BOOK REVIEWS

Haakan Hedenmalm, Boris Korenblum and Kehe Zhu, *Theory of Bergman Spaces,* Graduate Texts in Mathematics Vol. 199, Springer-Verlag, New York Berlin Heidelberg, 2000, ix+286 pp., ISBN: 0-387-98791-6.

Along with Hardy spaces, Bergman spaces constitute the most important spaces of analytic functions. While the function theory and and operator theory connected with Hardy spaces (zeros, interpolation, invariant subspaces, Toeplitz and Hankel operators) were well understood fifteen years ago, the study of their close relatives, the Bergman spaces, turned to be much more difficult. Significant breakthroughs, both function theoretic and operator theoretic, were done in the 1990's, and the present book concentrates on these latest developments. Some of them not achieved the final form so that the reader is brought to the frontier of current research in the area. The exercise sections at the end of each chapter includes, beside routine problems which can be used as homework assignments, also nontrivial ones (with references) or even open problems.

The Bergman spaces were introduced by the Polish mathematician Stefan Bergman in his book *The kernel function and conformal mapping,* (a second revised edition was published by the American Mathematical Society in 1970). Let $\mathbb{D}$ be the unit disk in $\mathbb{C}$. For $-1 < \alpha < \infty$ and $0 < p \leq \infty$, the Bergman space $A^p_\alpha = A^p_\alpha(\mathbb{D})$ is the space of analytic functions in $L^p(\mathbb{D}, dA_\alpha)$, for $dA_\alpha = (\alpha+1)(1-|z|^2)dA(z)$, where $dA(z) = \pi^{-1}dxdy$ is the normalized Lebesgue measure on $\mathbb{D}$. One puts $A^p = A^p_0$. They are closed subspaces in L^p, so that A^p_α is a complete linear metric space for $0 < p < 1$, respectively a Banach space for $p \geq 1$. For $1 < p < \infty$ the duality relation $(A^p_\alpha)* = A^q_\alpha$, with $p^{-1} + q^{-1} = 1$, holds, while for $0 < p \leq 1$ the dual of A^p_α is the Bloch space $\mathcal{B}$, which plays in the theory of Bergman spaces the same role as does the space BMOA in the theory of Hardy spaces. The Bloch space can be identified with the space of all analytic functions on $\mathbb{D}$ which are Lipschitz with respect to the Bergman metric.

The analogue of the Poisson transform in the context of Bergman spaces is the Berezin transform, which leads to the definition of a space of BMO type on the disk, whose analytic part is the Bloch space. The fixed points of the Berezin transform are exactly the harmonic functions.

The study of invariant subspaces of Bergman spaces is one of the central topic of the book. In fact, the old famous open problem of the existence of nontrivial invariant subspaces in separable Hilbert spaces is equivalent to a question of existence of some special z-invariant subspaces in the Hilbert-Bergman space A^2, explaining the growing interest in the study of Bergman spaces. With every invariant subspace $I \subset A^p_\alpha$ one associates an extremal problem – find $G \in A^p_\alpha$ which solves the extremal problem $\sup\{\mathrm{Re} f^{(n)}(0) : f \in I, \|f\|_{p,\alpha} \le 1\}$. It turns that G must be an A^p_α-inner function. One proves the existence of invariant subspaces I of arbitrary finite index $n = \dim(I/zI)$.

Other important topics treated in the book are: interpolation and sampling, characterizations of zero sets in A^p_α, cyclicity. One doesn't know geometric characterizations of zero sets as well as characterizations of cyclic vectors in Bergman spaces.

The prerequisites for the reading of the book are elementary real, complex, and functional analysis, and some familiarity with Hardy spaces H^p.

The authors are well known specialists in the field, and the book incorporates a lot of their original results.

Introducing the reader to an area of investigation of major interest, situated at the intersection between complex and functional analysis, the book appeals to graduate students and new researchers in these fields.

Ştefan Cobzaş

Marián Fabian, Petr Habala, Petr Hájek, Vicente Montesinos Sanatalucia, Jan Pelant, Václav Zizler, *Functional Analysis and Infinite-Dimensional Geometry,* Canadian Mathematical Society (CMS) Books in Mathematics, Vol. 8, Springer-Verlag, New York Berlin Heidelberg, 2001, ix+451 pp., ISBN: 0-387-95219-5.

Banach spaces are the natural framework for many branches of mathematics as operator theory, nonlinear functional analysis, abstract analysis, optimization theory, probability theory. The last years were marked by an intense research activity in this area with spectacular discoveries solving old standing problems or leading to new area of investigation. In fact the interplay between theory and its applications is more dialectical – for instance, in the case of probability theory, Banach space theory furnishes powerful tools and far reaching generalizations for probability theory but, at the same time, a lot of deep results in Banach space theory are proved by probabilistic methods. The situation is the same with abstract analysis – the study of the differentiability of vector valued functions led from the beginning to the introduction of some geometric concepts in Banach space theory (smoothness, rotundity), and still continue to generate new important classes of Banach spaces as Radon-Nikodym spaces, Asplund spaces, etc. A good account on the current state of affairs in this field is given in the books of R. Deville, G. Godefroy and V. Zizler, *Smoothness and Renormings in Banach Spaces*, Pitman, New York 1993, and M. FÁbian, *Differentiability of Convex Functions and Topology– Weak Asplund Spaces,* J. Wiley&Sons, New York 1997.

The specific of the present book is that it brings the reader from the fundamental results of the theory and leads him/her to the frontier of current research. The book by P. Habala, P. Hájek and V. Zizler, *Introduction to Banach Spaces*, could be considered as a preliminary version , or a skeleton, of the book, but the present one is considerably revised, updated and completed.

The book is based on graduated courses taught at the University of Alberta in Edmonton in the years 1984-1997, were the principal part of the text was prepared. In fact, each author spent some time at this university.

The book is divided into twelve chapters headed as follows: 1. *Basic Concepts in Banach Spaces,* 2. *Hahn-Banach and Banach Open Mapping Theorems,* 3. *Weak*

Topologies, 4. *Locally Convex Spaces,* 5. *Structure of Banach Spaces,* 6. *Schauder Bases,* 7. *Compact Operators on Banach Spaces,* 8. *Differentiability of Norms, Uniform Convexity,* 10. *Smoothness and Structure,* 11. *Weakly Compactly Generated Banach Spaces,* 12. *Topics in Weak Topology.* By its organization, the book can be used as a textbook for various types of courses in functional analysis: undergraduate first (Chapters 1-3 and 7) or second (Chapters 4-6, 8 and 10), graduate two-semester (Chapters 1-9), one semester (Chapters 1-3, 5 and 6 or 7), or graduate advanced one-semester (Chapters 8-10, or 11 and 12).

Beside classical material, the book contains also some recent and more specialized results as smooth variational principles, Lipschitz and uniform classification of Banach spaces, Asplund and weak Asplund spaces, Borel and analytic structures in Banach spaces, including original results of the authors.

The book is fairly self-contained, the prerequisites being basic courses in real analysis and topology (at the level of, e.g., Royden's book on real analysis). To make the text more accessible, the authors included the proofs of many facts considered as folklore by the specialists but which may look not such obvious for the newcomer and difficult to find. The book contain a large number of exercises with detailed hints, completing the main text with many important results.

The book is a valuable contribution to Banach space literature and can be used as a solid introduction to functional analysis, smoothing the way to more specialized books or research papers.

Stefan Cobzaş

Frank Deutsch, *Best Approximation in Inner Product Spaces,* Canadian Mathematical Society (CMS) Books in Mathematics, Vol. 7, Springer-Verlag, New York Berlin Heidelberg, 2001, xv+337 pp, ISBN:0-387-98940-4.

The book is based on a graduate course on Best Approximation taught by the author for over than twenty five years at the Pennsylvania State University. The course was attended by various categories of students - engineers, computer scientists, statisticians and mathematicians - who did not own the basic facts of functional and real analysis (e.g. L^p-spaces), necessary for the treatment of the subject in the context of normed linear spaces. In order to save the time necessary for these prerequisites and to concentrate on best approximation problems, the author decided to restrict the exposition to the framework of inner product spaces. These are the closest to the Euclidean space, such that the intuition and drawings help the reader to better understand the origins and the motivation of many considered notions and tools, without any references to other sources (excepting some linear algebra and advanced calculus).

The main innovation of the author is to work with incomplete inner product spaces rather than with Hilbert ones. This approach involves some technicalities but one gains in generality. For instance, Riesz representation theorem for the dual of a Hilbert space X is not true for inner product spaces, but the author finds a generalized representation for a functional $x^* \in X^*$ by a sequence (x_n) in X such that $x^*(x) = \lim_n < y, x_n >,\ y \in X$, and $\|x^*\| = \lim_n \|x_n\|$. The sequence (x_n) is Cauchy so that, if X is complete, $x = \lim_n x_n$ represents the functional x^*, and one obtains the Riesz representation theorem. This result allows to obtain a proof of the Hahn-Banach extension theorem in the case of inner product spaces without appealing to the Axiom of Choice. The author shows that a functional $x^* \in X^*$ is represented by an element of X if and only if x^* attains its norm on the unit ball of X. The representable functionals are important tools in the study of proximinality of various subsets of inner product spaces - hyperplanes, half-spaces, polyhedral sets, cones - as well as in the characterizations of best approximation elements. This is done in Chapters 4, *Characterizations of best approximation,* and 6, *Bounded linear* *functionals and best approximation from hyperplanes and half-spaces*, which are largely based on original results of the author.

As applications, we mention the study of generalized solutions (least square method) of linear equations and of generalized inverses of matrices and linear operators. A new proof of Weierstrass approximation theorem is also obtained.

A special attention is paid to algorithms for best approximation treated in Ch. 9, *The method of alternating projections.* This one, and Chapters 10, *Constrained interpolation from a convex set,* and 11, *Interpolation and approximation,* incorporate again a lot of original results of the author.

The last chapter of the book, Ch. 12, *Convexity of Chebyshev sets*, is concerned with the still unsolved problem of convexity of Chebyshev sets in Hilbert space.

Each chapter ends with a set of exercises and very interesting historical notes.

Written by a well-known specialist in best approximation theory, the book contains a good treatment of best approximation in inner product spaces and can be used as a textbook for graduate courses or for self-study.

Stefan Cobzaş

Operator Theory and Analysis, The M. A. Kaashoek Anniversary Volume, H. Bart, I. Gohberg and A.C.M. Ran - Editors, Operator Theory, Advances and Applications, Vol. 122, Birkhäuser Verlag, Boston-Basel-Berlin 2001, xxxix + 425 pp., ISBN 3-7643-6499-8.

The present volume contains the proceedings of the workshop organized at the Vrije Universiteit Amsterdam on November 12-14, 1997, on the occasion of the sixtieth birthday of Marinus (Rien) Adrianus Kaashoek. Professor M.A. Kaashoek is one of the leading experts in operator theory and its applications (especially to electrical engineering), the founder and the head of the Analysis and Operator Theory Group in Amsterdam. He published 6 books and over than 140 papers, many in cooperation with I. Gohberg. The worksop was attended by 44 participants from all over the world which presented 21 plenary lectures followed by lively discussions. An opening address, written by I. Gohberg and red by S. Goldberg, presents the charming personality and the remarkable scientific achievements of Professor M. A.

Kaashoek. Some personal reminiscences are presented by three of his PhD students: H. Bart, A.C.M. Ran and H.J. Woerdman. A photo, a Curriculum Vitae and a list of publications of M.A. Kaashoek are also included.

Beside these addresses and biographical material, the volume contains 16 contributed papers covering a wide range of topics in functional analysis and operator theory, centered around domains where the ideas and results of M.A. Kaashoek played an important role: factorization of matrix valued functions, Nevanlinna-Pick interpolation theory, spectral theory, Toeplitz operators, Jordan chains. Among the contributors to the volume we mention: V. Adamyan, R. Mennicken, D. Alpay, A. Dijksma, Y. Peretz, D.Z. Arov, H. Dym, R.L. Ellis, I. Gohberg, B. Nagy, A.E. Frazho, P. Lancaster, A. Markus, H. Langer.

Bringing together important new contributions to operator theory and its applications, written by leading experts in the field, the volume will be of interest to a wide range of readers in pure and applied mathematics and engineering.

S. Cobzaş

Daniel Beltiţă and Mihai Şabac, *Lie Algebras of Bounded Operators*, Operator Theory, Advances and Applications, Vol. 120, Birkhäuser Verlag, Boston-Basel-Berlin 2001, viii + 217 pp., ISBN 3-7643-6404-1.

The importance in the theory of finite dimensional Lie algebras of the Jordan canonical structure of linear map acting on finite-dimensional vector spaces is well known and well understood. The aim of the present book is to study the infinite dimensional case, emphasizing the role played by bounded operators on Banach spaces in the study of infinite dimensional Lie algebras. In fact, there is an interaction between operator theory and Lie algebra theory, the last offering solutions to some long-standing questions in operator theory related to the construction of joint spectral theory for non-commuting tuples of operators. Although in the infinite dimensional case one cannot speak about a plane Jordan canonical structure, like in the case of matrices, there are some classes of operators (Dunford spectral, Foiaş decomposable, scalar generalized and Colojoară scalar generalized operators) which admit a kind of Jordan decomposition.

The first chapter of the book, I. *Preliminaries,* containing three sections: A. *Lie Algebras,* B. *Complexes*, C. *Spectral Theory*, surveys the basic of Lie algebra theory, Koszul complexes in Banach spaces, and spectral theory for bounded operators. In this part, the proofs of the results which can be found in already existing books are omitted, with exact references to the corresponding books.

The rest is devoted to the exposition of the main theme of the book: the interplay between Lie algebra theory and spectral theory of bounded operators. A good idea on the topics the authors are dealing with is given by the headings of the chapters: II. *The Commutators and Nilpotence Criteria*, III. *Infinite Dimensional Variants of Lie and Engel Theorems,* IV. *Spectral Theory for Solvable Lie Algebras of Operators,* V. *Semisimple Lie Algebras of Operators.*

Modulo some basic results on Lie algebras and spectral theory, the book is self-contained. Original results of the authors, some of them published for the first time, are included. A rich bibliography, counting 173 items and covering practically all that was published in the field up to the present book, is included at the end of the book.

Exposing in a clear and accessible manner deep results on the interplay between Lie algebra theory and spectral theory of bounded operators on Banach spaces, the book will appeal to researchers working in both of these two areas. It can be used also as a base text for advanced graduate or postgraduate courses.

S. Cobzaş

Robert E. Megginson, *An Introduction to Banach Space Theory*, Graduate Texts in Mathematics Vol. 183, Springer-Verlag, New York Berlin Heidelberg, 1998, xix+596 pp., ISBN: 0-387-98431-3.

Many books on Banach spaces as, e.g., M. Day, *Normed Linear Spaces*, 3rd Edition, Springer Verlag 1973, or J. Lindenstrauss and L. Tzafriri, *Classical Banach Spaces*, Vols. I(1977) and II(1979), also published by Springer Verlag, can be used by graduate students wishing to do research in Banach space theory, but can be too difficult for a student at his first contact with functional analysis. The aim of the present book is to provide this student with detailed proofs and a careful presentation of the fundamental results in Banach space theory. The only prerequisites for its reading are some measure theory and topology as presented, for instance, in W. Rudin's book *Real and Complex Analysis,* McGraw Hill 1987. Measure theory is used only for the applications of Banach space theory to the spaces L_p, and not as an essential tool in the development of the subject. Restricting to sequence spaces and treating only metric theory of Banach spaces, it is possible to use the book for an undergraduate course. Nets, which are extensively used in the study of weak topologies, are presented in detail in the first section of the second chapter. Appendix D is devoted to ultranets and Tihonov's compactness theorem. Other Appendices are A. *Prerequisites,* B. *Metric Spaces* and C. *The spaces* ℓ_p *and* ℓ_p^n.

The book contains five chapters and four appendices, as presented above. Ch. 1, *Basic concepts*, includes norms, linear operators, Baire category and three fundamental theorems, quotients, direct sums, Hahn-Banach theorem, dual spaces and reflexivity. Ch. 2, *The weak and weak* topologies*, contains some results on topology, topological vector spaces and locally convex spaces needed for the study on weak and weak* topologies on Banach spaces (including weak compactness and James' theorem, extreme points and Krein-Milman's theorem, support points, support functionals and Bishop-Phelps subreflexivity theorem). Ch. 3, *Linear operators,* is concerned with linear operators and their adjoints, compact and weakly compact operators (including Schauder and Gantmacher theorems and Riesz' theory). Ch. 4, *Schauder bases*, contains some basic results on Schauder bases in Banach spaces. The last section of this chapter is devoted to a presentation of James space J. The last chapter of the book, Ch. 5, *Rotundity and smoothness*, presents some results from the geometry of banach spaces – rotundity, uniform rotundity and generalizations, smoothness, uniform smoothness and generalizations.

Each section is followed by a set of exercises completing the main text. A lot of historical notes and comments are spread through the book, mentioning the original sources or tracing the development of the ideas. The bibliography at the end of the book counts 249 items.

The result is an excellent book on the basics of Banach spaces, which can be warmly recommended as a textbook for the introduction to the subject.

Stefan Cobzaş

Theodore W. Gamelin, *Complex Analysis*, Springer New York, Berlin, Heidelberg, 2001, 478 pp., ISBN 0-387-95069-9.

This is a beautiful book which provides a very good introduction to complex analysis for students with some familiarity with complex numbers. It is based on lectures given over the years by the author at several places, particularly the Interuniversity Summer School at Perugia (Italy) (the present reviewer was one of those students that took his wonderful course in Perugia in 1992), also UCLA, Brown University, Valencia (Spain), and La Plata (Argentina). The book consists of three parts. The first part includes Chapters I-VII. It presents a basic material about the complex plane and elementary functions, analytic functions, line integrals and harmonic functions, complex integration and analyticity, power series, Laurent series and isolated singularities, and the residue calculus.

The second part contains chapters VIII-XI and includes certain special topics such as the logarithmic integral (the argument principle, Rouché's theorem, Hurwitz's theorem, etc), the Schwarz lemma and hyperbolic geometry, harmonic functions and the reflection principle, and conformal mappings (the Riemann Mapping Theorem, the Schwarz-Christoffel formula, compactness of families of functions, etc).

The third part contains chapters XII-XVI. This part consists of a careful selection of several topics which certainly serve to complete the coverage of all background necessary for passing PhD qualifying exams in complex analysis, such as compact families of meromorphic functions, approximation theorems, some special functions (the Gamma function, Laplace transform, the Zeta function, Dirichlet series), the Dirichlet problem and Riemann surfaces.

The book is clearly written, with rigorous proofs, in a pleasant and accessible style. It is warmly recommended to students and all researchers in complex analysis.

Gabriela Kohr

Approaches to Singular Analysis, Juan Gil, Daniel Grieser, Matthias Lesch - Editors, Operator Theory, Advances and Applications, Vol. 125, Subseries "Advances in Partial Differential Equations", Birkhäuser Verlag, Boston-Basel-Berlin 2001, vi + 256 pp., ISBN 3-7643-6518-8.

The book is based on the workshop "Approaches to Singular Analysis", held at the Humboldt University Berlin in April 8-10, 1999, and contains articles by the participants at the workshop as well as some invited contributions. The aim of the workshop was to bring together young mathematicians interested in partial differential equations on singular configurations. Two main approaches to these problems can be emphasized: (1) the pseudodifferential approach, meaning to set up a pseudodifferential calculus adapted to the underlying configuration (the schools of R. Melrose at MIT, of B.-W. Schulze at Potsdam, and the results of B.A. Plamenevski and his coworkers), and (2) the direct approach, meaning the analysis of the geometric differential operators (Dirac, Laplace, etc.) in specific situations (there is a vast literature on these topics as, e.g., the papers by Brüning and Seeley, Cheeger, Lesch, Müller, a.o.).

There are included 5 papers by the participants and 3 invited contributions. The contributed papers deal with Boutet de Monvel's calculus for pseudodifferential operators (E. Schrohe, pp. 85-116), the b-calculus (D. Grieser, pp. 30-84),completed by a paper by R. Lauter and J. Seiler on a comparison between cone algebra nad b-calculus (pp. 117-130). A paper by J. Seiler (pp. 1-29) is dealing with cone algebra and kernel characterization of Green operators, and one by D. Grieser and M. Gruber with singular asymtotics (pp. 117-130).

The three invited papers are by B.-W. Schulze on operator algebras with symbol hierarchies on manifolds with singularities (pp. 167-207), J. Brüning on the resolvent expansion on singular spaces (pp. 208-233), and the last by B. Fedosov, B.-W. Schulze and N. Tarkhanov on general index formula on toric manifolds with conucal points (pp. 234-256).

Bringing together important contributions in the field of partial differential and pseudodifferential operators, this collection of papers will be of interest for researchers and scholars working in this area, as well as for those interested in applications to mathematical physics.

Radu Precup

Problems and Methods in Mathematical Physics - The Siegfried Prössdorf Memorial Volume, J. Elschner, I. Gohberg and B. Silbermann - Editors, Operator Theory, Advances and Applications, Vol. 121, Birkhäuser Verlag, Boston-Basel-Berlin 2001, viii+523 pp., ISBN 3-7643-6477-7.

In the Spring of 1997 preparations had begun for a conference in honor of Siegfried Prössdorf's 60th birthday, but his sudden and untimely death stopped for a while these plans. Nevertheless, many of his friends and colleagues decided that the conference, the 11th TMP, be organized and dedicated to honor the life and work of S. Prössdorf. The Conference took place in Chemnitz, Germany, from March 25 to 28, 1999, and the present volume contains its proceedings. The volume starts with three contributions, by Bernd Silbermann, V. Maz'ya and Jürgen Sprenkels, evoking the life and the charming personality of S. Prössdorf as well as his outstanding contributions to integral and pseudodifferential equations, numerical analysis, operator theory, boundary value problems, boundary element and approximation theory. The lists of Prössdorf's publications (134 papers and 6 books) and of dissertations conducted by him are also included.

Beside these three papers, the volume contains 24 original papers, most written by friends an coworkers of S. Prössdorf, dealing with topics which were close to the broad spectrum of his scientific preoccupations. There is a joint paper by S. Prössdorf and M. Yamamoto, started during Yamamoto's visit in September 1997 at the Weierstrass Institut für Angewandte Analysis und Stochastik in Berlin, and finished by Yamamoto alone.

Containing important contributions to integral and pseudodifferential equations, boundary value problems, operator theory and applications in physics and engineering, the volume is addressed to a wide audience in the mathematical and engineering science.

Paul Szilágyi

Karlheinz Gröchenig, *Foundations of Time-Frequency Analysis,* Applied and Numerical Harmonic Analysis, Birkhäuser Verlag, Boston-Basel-Berlin 2001, xv+359 pp, ISBN 3-7643-4022-3 and 0-8176-4022-3.

Time-frequency analysis is a form of local Fourier analysis that treats time and frequency simultaneously and symmetrically. Classical Fourier analysis employs two complementary representations to describe functions - the function f and its Fourier transform $\hat{f}$. The study of the relations between f and $\hat{f}$ is governed by two principles: (1) the smoothness-and-decay principle (if f is smooth then $\hat{f}$ decays quickly, and if f decays quickly then $\hat{f}$ is smooth), and (2) the uncertainty principle (f and $\hat{f}$ cannot be simultaneously small). In applications, for instance, the variable $x \in \mathbb{R}$ may signify "time" and $f(x)$ is the amplitude or electric field , while the Fourier transform $\hat{f}(\omega)$ is understood as the amplitude of the frequency ω.

Time-frequency analysis has its roots in the early development of quantum mechanics by H. Weyl, E. Wigner and J. von Neumann around 1930, and in the theoretical foundation of information theory by D. Gabor in 1946. Time-frequency analysis as an independent mathematical field was established by A.J.E.M Janssen around 1980. Its characteristic features consist in the richness and beauty of the involved mathematical structures and applications, ranging from the theory of short-time Fourier transform and classical results about the Wigner distribution, via the recent theory of Gabor frames, to quantitative methods in time-frequency analysis and the theory of pseudodifferential operators.

Although its contents is intimately related to applications in signal analysis and quantum mechanics, the book, written by a mathematician, is primarily devoted to mathematicians, its aim being a detailed mathematical investigation of the rich and elegant structures underlying time-frequency analysis. It is also accessible to engineers and physicists with a more theoretical orientation. The book is written at an introductory level, with detailed calculations whenever necessary, the main prerequisites being a solid course in analysis and some Hilbert space theory.

The book starts with an introductory chapter containing an exposition (without proofs) of the basic principles of Fourier analysis. Other necessary results, from functional analysis and Lebesgue integration, are mentioned in an Appendix at the end of the book. The mathematical theory of time-frequency analysis is developed in the rest of the chapters: 2. *Time-frequency analysis and the uncertainty principle* , 3.*The short-time Fourier transform,* 4. *Quadratic time-frequency representations,* 5. *Discrete time-frequency representations: Gabor frames,* 6. *Existence of Gabor frames,* 7. *The structure of Gabor frames,* 8. *Zak transform methods,* 9. *The Heisenberg group: A different point of view,* 10. *Wavelet tranforms,* 11. *Modulation spaces,* 12. *Gabor analysis of modulation spaces,* 13. *Window design and Wigner's lemma,* 14. *Pseudodifferential operators.*

Supplying a unified and systematic introduction to the mathematical foundations of time-frequency analysis and emphasizing the interdiscliplinary aspects of the subject, the book is of great interest for mathematicians, physicists, engineers in signal and image analysis, researchers and professionals in wavelet and mathematical signal analysis. By the detailed and careful presentation of the subject, the book can be used by graduate students too.

Damian Trif