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BOOK REVIEWS

G. Ferreyra, G. R. Goldstein, F. Neubrander (eds.): EVOLUTION EQUATIONS. International Conference in Baton Rouge, Louisiana, January 7–11, 1992, Marcel Dekker, Lecture Notes in Pure and Applied Mathematics vol. 168, New York, 1995, xx+437 pages, ISBN 0-8247-9287-4.

These Proceedings contain a collection of papers originating from the International Conference on Evolution Equations held in Luisiana, 1992.

A variety of topics, concernig both evolution and stationary systems are contained in the volume. Partial differential equations of elliptic, parabolic and hyperbolic types, mostly nonlinear, as well as functional differential equations, Volterra integral equations and reaction-diffusion systems are studied. The abstract theory and applications, control theory and mathematical physics are present. Papers reflecting advances in the theory of semigroups of operators and spectral theory are also included and qualitative properties of solutions as bifurcation, asymptotic behaviour, blow-up questions are discussed.

The book can serve as a source for research and applied mathematicians and graduate students in differential equations, control theory, semigroups of operators and spectral theory.

Hana Petzeltová, Praha

Hendrik van Maldeghem: GENERALIZED POLYGONS. Birkhäuser, Basel, 1998, xv + 429 pages, 35 Fig's, ISBN 3-7643-5864-5, DM 218,–.

The present monograph is the first book covering the topic as a whole. The results either scattered in the literature or not yet published are collected here, proved and treated in a unified manner. Also the relations to other fields—projective geometry, geometries associated with groups of Lie type of relative rank 2, Tits buildings (generalized polygons are their building bricks) and graph theory are explained and discussed.

The notion of a generalized polygon is only about forty years old (it dates officially from the 1959 paper of Jacques Tits in the appendix of which the term was introduced). It may be perhaps recalled here that the starting point of the theory is a generalization of certain incidence relations of classical polygons. In particular, the number of points (vertices) incident with a line (edge) and the number of lines incident with a line are allowed to be higher than 2 and if both the numbers are everywhere and mutually equal, say to $s+1$, they determine the order s of the polygon. Considering as an example a classical quadrangle, its fundamental incidence property is as follows: whenever a point x and a line L are non-incident there exists a unique point-line pair (y, M) such that $x\mathbf{I}M\mathbf{I}y\mathbf{I}L$, $\mathbf{I}$ is the incidence. Just this property is conserved also by the generalized quadrangle. There is only one such quadrangle of order 2: it has 15 vertices and 15 edges and contains as a subset a classical pentagon (this is a rule, namely that a classical $(n+1)$-gon is an obligatory subset of any generalized n-gon). A fancy symbolical drawing of it precedes the preface of the book.

The first three chapters serve as an introduction and contain various definitions of terms occurring in incidence geometry. Besides the basic geometrical approach used throughout the book also the coordination approach is described, relevant aspects of projective geometry and group theory are reviewed, the relations of generalized polygons to buildings are established and graph-theoretic definitions of generalized polygons based on the incidence graphs are recalled.

The next six chapters are linked rather horizontally and can be read independently; the properties of automorphism groups of classical and mixed polygons are investigated

(chapter 4), the Moufang condition is explained (chapter 5), recognition of polygons—in particular of the Moufang ones—is carried out (chapter 6), polarities, ovoids and spreads are introduced (chapter 7), projective properties of polygons are examined (chapter 8) and, finally, a topological counterpart of all the preceding chapters is sketched (chapter 9). Five appendices (eigenvalue technique, a detailed proof—due to J. Tits—of the famous Bruck and Kleinfeld theorem on non-associated alternative division rings, Tits diagrams for Moufang quadrangles, matrices of root elations of some Moufang polygons and famous open problems) together with the exhausting bibliography close the book.

The book is meant as an introduction to the topic for graduate students as well as for specialists in this and related fields and will be useful as a reference book, too. It should also serve as a complementary volume to the monograph of Payne and Thas, Finite Generalized Quadrangles (Longman, London, 1984). Consequently, the generalized hexagons and octagons are examined preferably (many theorems on generalized n-gons indicate that the more interesting values of n are 3, 4, 6, 8; the 3-gons are in fact the projective planes).

I close my report by a general recommendation of the book to all interested in the progress of contemporary geometry, which follows rather fascinating ways in the present case.

Ivan Saxl, Praha

M. G. Nadkarni: BASIC ERGODIC THEORY. Birkhäuser Advanced Texts, Birkhäuser, 1998, 160 pages, ISBN 3-7643-5816-5, DM 68,–.

In the book the basic topics of ergodic theory such as Poincaré recurrence lemma, induced automorphisms and Kakutani towers, compressibility and E. Hopf's theorem, the Ambrose representation of flows are treated at the descriptive set-theoretic level before their measure theoretic or topological versions are presented. In addition, topics centering around The Glimm-Effros theorem, rank of automorphism and Dye's theorem are discussed. Results and arguments are presented in a lucid way. The book offers a quick and nice way to get acquainted with the basic topics of abstract ergodic theory and their connection with the descriptive theory.

El Houcein EL Abdalaoui, Rouen

M. G. Nadkarni: SPECTRAL THEORY OF DYNAMICAL SYSTEMS. Birkhäuser Advanced Texts, Birkhäuser, 1998, 192 pages, ISBN 3-7634-5817-3, DM 88,–.

Spectral Theory of Dynamical Systems is the first book devoted exclusively to this subject, moving from the basic topics to the treatment of some recent results of current research. In fact, Chapter 4 introduces the notion of rank and presents Chacon's theorem on the multiplicity of the finite rank automorphisms, while Chapters 6 and 10 are devoted respectively to the theorem due to H. Helson and W. Parry and the theorem due to B. Host. In Chapter 15 the Riesz products are considered, and they are used to describe the spectral types and eigenvalues of rank one automorphisms. Moreover, Ornstein family of mixing rank one automorphisms is described with construction and proof. Results and underlying ideas are presented in a lucid way. It can be strongly recommended to everybody who wants to get acquainted with the spectral theory of dynamical systems.

El Houcein EL Abdalaoui, Rouen

J. Escher; G. Simonett (eds.): TOPICS IN NONLINEAR ANALYSIS. The Herbert Amann anniversary volume. Birkhäuser, Basel, 1998, 760 pages, sFr. 188,–.

This volume presents articles of distinguished mathematicians dedicated to the 60th birthday of H. Amann.

The scientific interests of Herbert Amann (degree theory, fixed point theory, elliptic boundary value problems, abstract evolution equations, etc.) are reflected in the contributions presented in 31 full size original mathematical papers.

The H. Amann volume will be surely of great interest for scientists working in the fields mentioned above.

Štefan Schwabik, Praha

S. Kaufmann: MATHEMATICA–KURZ UND BÜNDIG. Birkhäuser, Basel, 1998, 220 pages, sFr. 42,–.

This volume is a short and instructive introduction to the well known program package Mathematica.

In the introductory chapter some of the basic capabilities of Mathematica are presented. The second chapter describes the most commonly known front ends and the way how commands have to be given to the program for solving the most usual mathematical tasks.

Graphical possibilities of Mathematica and working with lists are presented in the third chapter. The last chapter gives an introduction to programming in Mathematica.

The book is accompanied by a CD-ROM containing essentially all the content of the printed version in the form of Mathematica notebooks. These are available via the MathReader for viewing or directly for users of the full version of the Mathematica package.

Štefan Schwabik, Praha

C. O. Christenson, W. L. Voxman: ASPECTS OF TOPOLOGY. BCS Associates, Moscow, Idaho, USA, 1998, ISBN 0-914351-07-9, hard cover, $ 75,–; ISBN 0-914351-08-7, soft cover, $ 48,–.

The texbook is an introduction to point set topology, supplemented with a large amount of interesting material illustrating the ideas on examples from low-dimensional topology and other areas of 'applied' topology, as plane topology, homotopy theory, manifolds and simplicial topology.

The book covers the standard course of point set topology, starting from the basic concepts of continuity, connectedness, compactness, metric, separation, etc. Let us mention also chapters devoted to properties of continua, paracompactness, metrizability and dimension. Attention is paid also to induced topologies, such as the product topology, topology of inverse systems of topological spaces and topology of function spaces. CW complexes are introduced in the chapter on quotient spaces.

As pointed out above, the text is seasoned by some topics deviating from the standard course. Plane topology is represented by Jordan Curve Theorem and Schönflies Theorem. A brief trip through homotopy theory comprises the fundamental group, its relation to covering spaces and lifting theorems. In the chapter on simplicial (or piecewise linear topology) approximation theorems are proved and the edge-path groupoid introduced. Attention is paid also to manifolds, including the Classification Theorem for compact 2-manifolds.

The book contains hundreds of examples and each chapter is appended with a problem section. We may recommend it as a gentle introduction to point set topology with a glance into other branches of topology.

Martin Markl, Praha

D. W. Stroock: A CONCISE INTRODUCTION TO INTEGRATION THEORY. Birkhäuser, Basel, 1998, 272 pages, sFr. 50,–.

The book is the third edition since 1990 of an advanced textbook devoted to integration. It is based on the lectures of the author on the topic at M.I.T.

The exposition starts with the classical theory of Riemann and Riemann-Stieltjes integration.

Lebesgue measure and Lebesgue integration are presented in the second and third chapters of the book.

Fubini's Theorem and products of measures are described in the fourth chapter while changes of variables including the basic knowledge on surface measures and the Divergence Theorem are the topic of the fifth chapter.

Jensen, Minkowski and Hölder inequalities, properties of Lebesgue spaces, convolutions and elements of Fourier analysis conclude the main part of the book.

Many exercises can be found in the book as well, and an extensive solution manual can be found at the end.

It has to be stated that Stroock's book is a very attractive textbook which presents the most needed topics from integration theory in a concise and complete form for students and teachers.

Štefan Schwabik, Praha

E. Garber: THE LANGUAGE OF PHYSICS. The Calculus and the Development of Theoretical Physics in Europe, 1750–1914. Birkhäuser, Basel, 1998, 424 pages, sFr. 118,–.

The book explains the development of modern physics from the first half of the eighteenth century up to 1870 with an epilogue till 1914.

Mathematics as a language for physicists is studied in detail in all aspects and the whole complexity of this interaction is analysed in the book.

The problem of mathematics vs. physical experiments is dealt with geographically (France, Germany and Britain) and in some basic periods of development of theoretical physics in the given time interval.

In the notes to the book the author and/or the editors say that this work "will cause some raised eyebrows" and that this is a "provocative work".

Maybe the book is provocative, the main point is that it presents clearly and explicitly a new opinion on the complex connections between mathematics and physics. Therefore the work of E. Garber will be interesting for historians of science and of course for physicists and mathematicians.

Štefan Schwabik, Praha

Hava T. Siegelmann: NEURAL NETWORKS AND ANALOG COMPUTATION: BEYOND THE TURING LIMIT. Birkhäuser, Boston, 1999, 200 pages, ISBN 3-7643-3949-7, price DM 98,–.

The topic of this book is the theoretical study of neural networks and their comparison with other models of computing. This is a modern area of research, and the book will find its readers among students and researchers in theoretical computer science.

Neural networks have been studied from several different viewpoints. One is directly motivated by biology and our knowledge of human brain cells; this line of research eventually leads to the concept (or rather various concepts) of neural networks as a highly idealized mathematical model of the "computation" performed in the brain. Another possibility is the experimental design and simulation of neural networks for various tasks, often using certain self-improvement properties; this line of research justifies the model, since it shows that non-trivial computational tasks can be performed and thus the model is not oversimplified. The last possibility is the theoretical, mathematical study of the models of neural computing, which compares them with other theoretical models of computing.

The book makes use of the last approach and studies in depth the relations of neural networks to traditional models of discrete computation, like Turing machines and Boolean circuits, as well as some less usual models of analog computation. The number of

models of computation covered is surprisingly large. Nevertheless, the book is a readable and concise treatment of the important issues in this area.

Jiří Sgall, Praha

William I. Gasarch, Georgia A. Martin: BOUNDED QUERIES IN RECURSION THEORY. Birkhäuser, Boston, 1999, 240 pages, ISBN 3-7643-3966-7, price DM 98,–.

The topic of this book is the theoretical study of complexity of functions (and sets) using the methods and concepts of recursion theory.

Traditional recursion theory studies hard functions (i.e., not computable), and compares their difficulty. This is done by the concept of oracle computations, which formalizes the intuitive question: *If I had a complete knowledge of this hard function, which other functions could I compute?* The starting point of the study of bounded queries is the question: *If I had a knowledge of some k values (of my choice) of this hard function, could I compute any single value of another hard function?* The resulting theory refines the results of classical recursion theory.

In modern complexity theory, the objects studied are generally not the hard functions studied in this book, but functions computable even with a limited amount of resources (such as time and space). The goal is then a very fine classification of their complexity. Even though the object of study is different, a significant part of current structural complexity uses methods motivated by the recursion theory and in this way it is connected with the topic of the book.

An extensive index is very helpful for orientation in this technically very advanced text. The last chapter is an annotated bibliography of recent research papers in the area, which is helpful for further reading.

The book is primarily aimed at specialists in the area of recursion theory, but it is self-contained and can serve as a valuable reference for graduate students and researchers in related areas, including other branches of logic and also structural complexity.

Jiří Sgall, Praha

Jean-Pierre Aubin: MUTATIONAL AND MORPHOLOGICAL ANALYSIS. Tools for Shape Evolution and Morphogenesis. Systems & Control: Foundations & Applications, Birkhäuser, 1999, 425+xxxvii pages, ISBN 3-7643-3935-7 (Basel), ISBN 0-8176-3935-7 (Boston), DM 178,–.

What will a mathematician find in the book the title of which evokes biology? Four hundred pages of mathematics.

Roughly speaking, the author deals with set-valued maps and adequate differential calculus on metric spaces tailored to the study of set and shape evolution.

The monograph is divided into four parts. The first part, Mutational Analysis in Metric Spaces, introduces abstract tools for studying set evolution. Above all, *transitions* on a metric space E. These are maps $\vartheta : [0,1] \times E \to E$ possessing a few special properties. A set $\Theta(E)$ of transitions together with the space E forms a *mutational space*. By means of transitions, a *mutation* of a simple-valued map from E to another metric space F is defined as a counterpart of the common directional derivative of maps between vector spaces. The mutation is a set-valued map and arises in *mutational equations*, the subject of Chapter 1.

Some results of non-linear analysis in vector spaces are adapted to mutational spaces in Chapter 2.

The second part, Morphological and Set-Valued Analysis, focuses on set-valued maps and comprises three chapters.

First, in Chapter 3, mutational structures (called *morphological spaces*) are designed on the space $\mathcal{K}(X)$ of nonempty compact subsets of a finite dimensional vector space X equipped with the Pompeiu-Hausdorff distance. Also, *morphological transitions* are defined there.

Morphological equations governing the evolution of a tube $t \rightsquigarrow K(t)$ under a dynamics f and various constraints are studied in the next chapter.

Shapes can be viewed as maps represented by their epigraphs or hypographs. By regarding set-valued maps as maps of graphs, it is possible to introduce *graphical convergence* and *graphical derivatives*. This idea is elaborated and graphical derivatives compared with mutational derivatives in Chapter 5.

The third part, Geometrical and Algebraic Morphology, adds some geometry and algebra to the already presented analysis restricted to finite dimensional vector spaces.

Projectors on a closed subset, derivatives of distance functions and projectors, dual characterization of derivatives and other topics are treated in Chapter 6 whereas, in Chapter 7, algebraic techniques characterizing mathematical morphology are connected with the general morphological concepts arising in set evolution.

The final part, Appendix, summarizes the basics of differential inclusions needed in the book.

Opening the book, the reader is attracted by Introduction where applications as, to give a few examples, viability problems, image processing, shape optimization or dynamic economic theory are presented, basic notions are introduced and the outline of the book is given. Also, all chapters begin with an introduction outlining the contents of subchapters. A beginner in the field would probably appreciate more explicit applications to get stronger motivation.

Extensive bibliography (472 items) is preceded by ten pages of bibliographical comments—a valuable guide for further study.

Treating topics which can hardly be labeled as standard or classical, the text is surprisingly self-contained and assumes only limited preliminary knowledge, though the reader cannot expect a bedtime reading.

The book is an extensive source of information and touches many more mathematical subjects than listed in this review. However, considering the large number of definitions, theorems and statements, the reader might find the index too brief. He or she might also lack a list of symbols.

In spite of these small imperfections, scientists and graduate students will find a lot of mathematical tools for studying problems dealing with evolution of sets, shapes or images here.

Jan Chleboun, Praha

D. Motreanu, N. Pavel: TANGENCY, FLOW INVARIANCE FOR DIFFERENTIAL EQUATIONS, AND OPTIMIZATION PROBLEMS. Marcel Dekker, New York, 1999, x + 479 pages.

Basic results on the flow-invariance of a closed set in a Banach space with respect to vector fields on this set are presented. Optimization problems are studied. Unifying effects in the theory of differential equations and optimization are pointed out. Various applications are presented.

The book is divided into seven chapters (Tangent vectors to closed sets, Flow-invariant sets, Second order differential equations and flow-invariance, Flow-invariant sets with respect to semilinear differential equations $y' = Ay + f(t, y)$, A transversality approach to

flow-invariance, Optimization and optimal control via tangential cones, Critical point theory on flow-invariant sets) and four appendices on nonlinear analysis, difference schemes and nonlinear semigroups, Banach manifolds and vector fields and generalized gradients.

Many of the results presented are new results of the authors. There is no doubt that the book of D. Motreanu and N. Pavel represents a nice contribution to flow-invariance in an abstract setting and that it will be an indispensable reference for specialists in the field.

Štefan Schwabik, Praha

Rita Meyer-Spasche: PATTERN FORMATION IN VISCOUS FLOWS. The Taylor-Couette problem and Rayleigh-Bénard convection. Birkhäuser, Basel, 1999, 224 pages, ISBN 3-7643-6047-X, sFr. 98,–.

It is well known that in general the dynamics of fluid flow can be very complicated with obvious consequences for analytical treatment. Nevertheless, there are configurations which allow simple flow patterns (e.g. stationary flows between parallel plates or between cylinders rotating with different angular speeds). Several of these problems compose the core of this book targeted to engineers, mathematicians and physicists (notice the alphabetical order) interested in fluid dynamics. In the first chapter several representative experiments are described physically and relevant mathematical models are introduced. Central role is played by the axisymmetric flow between two cylinders described by incompressible viscous Navier-Stokes equations in cylindrical coordinates. Chapter 2 gives details of numerical approach to this problem with the emphasis on convergence, stability and numerical accuracy of selected algorithms. Chapter 3 is devoted to stationary Taylor vortex flows. The stationary axisymmetric flow in a wide gap between concentric cylinders is studied as for what types of flows are allowed by Navier-Stokes equations describing the system in the highly nonlinear regime (i.e. for large Reynolds number), how many solutions exist for a given set of parameter values, what is the structure of solution branches as the Reynolds number and axial period vary, what bifurcations they undergo. In the last Chapter 4 the main attention is paid to the relation between the above mentioned problem of two cylinders (Taylor problem) and the so-called Rayleigh-Bénard problem. This last problem concerns the heat convection in the fluid in a layer where there is a difference between the temperature in the upper and lower parts of the fluid. Mathematical description is expressed by the so-called Boussinesq approximation neglecting less significant carefully formulated effects under reasonable physical hypotheses. It is pointed out that there is a general qualitative correspondence between the onset of Taylor vortex flows in narrow gaps between concentric cylinders on the one hand and the onset of convection rolls between horizontal planes on the other. This relationship is then studied in detail. In conclusion, the book provides a sufficiently general review on the Taylor problem and other connections that adequately integrates the results which were obtained by numerical methods.

Ivan Straškraba, Praha

L. A. Sakhnovich: SPECTRAL THEORY OF CANONICAL DIFFERENTIAL SYSTEMS METHOD OF OPERATOR IDENTITIES. Operator Theory: Advances and Applications, vol. 107, Birkhäuser, Basel, 1999, 208 pages, ISBN 3-7643-6057-7, DM 178,–.

The book studies the spectral theory of differential equations of the form $\mathrm{d}Y/\mathrm{d}x = \mathrm{i}zJH(x)Y$, where J and $H(x)$ are $2m \times 2m$ matrices, $J = \begin{pmatrix} 0 & I_m \\ I_m & 0 \end{pmatrix}$, $H(x) \geqslant 0$, and $Y(x)$ is a $2m \times 1$ column vector. The Sturm-Liouville equation, the equation of the vibrating nonhomogeneous string, and some Dirac-type equations, for instance, can be transformed

into this form. The highlight of the author's approach is the use of operator-theoretic and systems-theoretic methods. These are developed in the first part of the book and include various factorization methods for matrix-valued and operator-valued functions (Wiener-Hopf, Potapov type, and multiplicative integral representations) and notions from systems theory (transfer function realizations, nodes). This machinery is then applied to obtain a description of the so-called spectral matrix functions of the above system (the direct spectral problem), and, conversely, to construct a differential system having a prescribed spectral matrix function (the inverse spectral problem). Both problems are considered on finite intervals as well as on the half-line or the whole line, and also in the periodic case. Questions of uniqueness are then discussed, and several important concrete examples are dealt with in more detail. Finally, in the last chapter the results of the spectral theory are used to study some nonlinear PDE's: the nonlinear Schrödinger equation, the modified Korteweg-de Vries equation, and the sinh-Gordon equation. The book will be of interest to pure and applied mathematicians whose work involves spectral theory, differential equations and systems theory.

Miroslav Engliš, Praha

Giovanni Sambin, Jan M. Smith (eds.): TWENTY-FIVE YEARS OF CONSTRUCTIVE TYPE THEORY. Proceedings of a Congress Held in Venice, October 1995.

The proceedings contains fifteen papers presented at the meeting. Most of the papers are concerned with various aspects of Martin-Löf's type theory. Per Martin-Löf introduced this theory to provide a set theoretical foundations for constructive mathematics, hoping that the theory would play the same role in constructive mathematics as Zermelo-Fraenkel set theory plays in classical mathematics. The theory is based on principles different from ZF, namely, on the type theory, introduced by Bertrand Russell, and uses intuitionistic logic, instead of classical logic.

The papers range from very technical contributions to a survey type papers, such as de Bruijn's "Type-theoretical checking and philosophy of mathematics".

The proceedings contain one of the original papers written by Martin-Löf in 1972: "An intuitionistic theory of types". The proceeding is intended for experts in constructive mathematics. The others should rather read some modern treatment about this approach to foundations of constructive mathematics.

Pavel Pudlák, Praha