in this volume: the stochastic climate models."

"The workshop [...] brought together scientists from the two areas of climate physics and mathematics, interested in the interplay of their fields of research. Researchers from two different cultures met to discuss problems of common interest and receive new ideas for their own projects [...]. The first outgrowth of this effort led to the articles of this volume".

The book comprises eighteen papers, divided into four chapters, which are entitled *The hierarchy of climate models*, *The emergence of randomness: chaos, averaging, limit theorems*, *Tools and methods: SDE, dynamical systems, SPDE, multiscale techniques*, and *Reduced stochastic models and particular techniques*. In vast majority of the papers, emphasis is laid on basic ideas, not on technical details, and the papers should serve as surveys of various climate models (on the physics side) or mathematical methods which might be useful in studying these models (on the mathematics side). Following his own mathematical tastes, the reviewer would like to mention explicitly at least two of the contributions: Jerzy Zabczyk's mini course on stochastic partial differential equations and Yuri Kifer's paper providing an overview of the averaging method. Stochastic climate modelling is undoubtedly a very challenging topic and these proceedings are a necessary reading for everybody who wants to enter this interesting field of research.

Ivo Vrkoč

J. Neustupa, P. Penel (eds.): MATHEMATICAL FLUID MECHANICS, RECENT RESULTS AND OPEN QUESTIONS. Advances in Mathematical Fluid Mechanics. Birkhäuser-Verlag, Basel, 2001, 290 pages. ISBN 3-7643-6593-5, price EUR 78.–.

This collection of papers is composed of a part of topics discussed during the 1st International French-Czech Conference on Mathematical Fluid Mechanics held in Marseille (Centre International de Rencontres Mathématiques de la Societé Mathématique de France), March 20–24, 2000.

The following issues are included: What use for the mathematical theory of the Navier-Stokes equations, An iterative scheme for steady compressible viscous flow, modified to treat large potential forces, Asymptotic results for the linear stage of the Rayleigh-Taylor instability, Recent progress in the mathematical theory of viscous compressible fluids, Numerical methods for compressible flow, Instability of steady flows of an ideal incompressible fluid, Finite volume solution of $2D$ and $3D$ Euler and Navier-Stokes equations, On a conjecture concerning the Stokes problem in nonsmooth domains, On well-posedness of the Navier-Stokes equations, Anisotropic and geometric criteria for interior regularity of weak solutions to the Navier-Stokes equations.

The Appendix provides references to basic literature on mathematical fluid mechanics where the readers can find explanation of the backgrounds to most of the topics discussed in this book.

The book is suitable for specialists in the mathematical theory of fluids and its applications in various applied problems arising in this field. It provides a concise and representa-

tive up to date information in selected topics of mathematical fluid mechanics surveyed in a single volume.

Ivan Straškraba

M. Falk, F. Marohn, B. Tewes: FOUNDATION OF STATISTICAL ANALYSES AND APPLICATIONS WITH SAS. Birkhäuser-Verlag, Basel-Boston-Berlin, 2002, x+400 pages. ISBN 3-7643-6893-4, price EUR 54.21.

The authors were successful in writing a rather non-standard and extremely valuable textbook combining a reasonable amount of theory with computational practice. It fills the gap between texts on probability and statistics and programming manuals. The magic is hidden in the organization of the text which is as follows: every important group of notions and every piece of statistical theory are immediately followed by an SAS-specific part (6.12 version in most cases, only exceptionally version 8) including data, graphics and detailed commentary. Nearly 30 samples of data excerpted from recent literature are analysed in more than 100 program examples. Their selection demonstrates the application of statistical analyses in various areas, in particular in forestry, air pollution control, economy, physics, chemistry, and in medical and social sciences (the programs as well as the data files can be downloaded from `http://statistics-with-sas.ku-eichstaett.de` and also further information relating to them is available there). Moreover, each chapter is closed with numerous exercises (more than 180) helping to understand the theory as well as to develop the computational skill.

The list of topics covered in eight chapters is quite impressive. Elements of exploratory analysis include beside standard and robust measures of location, spread, asymmetry and shape also boxplots, kernel estimators, quantile plots, hanging histograms and rootograms. The second chapter is concerned with normal and related distributions, testing hypothesis, confidence intervals, power of tests and Wilcoxon test. The next chapter describes linear and multiple linear regression and the method of least squares. Contingency tables and categorical regression form the content of the chapter on categorical data analysis. The following three chapters describe the analysis of variance, discriminant and cluster analyses. The closing statistical chapter describes the principal component analysis and the factor analysis based on principal components.

The Appendix is a brief introduction to the present conception of SAS as a businessmade instrument for information and decision equipped with a huge analysis package for all different sorts of statistical problems.

The target of the book are students and practitioners interested in statistics and using it as an important tool in various branches of science like economics, finances, biomathematics etc.

Ivan Saxl

Erwin Bolthausen, Alain-Sol Sznitman: TEN LECTURES ON RANDOM MEDIA. Birkhäuser-Verlag, Basel, 2002, 128 pages. ISBN 3-7643-6703-2, price EUR 28.–.

The monograph offers a rather new point of view on random particle systems. Unlike the traditional concept where the medium for the particles is given and the irregularity of the movement is modelled through a random motion, the idea here is to study more complicated systems where not only the particles are driven by a random motion but the environment which influences the motion is random itself. Examples and motivations originating from condensed matter physics, physical chemistry, biophysics or geology are included.

The book splits into two parts. The first one is devoted to the study of random motions in random media and is further divided into five lectures covering problems such as the

central limit theorem for random walks in random environment, long time survival among random traps, or multi-dimensional random walks in random environment.

The second part deals with spin glasses and is divided into five lectures as well. The topics covered are the Sherrington-Kirkpatrick model of spin glasses (high temperature and nonzero magnetic field), the random energy model, the generalized random energy model and induced clusterings, and finally the Markovian clustering, reshuffling, and a self-consistency equation.

The book is recommended for postgraduates and researchers in probability theory and mathematical physics.

Martin Ondreját

Jörg Steinbach: A VARIATIONAL INEQUALITY APPROACH TO FREE BOUNDARY PROBLEMS WITH APPLICATIONS IN MOULD FILLING. Birkhäuser-Verlag, Basel-Boston-Berlin, 2002, vii+294 pages. ISBN 3-7643-6582-X, price EUR 116.–.

An evolutionary variational inequality approach to degenerate moving free boundary problems is studied. Analytical as well as numerical methods are discussed and numerical simulation results for applications in polymer processing are given.

After Introduction (Chapter 1), a general moving free boundary problem is introduced in Chapter 2. Different fixed domain formulations are derived and their relation is discussed. In particular, a variational inequality formulation is obtained by using a generalized Baiocchi type transformation. The variational inequality considered is of an obstacle type. It takes an intermediate position between elliptic and parabolic inequalities and is given by an elliptic bilinear form, a memory term with time dependent coefficients, time dependent convex (constraint) set, and different types (Dirichlet, Neumann, Newton) of boundary conditions. Applications to quasi-steady state Stefan problem, non-isothermal injection moulding, non-isothermal compression moulding and electro-chemical machining process are described.

In Chapter 3, general properties of variational inequalities are studied. The existence and uniqueness of a solution is proved by using a fixed point argument in connection with elliptic inequalities. The regularity with respect to time is studied by using the Lewy-Stampacchia bounded penalization method. For the study of the space regularity, a semi-discretization in time together with some elliptic regularity results is used for the associated penalty problem.

A numerical treatment of elliptic variational inequalities is the subject of Chapter 4. The results given are interesting themselves and are used in Chapter 5 for the numerical study of the evolutionary case. In both chapters, the finite element and finite volume approximations are discussed and compared. The convergence rate of approximations is studied. The error analysis is based on the regularity results of Chapter 3.

The mathematical modelling and numerical simulation of the injection and compression moulding process is further extended in Chapter 6. Not only the application of the variational inequality is given but also a geometrical (asymptotic) approach and some recent developments concerning the full three-dimensional simulation methods governed by generalized Stokes and Navier-Stokes flows are described. Some results of numerical experiments are presented. In particular, an influence of some basic geometrical and operating conditions for several real plastic products is discussed.

Short discussion of the main results as well as recomendations for further study are given in the last chapter.

The book is addressed mainly to aplied mathematicians but can be useful also to physicists and engineers.

Milan Kučera