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Book Reviews

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BOOK REVIEWS

A. Fasano, ed.: COMPLEX FLOWS IN INDUSTRIAL PROCESSES. Birkhäuser Verlag, Boston-Basel-Berlin, 1999, 352 pages, ISBN 3-7643-4087-8, price DM 168,–.

The goal of this book is to present a variety of industrial applications and models that address current work in the field of complex flow conditions and systems occurring in industrial processes. For some of the problems discussed also the solutions are presented. The book appeared as a contributed volume in the series "Modeling and Simulation in Science, Engineering and Technology". The 19 contributors are from Italian universities and industrial enterprises mostly. We would like to mention A. Fasano from Universitá di Firenze in this respect and note also R. M. M. Mattheij from Eindhoven University of Technology as a representative of the three foreign authors, all of them being from The Netherlands.

The book contains state-of-the-art surveys for the selected models and applications and provides a number of examples showing how frequently new mathematical models for flows of particular complexity are required in modeling many industrial processes in which fluid dynamics and filtration through porous media are involved. The contributions are organized into three broad categories: flows of nonlinear materials, flows accompanied by thermal processes, and nonlinear flows in porous media. To give just examples of the contributions contained in the book we quote the discussion of molecular theories of polymer viscosity by G. Marrucci and G. Ianniruberto (Part I of the book), a paper on the mathematical modeling of some glass problems by K. Laevsky and R. M. M. Mattheij (Part II), and the study of a model of porous media with hydrophile granules by A. Fasano (Part III).

The book is an essential resource and reference for the analysis and modeling of complex industrial problems in fluid dynamics and filtration. It will be useful for researchers and practitioners involved in the applications of mathematical methods to fluid dynamics, chemical process engineering, or materials engineering. It may also serve as a stimulating reading for those interested in general applied mathematics or scientific computing.

Petr Přikryl

O. E. Barndorff-Nielsen, T. Mikosch, S. I. Resnick, eds.: LÉVY PROCESSES. THEORY AND APPLICATIONS. Birkhäuser Verlag, Boston, 2001, x+415 pages, ISBN 0-8176-4167-X, price DM 196,–.

Let us start our review with a quotation from Editors' Preface, since it describes their motivation very clearly: "During the last several years, there has been a renaissance of interest in Lévy processes and many new developments. ... Most of the work on Lévy processes has been focused on the ramifications and modifications of Brownian motion. The non-Gaussian Lévy world of jump processes has mostly been treated as a curiosity. The emphasis of this volume is on non-Gaussian Lévy processes ... non-Gaussian Lévy processes have not received the attention they deserve."

The reviewer finds the present book very timely: the eighteen survey papers included in the book could help the reader understand the rapid recent development both in the theory of Lévy processes and in their applications in various fields.

The book opens with a useful tutorial *Basic results on Lévy processes*, written by Ken-iti Sato (who published an authoritative monograph on the topic two years ago). A rich bibliography with 180 items is worth being mentioned separately. The next section, Distributional,

pathwise, and structural results, comprises four papers, in the third section Extensions and generalizations of Lévy processes the reader will find three papers. The next two sections are devoted to applications to physics and finance (each section containing four papers). The final section is entitled Numerical and statistical aspects. Altogether, twenty six authors have contributed to the volume, of whom let us name for example D. Applebaum, J. Bertoin, N. Jacob, P. Protter, W. A. Woyczynski or M. Yor.

To conclude, the book is a welcome addition to the not so rich literature on general Lévy processes.

Ivo Vrkoč

V. P. Pikulin, S. I. Pohozaev: EQUATIONS IN MATHEMATICAL PHYSICS. A PRACTICAL COURSE. Birkhäuser Verlag, Basel-Berlin-Boston, 2001, viii+207 pages, ISBN 3-7643-6501-3, price EUR 98,–.

The goal of the book is to describe basic methods for solving the classical linear problems in mathematical physics. The text consists of three chapters devoted successively to elliptic, hyperbolic and parabolic problems. Various methods are presented (rather without any detailed mathematical justification) and illustrated by examples with detailed analysis of their solution. For a deeper understanding, the reader is refered to the bibliography.

Chapter 1 deals with the Fourier method for the Laplace and Poisson equations in domains with a certain symmetry, the Fourier method for the Helmholtz equation (including the case of unbounded domains) and the Green function method.

Chapter 2 concerns hyperbolic problems. The methods of travelling and steady waves, of Fourier, Laplace and Hankel transformations, of separation of variables and the perturbation method are demonstrated and their applications are described.

Chapter 3 contains the application of the Fourier method for parabolic problems in domains with a certain symmetry. The methods of the Fourier and Laplace integral transformations and the method of separation of variables are used for the Cauchy problem in the case of the homogeneous heat equation.

Problems for independent study and answers are given at the end of each chapter.

The handbook is written in an understandable form and can be valuable for students as well as for engineers and scientists.

Milan Kučera

R. B. Schinazi: PROBABILITY WITH STATISTICAL APPLICATIONS. Birkhäuser Verlag, Boston, 2001, softcover, 232 pages, ISBN 3-7643-4247-1, price EUR 58,–.

The book is an introduction to the mathematical statistics for readers without deep mathematical background. The author prefers to explain the theory in examples rather than in rigorous proofs and leads the student in a direct yet comprehensible way to useful tools such as limit theorems, estimation and hypothesis testing, linear regression, moment generating functions or sums of independent random variables. Basic notions of probability are introduced only to such extent that the reader can follow the exposition.

The text is divided into 8 chapters plus appendices with tables of normal, Student and chi-square distributions, and the structure is well arranged as the important facts are boxed.

Especially undergraduate students in biology, computer science, engineering, physics and mathematics will find the book interesting.

Martin Ondreját

K. Gröchenig: FOUNDATIONS OF TIME-FREQUENCY ANALYSIS. Birkhäuser Verlag, Boston-Basel-Berlin, 2001, hardcover, 376 pages, ISBN 0-8176-4022-3, price DM 148,–.

This is a very nice exposition of the parts of harmonic analysis which lie at the bases of quantum mechanics, signal processing and wavelet theory. The book starts with establishing the basic facts about the Fourier transform and various forms of the uncertainty principle. Then the windowed Fourier transform and the Wigner distribution are discussed. Next, the theory of Gabor frames is developed: their existence, structure, the Zak transform and Wilson bases, etc. The subsequent two chapters offer a more abstract view of the theory from the perspective of the Heisenberg group, and an excursion into the wavelet theory, respectively. The final three chapters give a systematic treatment of the modulation spaces of H. G. Feichtinger, including their applications in operator algebras and in the theory of pseudodifferential operators. The exposition is both lucid and extremely readable and places the book on a par with, for instance, G. B. Folland's *Harmonic analysis in phase space* or I. Daubechies' *Ten lectures on wavelets*; however, the overlap with these two books, as well as with other existing treatises on time-frequency analysis or wavelets, remains moderately small. In particular, the results on modulation spaces appear here for the first time in a book form; in addition, a number of known results are presented here in a new or simplified approaches, and several new results or improvements upon existing ones are also included. The book will be a useful resource for mathematicians as well as physicists and engineers interested in harmonic analysis, signal processing or wavelet theory.

Miroslav Engliš

J. J. Benedetto, P. J. S. G. Ferreira, eds.: MODERN SAMPLING THEORY. MATHEMATICS AND APPLICATIONS. Birkhäuser Verlag, Boston-Basel-Berlin, 2001, xvi + 418 pages, 37 Fig's, ISBN 3-7643-4023-1, price DM 220,–.

The book appears in the series Applied and Numerical Harmonic Analysis and is written by 28 specialists on sampling in Fourier and signal analysis and its applications in communication theory and practice.

The introductory section (written by the editors) contains, besides an overview of various sampling theorems and an outline of the book, also the English translation of the famous and widely cited Kotelnikov's paper On the Transmission Capacity of the "Ether" and Wire in Electrocommunications (published in Russian in 1933).

The next 17 chapters of the book are organized in three sections. The first of them, Sampling, Wavelets and the Uncertainty Principle, covers sampling in the context of Sobolev spaces, Hilbert spaces and other distribution spaces and describes the interplay between various uncertainty principles and weighted norm inequalities on the one hand, and their interpretations on the other. Further, Shannon's wavelets are suitably generalized and their properties examined.

The second section, entitled Sampling Topics from Mathematical Analysis, describes discretization of the sampling problem by trigonometric polynomials, analysis of oscillatory behaviour in signals, sampling techniques in deconvolution, sampling theorems on the iteration of low order differential operators, and approximation of continuous functions by Rogosinsky-type sampling series.

The six chapters of the last section, Sampling Tools and Applications, include fast and robust algorithms for computing discrete Fourier expansions for non-uniformly distributed data, sampling for noisy and grouped data, efficient sampling of signals with frequency support over non-commensurable sets and of the rotation-invariant Radon transform, fi-

nite bidimensional models for oversampled filter banks, and, finally, sampling problems in magnetic resonance imaging.

The book is destined to specialists in speech and image processing, information theory and biomedical engineering, and will serve, with its nearly 450 references, as a modern guide to sampling theory.

Ivan Saxl

Y. Zheng: SYSTEMS OF CONSERVATION LAWS. Birkhauser Verlag, Basel-Berlin-Boston, 2001, 336 pages, ISBN 3-7643-4080-0, price DM 148,–.

This work can serve as an introductory text for graduate students and researchers working in the important area of partial diferential equations with a focus on problems involving conservation laws. The main intention in this book is to give a concise introduction to solving 2-d compressible Euler equations with Riemann data, which are special Cauchy data. This book covers new theoretical developments in the field over the past decade or so. The book is divided into three parts. The first part is devoted to basics in one dimension (one-dimensional scalar equation, Riemann problems, Cauchy problem). The second part deals with two dimensional theory (2-d scalar Riemann problem, 2-d Riemann problem and pseudo-characteristics, axisymmetric and self-similar solutions, plausible structures for 2-d Euler systems, pressure-gradient equations of the Euler systems, the convective systems of the Euler systems, the two-dimensional Burgers equations). Finally, numerical schemes are presented (upwind-linear and nonlinear, Lax-Friedrichs scheme, Godunov method, approximate Riemann solver, higher order methods (Lax-Wendroff scheme, slope limiter, flux limiter, TVD), positive schemes). Written in a clear, accessible style, the book emphasizes more recent results that will prepare readers to meet modern challenges in the subject, that is, to carry out theoretical, numerical and asymptotical analysis.

Šárka Nečasová

L. Debnath: WAVELET TRANSFORMS AND THEIR APPLICATIONS. Birkhäuser Verlag, Boston, 2001, 584 pages, ISBN 0-8176-4204-8, price EUR 105,–.

Wavelets are an important general tool for many applications of mathematics to different fields of human activities. The book presents both the theory and a systematic description of the applications of the subject chosen.

The monograph consists of a preface, 9 chapters, answers to exercises, and bibliography. Chapter 1 starts with an introduction to the Fourier transform, which is a prerequisite, and the definition of the wavelet transform. Chapter 2 brings a general overview of functional analysis background of the theory. Chapter 3 presents some applications of the Fourier transform.

Chapters 4 and 5 are devoted to several modern methods for the time-frequency signal analysis. Some special features and applications of wavelet transforms are discussed in Chapters 6 to 9.

The major emphasis is on the logical development of the fundamental ideas and on the treatment of wavelet analysis and of its applications to a wide variety of problems in various interdisciplinary areas. A general scheme of the presentation is definition-theorem-proof which makes the material of the book well structured.

The monograph provides a large number of figures, examples, and exercises from the mathematical, physical, and engineering contexts to which the theory is applied. The book is undoubtedly accessible to a large audience with diverse background and interests in mathematics, science, and engineering.

Karel Segeth

L. Debnath, ed.: WAVELET TRANSFORMS AND TIME-FREQUENCY SIGNAL ANALYSIS. Applied and Numerical Harmonic Analysis. Birkhäuser Verlag, Boston, 2001, xx+428 pages, hardcover, ISBN 0-8176-4104-1 (Boston), ISBN 3-7643-4104-1 (Basel), price DM 170,–.

The monograph comprises twelve fairly selfcontained and mutually independent chapters.

Eight chapters dwell on wavelets and wavelet transforms, and form Part I of the book.

The opening chapter by J. J. Benedetto and O. M. Treiber deals with wavelet frames, i.e., countable systems in $L^2(\mathbb{R})$ generated via a wavelet function and having certain density, orthogonality, and approximative properties leading to the notion of multiresolution analysis and wavelet expansions.

The rate at which multiresolution and wavelet expansions converge to sufficiently smooth functions from a given Sobolev space in the supremum error norm is the subject of Chapter 2 by M. A. Kon and L. A. Raphael.

Chapter 3 by K. Berkner and R. O. Wells, Jr., concentrates on a generalization of the Donoho–Johnstone denoising scheme to nonorthogonal wavelet transforms.

A new hierarchical modeling of scalar field theories is introduced in Chapter 4 by G. Battle. It is based on an incomplete set of continuous piecewise linear two-dimensional wavelets partly exhibiting Sobolev-orthogonality properties (Osiris wavelets). As an application, the derivation of a renormalization group recursion formula for the dipole gas is presented.

The authors of Chapter 5, A. I. Zayed and G. G. Walter, focus on wavelets in closed form. They suggest a procedure for obtaining orthonormal, as well as nonorthogonal but interpolating, wavelets.

In Chapter 6 by C. Pérez and R. Schneider, Galerkin methods based on biorthogonal wavelets are applied to a coupling of finite and boundary methods to solve an exterior three-dimensional Poisson equation. A convergence analysis is performed, too.

Chapter 7 by K. Schneider and M. Farge briefly reviews basic tools for wavelet modeling and computing two-dimensional turbulent flow. Then, an adaptive wavelet method for solving the Navier-Stokes equations is presented together with numerical results.

Chapter 8 finishes Part I and also serves as a link to Part II of the book. L. Cohen obtains both a global and a local uncertainty principle for the short-time Fourier transform there. That is, he derives the relevant explicit spectrogram expressions in terms of the uncertainty product of the signal and the window. Other uncertainty relations as well as some moments of the scalogram are dealt with, too.

Part II is devoted to the study of time-frequency signal analysis.

Chapter 9, written by F. Hlawatsch and G. Matz, sticks at quadratic time-frequency representations of linear time-varying systems. Using the Wigner distribution, the authors propose two other distributions and discuss the properties of all three representations.

Chapter 10 by P. Flandrin deals with a specific form of the Melin transform, referred to as the scale transform. A number of inequalities involving quantities (such as energy, arithmetic mean, arithmetic variance, etc.) derived from a signal and its scale transform are inferred.

In Chapter 11, B. Boashash and B. Barkat present fundamental principles of time-frequency signal analysis and review the main contributions to the field, including recent advances. Many examples are presented.

To eliminate deficiencies of time-frequency representations, W. J. Williams in Chapter 12 proposes a possible remedy that utilizes special sets of orthonormally related windows and applies to time shift and frequency shift invariant time-frequency distributions, and, more generally, to Cohen's class of distributions.

Each chapter is accompanied by a list of references. A global index concludes the book.

The monograph aims at scientists, engineers, and pure and applied mathematicians. Though some chapters seem to assume rather advanced or specialized readers, others can address a wide audience or serve as a well-written surveying introduction to a particular subject.

Jan Chleboun

L. A. Peletier, W. C. Troy: SPATIAL PATTERNS. HIGHER ORDER MODELS IN PHYSICS AND MECHANICS. Progress in Nonlinear Differential Equations and Their Applications, Vol. 45. Birkhäuser Verlag, Boston-Basel-Berlin, 2001, xvi + 342 pages, 205 Fig's, ISBN 3-7643-4110-6, price DM 196,–.

Spatial patterns and their evolution in time occur in widely different situations like water waves, pulses in optical fibres, periodic alloy structures, folds in rock formation, cloud patterns in sky etc. The recent results of their study by simplified model equations are the topic of the present book. The classical modelling was usually based on second-order partial differential equations; here the family of fourth-order canonical equations $u^{(\mathrm{iv})} + qu'' + f(u) = 0$ with the source function $f = (u - a)(u^2 - u)$ is considered.

The introductory chapter presents an overview of models (Fisher-Kolmogorov, Burgers, Swift-Hohenberg, non-linear Schrödinger, wave equations etc.) and methods of solution (topological shooting, Hamiltonian and variational methods, methods based on the Maximum Principle). The current relevance of the topic and the outbreak of interest in it are best demonstrated by the fact that only one third from the nearly 200 citations were published before 1990 and only one fifth of them appeared before 1980.

The substantial part of the book focuses on the odd nonlinearity ($a = 0$) of the canonical equation with a symmetric double-well potential F (the primitive to f), which arises frequently in the theories of phase transitions. First the effect of the value of q is described and a complete catalogue of the set of bounded solutions is given for $q < -\sqrt{8}$. In the opposite case, an extremely rich set of solutions is obtained and periodic solutions, kinks and pulses, and chaotic solutions are examined by a combination of a rigorous mathematical analysis and computational studies. Finally, the variational approach to the canonical equation is developed.

In the second part of the book, the more general case of double-well asymmetric potential ($0 < |a| < 1$) is examined in two important examples with applications in physics (convection, crystallisation kinetics) and mechanics (travelling waves in supported beams and suspension bridges).

Numerous graphs of solution obtained by numerical computations are presented; they make possible a deeper insight in the structure of the bounded solutions. Also, numerous exercises and problems are included. The book is intended for mathematicians, mathematical physicists and graduate physicists.

Ivan Saxl