BOOK REVIEWS

Yoichi Miyaoka, Thomas Peternell: GEOMETRY OF HIGHER DIMENSIONAL ALGEBRAIC VARIETIES. DMV Seminar, vol. 26, Birkhäuser, Basel 1997, vi+217 pages, ISBN 3-7643-5490-9 (Basel), ISBN 0-8176-5490-9 (Boston), DM 44,–/ öS 321,–/sFr. 38,–.

This volume of the Seminars of the Deutsche Mathematiker Vereinigung devoted to the Mori theory is based on lecture notes of a DMV-seminar held at Oberwolfach from April 2 to 8, 1995. It consists of two parts. The first part Geometry of Rational Curves on Varieties was written by Y. Miyaoka, and the second part An Introduction to the Classification of Higherdimensional Complex Varieties by T. Peternell. The main aim of this volume is to give an introduction to the classification of complex algebraic varieties of dimension at least 3, and basically represents the whole minimal model program well known in the classification theory. The first part prefers algebraic methods and is devoted to deformation theory, existence and properties of rational curves on varieties. The second part is more analytic, and deals first of all with vanishing theorems. The starting point here is the Kodaira classification of smooth projective surfaces. The volume can be used as a very good introduction into this rapidly developing field. It contains also very recent results, and can be considered a good preparation for more advanced studies.

The presentation is very careful and clear. Always when proofs are omitted, you find necessary references. The reader is assumed to know the classical theory of curves and algebraic surfaces, and to have only a basic knowledge of schemes. Many special notions are explained in the text. For graduate students of algebraic geometry the volume will be surely very interesting.

Jiří Vanžura, Brno

W. Gautschi: NUMERICAL ANALYSIS: AN INTRODUCTION. Birkhäuser, Basel 1997, 506 pages, hardcover, ISBN 3-7643-3895-4 (Birkhäuser, Boston, ISBN 0-8176-3895-4), DM 118,–.

The textbook aims mainly at the numerical solution of ordinary differential equations and related topics. Numerical linear algebra is not included. Consequently, methods resulting in a system of algebraic equations are covered only marginally. Chapter 0 (Prologue), however, presents a survey of selected books on the topics omitted as numerical solution of partial differential and integral equations, constructive methods in optimization and complex analysis, numerical linear algebra, computational number theory, algebra and geometry, to give a few examples. Attention is also paid to the major sources of numerical analysis software.

The exposition starts up by Chapter 1, where machine numbers, machine arithmetic, error propagation as well as the numerical condition of problems and algorithms are dealt with.

Approximation of functions is studied in Chapter 2: least squares approximation, polynomial interpolation (e.g. Lagrange, Hermite, Chebyshev), and spline functions.

Numerical differentiation and integration are treated in Chapter 3: differentiation formulae, the trapezoidal and Simpson's rules, Newton-Cotes and Gauss formulae. Also included are approximation of linear functionals and Richardson extrapolation.

Basic methods for solving nonlinear equations are introduced in Chapter 4: bisection, Sturm sequences, the method of false position, the secant and Newton's method, fixed point iterations.

Chapter 5 focuses on one-step methods tailored to solve initial value problems for ordinary differential equations. Besides the introduction of the common Euler and Runge-Kutta methods, a more general concept of one-step methods is studied to address the questions of stability, convergence, error monitoring, step control, and stiffness of differential equations.

The next chapter is designed in a similar way but, contrary to its predecessor, it deals with multistep methods. As examples the Adams-Bashforth, Adams-Moulton, and predictor-corrector methods serve.

In the final part, Chapter 7, methods for solving two-point boundary value problems for ordinary differential equations are considered, namely, shooting, finite difference, and variational methods.

Each chapter is amended with extensive notes deepening the reader's insight into the preceding exposition, and, above all, including many pointers to literature for related and advanced study.

A significant feature of the book is a large collection of exercises and machine assignments (90 pages in total). Mostly, the former tends to the theory, and the latter to practical computing, i.e., the use of a computer and some software is required. Results and answers are not given unless they are included in the formulation of a task.

The reader will certainly appreciate numerous biographical footnotes on mathematicians whose names appear on the pages of the textbook.

The exposition is lucid and carefully written. The author does not present a flood of various numerical methods but chooses a few proper representatives and concentrates on the underlying theory. The reader is expected to have a background in calculus and some knowledge of linear algebra, complex analysis and ordinary differential equations.

The book is primarily intended for a graduate programme but it can be used in an undergraduate course too, e.g. Chapter 1–4 and some subsections of the others.

My final remark concerns the References section. It comprises approximately 500 items covering or at least touching all main areas of numerical analysis. Surprisingly, Ralston's *A First Course in Numerical Analysis* is missing. This seems curious because the design of the textbook under review has much in common with that classic.

Jan Chleboun, Praha

I. Grattan-Guinness, G. Bornet: GEORGE BOOLE – SELECTED MANUSCRIPTS ON LOGIC AND ITS PHILOSOPHY. Birkhäuser, Basel 1997, 305 pages, hardcover, ISBN 3-7643-5456-9, DM 58,–/ öS 424,–/ sFr. 48,–.

The book contains a number of Boole's manuscripts concerning logic and its philosophical foundations. Many of them are published for the first time, among them also some fragments and letters.

The comprehensive introduction offers a description of Boole's life, his scientific activities and also the fate of his manuscripts. From the present viewpoint it is surprising that in his time Boole was known more by his work in analysis than in logic or algebra.

While the book does not reprint Boole's books on logic that appeared during his lifetime, which is only natural, it does contain parts of his unfinished book *Philosophy of Logic*.

Antonín Sochor, Praha

M. A. Akivis, V. V. Goldberg: CONFORMAL DIFFERENTIAL GEOMETRY AND ITS GENERALIZATIONS. John Wiley and Sons, New York 1996, xiv+383 pages, USD 69,95.

The historical development of conformal differential geometry within the framework of classical geometry was analogous to the projective case. However, for certain specific reasons the conformal differential geometry became an independent branch of differential geometry much later than the projective one. So the book under review is the first monograph dealing systematically with the subject. Nevertheless, all contemporary directions in conformal differential geometry are reflected in the book. Special attention is paid to numerous relations to mathematical physics and to different kinds of applications.

The book starts with basic facts on conformal and pseudoconformal spaces and the moving frame method. In particular, the straight lines of the 3-dimensional projective space P_3 form a pseudoconformal space of signature 2. The second chapter presents a complete theory of hypersurfaces in a conformal space. This theory is essentially based on the use of the general concept of the geometrical object and the moving frame method. The next chapter deals with arbitrary submanifolds of a pseudoconformal space. Several relations to the line geometry in P_3 are studied. Chapter 4 discusses an 'abstract' conformal structure on a manifold and presents all standard relations to Riemannian geometry. Chapter 5 is devoted to various types of 4-dimensional pseudoconformal structures, which are important for many problems in mathematical physics. But even some webs can be effectively studied from such a viewpoint. Next it is clarified that the Grassmann manifolds are closely related to pseudoconformal spaces. This yields several interesting results about multiparameter families of linear subspaces in a projective space. The last chapter introduces the general concept of the almost Grassmann structure. This is first studied as a special second order G-structure. Then several applications to the web theory are discussed.

This book fulfils successfully all duties of a monograph. It is self-contained, carefully written and the material is well organized. Each chapter concludes with extended Notes, which point out the milestones in history and characterize the main sources of contemporary research in detail. The bibliography is very comprehensive (about 400 items). A specific feature of the book is that it makes accessible numerous results of the geometers from the former Soviet Union to the English reading audience. The book is intended for graduate students whose field is differential geometry and for researchers, including mathematical physicists. It is expected that this monograph will be a standard reference on conformal differential geometry and its applications for the next few years.

Ivan Kolář, Brno

Andrej Cherkaev, Robert Kohn (eds.): TOPICS IN THE MATHEMATICAL MODELLING OF COMPOSITE MATERIALS. Progress in Nonlinear Differential Equations and Their Applications, Vol. 31., Birkhäuser, Basel 1997, xiv+322 pages, 53 Figs., ISBN 3-7643-3662-5, DM 308,–.

The book si a collection of nine fundamental papers devoted to mathematical study of the macroscopic behaviour of microscopically heterogeneous materials. Beside the common topic, the unifying features of the papers are that they were written (in the period 1971–1987) either in French or in Russian and that they were rather inaccessible to the public as they appeared in conference proceedings or Russian journals or they circulated as reports or in a mimeographed version only. The increased interest in the topic revealed in the past two decades motivated the edition of their English translations in one volume. The translations were arranged either by the authors themselves or with cooperation from the authors. Moreover, several papers are accompanied by recent commentaries or at least by notes and further references. Introduction written by the editors includes, beside short commentary on the origin and content of the papers, also a commented list of more recent works covering the period 1979–1996.

Five papers of the French provenance are mutually connected by the names of F. Murat and L. Tartar and provide the mathematical framework for the analysis of composite materials, namely the methods of solving partial differential equations with highly oscillating coefficients. The main tool is the homogenization method consisting in finding very close (in weak topology) solutions of equations with rather smooth ('homogenized') coefficients. Consequently, the weak convergence is used as a general language for the discussion of macroscopic behaviour, optimal control theory is applied to structural optimization, deep links between the analysis of microstructure and the multidimensional calculus of variation are properly recognized.

Four Russian papers (one of them in the form of an Appendix) provide detailed applications of homogenization method to problems of optimal design and will certainly be highly appreciated by researchers in engineering and materials science; A. Cherkaev is the co-author of three of them.

Titles of a few included papers show perhaps in the best way the scope of the book: *Estimation of homogenized coefficients, H-convergence, Calculus of variation and homogenization, Design of composite plates of extremal rigidity, Effective characteristics of composite materials and the optimal design of structural elements.*

The editors believe that the selected collection of 'hidden papers' represents 'fundamental work, worth of reading and studying today'. As such, the book can be recommended to a wide scientific community including engineers, physicists and mathematicians and to researchers already working in the area as well as to those who wish to enter it.

Ivan Saxl, Praha

I. Csiszár, Gy. Michaletzky (eds.): STOCHASTIC DIFFERENTIAL AND DIFFERENCE EQUATIONS. Progress in Systems and Control Theory, Vol. 23, Birkhäuser, Boston 1997, xvii+353 pages, ISBN 0-8176-3971-3, DM 238,–.

These proceedings comprise twenty eight papers submitted by the participants of the Conference on Stochastic Differential and Difference Equations which, being a satellite event to the Vienna congress of the Bernoulli Society, took place in Győr, Hungary, in August 1996. Most of the papers are mere announcements of new results or the authors provide a short introduction to their results published elsewhere; several interesting full-length papers, however, are also included. Let us list in random a few of them to indicate the wide spectrum of problems addressed in the book. For example, H. Kunita in his paper investigates stochastic processes with independent increments on Lie groups; the contribution of I. Gyöngy is devoted to existence and uniqueness theorems for a class of semilinear stochastic parabolic equations (including the stochastic Burgers equation as a particular case); in the paper by M. E. Caballero, B. Fernández and D. Nualart a characterization of the topological support of the law of the solution to a stochastic differential equation with a random initial condition is found.

Jan Seidler, Praha

D. M. Salopek: AMERICAN PUT OPTIONS. Pitman Monographs and Surveys in Pure and Applied Mathematics 84, Longman, Harlow 1997, 116 pp., ISBN 0-582-31594-8.

American put option is a contract providing its holder with the right to sell an asset at any time prior to a prescribed time in the future (the expiry date) for a prescribed amount (the exercise price). The valuation of American options is more complicated than that of their European counterparts and leads to free boundary problems. The slim book by Donna Salopek aims at surveying the recent progress, both theoretical and computational, in treating pricing of the American put. In the first two chapters, the basic Black-Scholes model and S. Jacka's optimal stopping approach to the American put option are reviewed. The next chapter is devoted to several analytical approximations to the American put price, while the relevant numerical methods are dealt with in the final, fourth chapter.

The reader is assumed to have some knowledge of stochastic analysis and PDE's theory, which corresponds to the rather complex nature of the topic.

The book stemmed from author's MSc. Thesis, completed in the year 1994, so a short section listing post-1994 papers concerning the American put option was added to Chapter 4. Unfortunately, this amendment probably caused that the numbering of references in the text and in Bibliography does not agree now.

Bohdan Maslowski, Praha

J.-M. Souriau: STRUCTURE OF DYNAMICAL SYSTEMS, A SYMPLECTIC VIEW OF PHYSICS. Progress in Mathematics 149, Birkhäuser 1997, 432 pages, ISBN 0-8176-3695-1, ISBN 3-7643-3695-1, DM 188,–.

The book is a translation of the classical textbook 'Structures des Systémes Dynamiques', Paris, Dunod 1970.

It gives a self-contained introduction to dynamical systems based on the concept of the evolution space, which is a presymplectic manifold whose characteristic foliation describes the dynamics. The usual symplectic structure on the phase space is, in this approach, induced by a presymplectic structure of the evolution space.

The first two chapters of the book are devoted to the necessary background in differential geometry, symplectic geometry, variational calculus, and transformation groups.

Then the author introduces the 'geometric structure of classical mechanics'. He formulates the so-called Maxwell principle saying that the proper formulation of equations of motion must be such that the corresponding Lagrange form, defining the presymplectic structure on the evolution space, is closed.

This approach is applied to a symplectic formulation of classical mechanics, with the classification of (relativistic and nonrelativistic) elementary particles (with or without spin).

In the following chapter, after recalling the necessary facts from measure theory, a symplectic formulation of statistical mechanics is given, with special attention paid to the kinetic theory of gases.

The last chapter is devoted to a geometric quantization. The first step of this procedure, the pre-quantization, is provided by a certain presymplectic manifold foliated over the evolution space. In the second step, the standard attributes of a quantization as a Hilbert space with a certain system of operators is constructed out of this structure.

This kind of quantization is then applied to the elementary dynamical system (particles) and to 'ensembles' of those particles, which gives rise to the construction of the Fock space.

The book is addressed to students and researchers interested in symplectic geometry, mechanics and quantization.

Martin Markl, Praha

Christoph Hummel: GROMOV'S COMPACTNESS THEOREM FOR PSEUDO-HOLOMORPHIC CURVES. Progress in Mathematics 151, Birkhäuser, 1997, 136 pages, ISBN 3-7643-5735-5, ISBN 0-8176-5735-5, DM 58,–.

Recall that the M. Gromov's compactness theorem says, roughly speaking, that in any sequence of closed pseudo-holomorphic curves of bounded area, in a compact almost complex manifold with a Hermitian metric, there exists a subsequence converging to some cusp curve. The central aim of the book is to give a detailed, self-contained proof of this theorem.

After recalling, in Chapter I the necessary notions of differential geometry and topology, the author proves Gromov's Schwarz- and monotonicity lemma for J-holomorphic curves (Chapter II) and introduces the concept of convergence for J-holomorphic maps (Chapter III). Chapter IV is devoted to the classical structure theory for hyperbolic surfaces (pair of pants decomposition, thick-thin decomposition), in the extent necessary for the proof of the compactness theorem, which occupies Chapter V. The last chapter gives some applications of the theory to symplectic geometry. Namely, the proof of the famous Gromov's squeezing theorem is (up to analysis) given.

The book has two brief appendices, one containing a short proof of the classical isoperimetric equality, and the second introducing the C^k-convergence for maps between manifolds.

The book is addressed to students and researchers interested in complex and symplectic geometry. Reading the book requires only a basic familiarity with differential geometry and topology.

Martin Markl, Praha

E. E. Tyrtyshnikov: A BRIEF INTRODUCTION TO NUMERICAL ANALYSIS. Birkhäuser, Boston 1997, 214 pages, ISBN 3-7643-3916-0, DM 118,–.

This is a textbook remarkable from the viewpoint of its contents as well as the author's approach.

It covers, on a rather elementary level, all principal topics of numerical analysis except for differential equations. From the contents, let us mention prerequisites like norms, singular value decomposition, condition, floating-point arithmetic, and further subjects like triangular factorization, QR and other decompositions, polynomial and spline interpolation, function approximation and minimization, numerical integration, nonlinear equations, matrix iterative methods, and integral equations. The choice of material is not only 'classical'. It comprises also many very recent concepts.

The book is divided into 21 chapters, each of them subdivided into many short paragraphs of at most one page length. The contents of each paragraph are clear, compact, and easy to grasp. This is the intention of the author he claims in the preface. Every chapter is concluded with exercises to be solved.

This approach allows the author to explain the subject briefly and, at the same time, to show interconnections between virtually different concepts of numerical mathematics and, moreover, to point at open problems. The means for presenting such relations is usually linear algebra. On the other hand, this approach may be rather difficult for a complete beginner who might prefer larger blocks devoted to a single subject.

In any case, the book can serve as a very valuable source of exercises for advanced students. It stimulates the understanding of coherences in numerical analysis. Being quite original, the book by Tyrtyshnikov will certainly find its position among many other textbooks on the fundamentals of numerical analysis.

Karel Segeth, Praha

A. Lubotzky: DISCRETE GROUPS, EXPANDING GRAPHS AND INVARIANT MEASURES. Series Progress in Mathematics. Birkhäuser, 1994, 208 pages, DM 78,–.

The author reports on two difficult concrete problems. The first is the explicit construction of expanding graphs and the second the problem from measure theory posed about 70 years ago by Ruziewicz and studied by Banach, namely, whether the Lebesgue measure is the only finitely additive measure of total mass one, defined on the Lebesgue-measurable subsets of the n-dimensional sphere and invariant under all rotations. One wonders what these problems could have in common. Surprisingly much: both problems were recently solved by amazingly similar methods from representation theory and automorphic forms. The author presents the two problems from a unified point of view and shows that both solutions are two different aspects of the same phenomenon: for some concrete group G, its trivial one-dimensional representation is isolated from some subclass of irreducible unitary representations of G.

In the book, all the machinery of representation theory and analytic number theory (including recent deep results of Selberg, Deligne and Jacquet-Langlands) needed for the construction of such a group are explained in a form accessible to graduate students. The interplay between different branches of mathematics such as graph theory, measure theory, Riemannian geometry, discrete subgroups of Lie groups, representation theory and analytic number theory is really fascinating. A number of problems and suggestions for further research are presented.

Jaroslav Fuka, Praha

M. P. Brodmann, R. Y. Sharp: LOCAL COHOMOLOGY: AN ALGEBRAIC INTRODUCTION WITH GEOMETRIC APPLICATIONS. Cambridge University Press, Cambridge 1998, xv+416 pages, ISBN 0-521-37286-0.

The book is an introduction to Grothendieck's local cohomology theory with application to algebraic geometry and commutative algebra.

After recalling basic concepts of local cohomology functors, torsion modules and ideal transforms (Chapters 1 and 2), the authors proceed to the Mayer-Vietoris sequence and the Independence and Flat Base Change theorems for local cohomology (Chapters 3 and 4). An alternative approach based on the Čech and Koszul complexes is briefly explained in Chapter 5.

The next three chapters are devoted to various vanishing and non-vanishing theorems for local cohomology. The book continues, in Chapter 9, by Grothendieck's Finiteness and Annihilator theorems.

Chapters 10 and 11 are devoted to the duality. In Chapters 12 and 13, the definition and results are generalized and modified to graded rings, with an eye for applications in projective geometry. These applications are then studied in Chapter 14.

The following five chapters of the book deal with applications in geometry and commutative algebra (Castelnuovo regularity, Hilbert polynomials, connectivity in algebraic varieties). In the last chapter, relations to sheaf cohomology are discussed.

We believe that the following quotation from the author's introduction reflects well the spirit of the book: 'Our philosophy throughout has been to try to give a careful and accessible presentation of basic ideas and some important results, illustrating the ideas with examples, to bring the reader to the level of expertise where he or she can approach with some confidence recent research papers in local cohomology.'

Martin Markl, Praha