BOOK REVIEWS

G.-C. Rota: INDISCRETE THOUGHTS. Birkhäuser, Basel 1996, 296 pages, ISBN 3-7643-3866-0, DM 68,–.

The book concludes a series of essays which the author G.-C. Rota has published in the last twenty-five years. The book offers a monumental account of the science and technology as viewed by a mathematician. The text involves the era from 1950 to 1990—the so called golden age of American science and universities.

The book is divided into three parts. In the first part *Persons and Places* the author draws portraits of some of the great scientific personalities like Stanislav Ulam, Solomon Lefschetz, William Feller, Jack Schwartz etc. He describes not only their contributions to science, but also their kindness, their egos and their absurdities. He presents them as living human beings.

In the second part *Philosophy: A minority View* Rota presents some of the fundamental ideas of phenomenology (especially the phenomenology of E. Husserl, phenomenology of mathematical proof and truth etc.). He describes the influence of mathematics upon philosophy.

The next part *Readings and comments* contains some Rota's original thoughts on teaching, publishing, on the mathematics world, etc.

Rota's texts are rich in hidden allusions and ironies which an experienced reader will catch and appreciate. Rota's essays and thoughts provide controversial views of the contemporary science and technology.

This book can be recommended to everybody who are interested in the philosophy of mathematics and science.

Martina Němcová, Praha

V. I. Lebedev: AN INTRODUCTION TO FUNCTIONAL ANALYSIS AND COMPUTATIONAL MATHEMATICS. Birkhäuser, Boston 1997, xi + 255 pages, ISBN 3-7643-3888-1, DM 118,–.

This book has arisen as a result of lectures on functional analysis and numerical mathematics given by the author at the Moscow Institute for Physics and Technology. Its aim is to introduce fundamental mathematical tools for solving several important problems in computational and applied mathematics. The book consists of three chapters.

In the first chapter, the author analyzes the structure of various spaces (e.g., metric spaces, linear spaces, Banach spaces, Hilbert spaces). He also deals with the theory of approximation, contraction mapping principle, properties of the Chebyshev polynomials, orthogonal systems, Fourier series and many other basic notions from functional analysis.

The second chapter is devoted to linear functionals and linear operators. The main theorems here include, e.g., the uniform boundedness principle, the Banach-Steinhaus theorem, the Riesz theorem, the Hahn-Banach theorem. They are applied to some problems with adjoint, selfadjoint and symmetric operators, to optimization problem for quadrature formulae, to eigenvalue problems etc. Further, the standard Sobolev spaces are defined and the weak solution of the second order elliptic equation with Dirichlet boundary conditions and its Ritz-Galerkin approximations are investigated.

Finally, in the third chapter, a general theory of iteration methods for the solution of operator equations is described. In particular, the method of successive approximations, the method of steepest descent and the Newton method are examined. Several acceleration techniques, optimization procedures and efficient algorithms are presented as well.

The book is a valuable resource for numerical analysts, applied mathematicians, researchers working in the areas of optimization and computational mathematics, and upper-level undergraduate and graduate students in these disciplines.

Michal Křížek, Praha

H. J. Leisi: KLASSISCHE PHYSIK. BD. I: MECHANIK. Birkhäuser, Basel 1996, vi + 429 pages, 245 Fig's. ISBN 3-7643-5489-5, DM 58,–.

The book is the first part of a two-volume project of a textbook destined for the propaedeutic course of physics for undergraduate students of physics, mathematics, chemistry and engineering. The second volume will cover electrodynamics and thermodynamics. Its purpose—as stated in the preface—is to reflect the development of physics in the XXth century leading to a compelling importance of nuclear and particle physics, astrophysics, physics of condensed matter and materials science. The book is based on lectures delivered by the author at the ETH Zürich and is intended as a one year course (4 one-hour lessons, 2 hours of exercises weekly).

The content is divided into eight chapters. The introducing chapter is devoted to the motion of a material point (Newton laws including gravitation law, basic notions of impulse, torque, energy etc., various motions in the gravitational field as exercises). In the second chapter, the symmetry and invariance of physical laws and systems are treated (Galilei invariance, invariance with respect to Euclidean motions, parity invariance and its break down in weak interactions with a deep discussion). The third chapter contains the central part of mechanics, namely the consideration of systems of material points; it starts with two-body problems (the Kepler law revisited and corrected) and then transposes the notions and laws of the first chapter to systems of many material points. The results obtained are applied to the motion of a rigid body in Chapter 4 and to elasto-plastic bodies, gases, ideal and viscose fluids in Chapter 5. Thus the latter chapter contains much of continuum mechanics, *e.g.* equation of continuity, internal friction, Bernoulli and Hagen-Poisseuille laws, Navier-Stokes equations, turbulent and whirling flow *etc.* The following two chapters are devoted to periodic motions. In the former, the systems with a finite number of degrees of freedom are treated (damped oscillations, coupled systems, resonance and chaotic behaviour). The latter is a very detailed treatment of elastic waves including, in particular, production and transmission of sound waves in solid bodies, fluids and gases. Finally, the last chapter is—somewhat non-traditionally but in correspondence with the proclaimed goal of the textbook—a short comprehensive overview of the special theory of relativity. In four appendices, the fundamental notions of vector algebra, vector analysis and Fourier analysis are explained and moments of inertia of bodies of simple shape are calculated.

The style of the book is exquisitely didactic. The basic laws and rules are explained concisely, usually rigorously proved, sometimes the details are postponed to solved exercises. Then they are demonstrated on carefully selected—occasionally quite ingenious and complicated—*demonstration experiments* (there are nearly 50 of them) intended for presentation at the lectures and *numerous examples.* They all are carefully described, solved in detail and discussed. The fundamentals explained are further developed in 55 *solved exercises; some of them only verify or test the basic laws, others involve extending the theory.* An inseparable part of the book is formed by nearly 250 excellent figures covering the whole range of pictorial information—from simple sketches to schemes of complicated mechanical systems and their actions and to graphical presentation of intricate mathematical solutions.

The organization of the text ensures its flexibility when used as a textbook; the complicated examples and difficult exercises can be skirted in the basic course but they are shedding much light on the theory and will certainly be enjoyed by more curious students. Even if the last chapter is not intended for a standard course it represents an extra development as well as an antithesis to the Newtonian mechanics, which is the topic of the bulk of the book. Perhaps the only shortcoming is either missing or somewhat non-systematic bibliography scattered in the text.

To conclude, the book can be strongly recommended to undergraduate students of mechanics for its truly modern conception, instructive presentation and, most of all, for its excellent demonstration and examples. It can be expected that a pleasure from them will be shared by graduate students, too.

Ivan Saxl, Praha

A. Visintin: MODELS OF PHASE TRANSITIONS. Birkhäuser, Basel 1996, 336 pages, DM 138,–.

The present volume collects main results of Visintin's systematic effort to make the mathematics of phase transitions more transparent for mathematicians as well as for specialists in applied research. Starting from the classical Stefan problem and passing through more complex models involving undercooling and overheating phenomena, surface tension effects at different scales, nucleation and growth and mean curvature flow, the reader can discover step by step the relation between the underlying physical principles and the limits of their validity on the one hand and the corresponding rigorous mathematical hypotheses on the other. The first part of the book is devoted to a detailed survey of methods of solving basic types of nonlinear parabolic differential inclusions in the framework of Sobolev spaces. The analysis is based mainly on time discretization combined with monotonicity and compactness arguments and semigroup theory. The results are referred to in the second part, where the author explains in each concrete case the transition from the original physical issues to mathematical models. Necessary theoretical tools are summarized in the Appendix, including the concept of compactness by strict convexity developed recently by the author. A reader interested in phase transitions modeling with a solid background in partial differential equations will certainly enjoy this contribution to the discussion on mathematics in real world problems.

Pavel Krejčí, Praha

M. Matzeu, A. Vignoli (eds.): TOPOLOGICAL NONLINEAR ANALYSIS: DEGREE, SINGULARITY AND VARIATIONS; TOPOLOGICAL NONLINEAR ANALYSIS II: DEGREE, SINGULARITY AND VARIATIONS. Birkhäuser, Boston 1994 and 1997, 531 and 601 pages, SFR 178,– and 218,–.

Each of these two volumes represents a collection of papers giving a survey of some of the most significant results in the main streams of nonlinear analysis obtained by topological methods during the last three decades. The papers start with an historical introductory background of the different disciplines and conclude with an explanation of the most recent results. All authors are well-known top specialists and their personal points of view are reflected in the text giving a good picture of the present state of the topics under consideration. Perhaps the best way how to characterize briefly both books and to emphasize their high level is to give the list of the authors and titles of the contributions.

Part I: A. Ambrosetti, Variational Methods and Nonlinear Problems: Classical Results and Recent Advances; V. Benci, Introduction to Morse Theory: A New Approach; J. Damon, Applications of Singularity Theory to the Solutions of Nonlinear Equations; E. N. Dancer, Fixed Point Index Calculations and Applications; J. Ize, Topological Bifurcation; P. H. Rabinowitz, Critical Point Theory; C. Viterbo, Symplectic Topology.

Part II: G. Dell'Antonio, Classical Solutions for a Perturbed N-Body System; H. Brezis, Degree Theory: Old and New; P. T. Church and J. G. Timourian, Global Structure for Nonlinear Operators in Differential and Integral Equations I. Folds; P. T. Church and J. G. Timourian, Global Structure for Nonlinear Operators in Differential and Integral Equations II. Cusps; K. Geba, Degree for Gradient Equivariant Maps and Equivariant Conley Index; U. Mosco, Variations and Irregularities; B. Ruf, Singularity Theory and Bifurcation Phenomena in Differential Equations; C. A. Stuart, Bifurcation from the Essential Spectrum; P. P. Zabrejko, Rotation of Vector Fields: Definition, Basic Properties and Calculation.

Most of the material of both the first and the second part was presented by the authors at the Topological Analysis Workshop on Degree, Singularity and Variations in May 1993 and June 1995 at Villa Campitelli and Villa Tuscolana, respectively, Frascati, near Rome.

Milan Kučera, Praha

R. M. Kauffman: EIGENFUNCTION EXPANSIONS, OPERATOR ALGEBRAS AND RIEMANNIAN SYMMETRIC SPACES. Pitman Research Notes in Mathematics, vol. 355, Addison Wesley Longman, Harlow, 1996, 147 pp., £ 25.00, ISBN 0-582-27634-9.

The ultimate goal of this book is to provide a rigorous study of (bounded or differential) linear operators on a Riemannian symmetric space that commute with the group of isometries; however—more broadly—the book is, in fact, a systematic treatment of generalized eigenfunction expansions for families of commuting operators from the point of view of operator theory and operator algebras in particular. There are seven chapters of, more or less, decreasing length. The first chapter, occupying almost half of the book, contains an exhaustive exposition of the background material from differential geometry (Lie groups and symmetric spaces), functional analysis (locally convex topological vector spaces, von Neumann algebras, trace class and Hilbert-Schmidt operators, Montel and barrelled spaces, vector-valued integration) and PDE (differential expressions and operators); though sometimes perhaps too condensed for a comfortable reading, it definitely serves as a good guide for a non-expert and makes the book quite self-contained. The next three chapters constitute the heart of the book. A general framework is developed for simultaneous eigenprojection expansions of families of normal operators, parameterized by the maximal ideal space of a certain commutative von Neumann algebra. Replacing the maximal ideal space by the joint spectrum, also the more traditional expansions parameterized by points in the complex n-space are then obtained. In the last three chapters the exposition culminates by applying this apparatus to the study of von Neumann algebras of operators on a Riemannian symmetric space that commute with the identity component of the isometry group. Although some of the material can be found scattered in various sources, a concise monographic treatment like this has been lacking in the literature. The applications to Riemannian symmetric spaces are probably interesting only to specialists, but the general theory developed in this book, given the ubiquity of eigenfunction expansions in mathematics, will be of benefit for any analyst.

Miroslav Engliš, Praha

E. D. Bloch: A FIRST COURSE IN GEOMETRIC TOPOLOGY AND DIFFERENTIAL GEOMETRY. Birkhäuser, Boston 1997, xii+421 pages, ISBN 3-7643-3840-7, DM 118,–.

This is a very impressive textbook. It is centered around 2-dimensional surfaces which serve as objects for the basic study of topology and differential geometry. The book is really designed for a first course on the two subjects, and we must admit that the author managed the explanation with very limited technical means. Nevertheless he succeeded in incorporating quite a lot of interesting material. Evidently, he has a great experience in teaching the subjects and devoted maximal effort to the preparation of the text. When reading the book you can feel very strongly that he paid a great attention to the organization of the text and that he tried (very successfully) to make the reading really interesting. You will find in the book many exercises which are really well chosen and arise the interest of the reader. At the end hints for some of them are included. In the book there are also many comments connecting the explanation with more advanced results and also several pages containing suggestions for further study. I would say that in the category of basic textbooks on topology and differential geometry this book occupies a very high position.

Jiří Vanžura, Brno

G. Baker, A. Freire (eds.): NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS IN GEOMETRY AND PHYSICS. The 1995 Barret Lectures. Birkhäuser, Basel 1997, 168 pages, DM 68,–.

The book is the 29th volume of the series Progress in Nonlinear Differential Equations and Their Applications and contains four survey essays providing an up-to-date overview and an introduction to the research literature in the following areas: The Seiberg-Witten equations and their application to problems in four-dimensional topology. Nonlinear hyperbolic systems arising from classical relativistic field theories. Dynamics of vortices in the Ginzburg-Landau model of superconductivity. Wave maps, i.e. harmonic maps from Minkowski space-time to a Riemannian manifold.

The first essay New Directions in 4-Manifold Theory by R. Fintushel gives first a brief overview of Donaldson invariants and an introduction to the Seiberg-Witten equations and then deals with the recent proof of the "Immersed Thom conjecture" using the new invariants, and with very recent progress towards the so called "11/8 conjecture"—an attempt to characterize the indefinite integral quadratic forms which occur as intersection forms of smooth manifolds of dimension 4.

In the second essay On the Regularity of Classical Field Theories in Minkowski Space-Time $\mathbb{R}^{3+1}$ S. Klainerman analyzes break-down of solutions in finite time from smooth initial data, global existence of solutions, and the minimal regularity of the data required for well-posedness of the Cauchy problem. The main examples are wave maps, Yang-Mills equations and the Einstein field equations. In the third essay Static and Moving Vortices in Ginzburg-Landau Theories Fang-Hua Lin discusses the limiting behavior of vortex lines as the "Ginzburg-Landau parameter" approaches zero, in both static and time-dependent models. Finally the fourth essay Wave Maps by M. Struwe concentrates on the problem of blow-up, global existence and well-posedness in the energy class (in two space dimensions).

All the essays are on the topmost professional level and are highly recommended to researchers and especially to young specialists in mathematical physics, PDE, differential geometry and topology, because they illustrate brilliantly the recent tendency in the theory of nonlinear PDE, traced back to 1954 through the work of the physicists C. W. Yang and R. Mills, namely the realization that structures originally introduced in the context of mathematical models in theoretical physics may turn out to have important applications in topology and (differential) geometry.

Jaroslav Fuka, Praha

H. Kimura: CHAIN-SCATTERING APPROACH TO H^∞CONTROL. Systems & Control: Foundations & Applications, Birkhäuser, Boston 1997, x+246 pages, ISBN 0-8176-3787-7, DM 118,–.

Let us quote a few sentences from the author's Preface explaining the aim of the book in a very lucid way: " ... H^∞control became an established control technology to achieve desirable performances of control systems ... It is questionable, however, that theoretical implications of H^∞control are well understood by the majority of its users. It is true that H^∞control theory is harder to learn due to its intrinsic mathematical nature ... This book is a compilation of the author's recent work as an attempt to give a unified, systematic, and self-contained exposition of H^∞control theory based on the three key notions: *chain-scattering representation, conjugation*, and *J-lossless factorization*."

The reader is supposed to be acquainted with the linear systems theory only at an elementary level and, although full proofs are given, the exposition is careful so that it may be accessible to engineers. H. Kimura's textbook is a useful source of information for everybody who wants to learn this part of the modern control theory in a thorough manner.

Bohdan Maslowski, Praha

T. Ogden: ESSENTIAL WAVELETS FOR STATISTICAL APPLICATIONS AND DATA ANALYSIS. Birkhäuser, Boston 1997, xviii + 206 pages, ISBN 0-8176-3864-4, DM 78,–.

The aim of the book is to present an accessible introductory survey of new tools of wavelet analysis and how they can be applied to basic data analysis problems such as signal processing, image analysis, data compression, etc. The author shows how these problems can be solved by fast algorithms which are of a simple form. Solutions of many practical examples are presented.

Contents of the book is following: Preface, Prologue: Why Wavelets?, 1. Wavelets: A Brief Introduction, 2. Basic Smoothing Techniques, 3. Elementary Statistical Applications, 4. Wavelet Features and Examples, 5. Wavelet-based Diagnostics, 6. Some Practical Issues, 7. Other Applications 8. Data Adaptive Wavelet Thresholding, 9. Generalizations and Extensions.

The book is ideal for a broad audience including advanced undergraduate students and graduates. The only technical prerequisite is a basic knowledge of linear algebra, statistics and calculus. Also professionals in statistics, researchers and engineers who use methods of data analysis and their applications in statistics, will learn about new wavelet methods. Web site for the book: `http://www.birkhauser.com/books/isbn/0-8176-3864-4`

Michal Křížek, Praha

A. L. Skubachevskii: ELLIPTIC FUNCTIONAL DIFFERENTIAL EQUATIONS AND APPLICATIONS. Birkhäuser, Basel 1997, 302 pages, DM 178,–.

The book is devoted to the theory of boundary value problems for elliptic functional differential-difference equations. The properties of elliptic differential equations and elliptic differential-difference ones are very different. The smoothness of the generalized solutions can be violated in bounded domains for elliptic differential-difference equations and is preserved only in some subdomains. Also the symbol of a self-adjoint semibounded functional differential operator can change its sign.

The aim of this book is to describe for the first time the general results concerning solvability and spectrum of these problems, a priori estimates and smoothness of solutions.

The book consists of five chapters. In the first chapter the author demostrates the methods used in the book in the simplest one-dimensional case. The author considers the equations of the second order with boundary conditions containing only the values of the unknown function. Besides the properties of ordinary differential equations, he studies the connection between ordinary differential equations with non-local boundary conditions and boundary value problems for differential-difference equations. Further, he shows necessary and sufficient conditions providing the existence of a smooth solution and gives applications to control systems with delay.

In the second chapter he studies solvability, spectrum and smoothness of the generalized solution of the first boundary value problem for strongly elliptic differential-difference equations and applies these results to the investigation of elliptic differential equations with nonlocal conditions.

In the third chapter application is given to the mechanics of a deformable body. In Chapter 4 elliptic differential-difference equations with degeneration are investigated. Finally, in Chapter 5 nonlocal elliptic boundary value problems are studied. Besides many important problems, the theory of multidimensional diffusion processes is investigated and combining the results for nonlocal elliptic boundary value problems and boundary value problems for elliptic differential-difference equations, the autor establishes the existence of the Feller semigroup. The theory is illustrated by numerous figures and examples.

The book is suitable for graduate students and mathematicians with interests in functional differential equations and partial differential equations. It will also be useful to specialists in the fields of control theory, theory of diffusion processes and elasticity theory.

Šárka Matušů-Nečasová, Praha

C. Kubrusly: AN INTRODUCTION TO MODELS AND DECOMPOSITIONS IN OPERATOR THEORY. Birkhaüser, Basel 1997, 132 pages, DM 78,–.

The book is an introduction to the Hilbert space operator theory.

In the preliminaries and the first chapters the author treats in an elementary way basic concepts and results such as spectrum, operator topologies, projections, isometries, unilateral and bilateral shifts, spectral theorem for normal operators, similarity and quasisimilarity, invariant and hyperinvariant subspaces. This provides the necessary background to the main topics of the book: various versions of the Wold decomposition and the Sz.-Nagy-Foiaş model theory for contractions.

The approach is elementary and the book has been written mainly for graduate students. However, a number of comments illustrate connections with recent deep results and with the most important open problem of the operator theory—invariant subspace problem.

Vladimír Müller, Praha

Edmund Husserl (1859-1938), the founder of phenomenology, looked at problems of individuality in a systematic way. He purposely ignored any question that did not arise from our direct awareness of the world, what he called the â€˜world of lifeâ€™ (Lebenswelt): he was only concerned with our first-person experience.Â For all these thinkers our sudden coming into existence presents the question of what we are to become. Sartre claimed that in a search for personal identity we can escape neither personal responsibility, nor society: â€œHell is other people.â€Â Analytic philosophy also appears prominently in the thinking of Ludwig Wittgenstein (1889-1951), whose Tractatus Logico-Philosophicus (1922) says that the world is â€œthe totality of facts, not things.â€