Daniel Alpay and Victor Vinnikov (Editors), *System Theory, the Schur Algorithm and Multidimensional Analysis*. Operator Theory: Advances and Applications 176, Birkhäuser Verlag, Basel, 2007, ix + 322 pp., ISBN 978-3-7643-8136-3.

This book originates in the workshop "Operator Theory, System Theory and Scattering Theory: Multidimensional Generalizations and Related Topics, 2005" held at the Ben-Gurion University of the Negev. The main topics covered by the six paper in this volume are Schur analysis, quaternionic analysis, multidimensional operator theory, and moment problems.

The article *The transformation of Issai Schur and related topics in an indefinite setting* by D. Alpay, A. Dijksma and H. Langer is a 98-page review paper devoted to the authors recent work on the Schur transformation for generalized Schur and Nevanlinna functions. The second paper, *A truncated matrix moment problem on a finite interval. The case of an odd number of prescribed moments*, by A. Choque Rivero, Y. Dyukarev, B. Fritzsche, and B. Kirstein, takes up the problem referred to in the title by means of the system of fundamental matrix inequalities in the sense of V.P. Potapov. There follows the paper *On the irreducibility of a class of homogeneous operators* by G. Misra and S. Shyam Roy. In this paper one uses the jet construction for Hilbert modules in order to construct a class of homogeneous irreducible Hilbert modules over the disk algebra, which belong to the Cowen-Douglas class and are mutually inequivalent.

The fourth paper *Canonical forms for symmetric and skewsymmetric quaternionic matrix pencils*, is authored by L. Rodman. Besides the description of these canonical forms, one also indicates some of their applications involving symmetry with respect to quaternion-valued inner products, numerical ranges and numerical cones. The next paper, *Algorithms to solve hierarchically semi-separable systems*, by Z. Sheng, P. Dewilde, and S. Chandrasekaran, includes a discussion of an important class of structured matrices that define linear systems which can be solved with a complexity depending linearly on the corresponding matrix size. The last paper, *Unbounded normal algebras and spaces of fractions*, by F.-H. Vasilescu, is devoted to an investigation of families of unbounded normal operators which commute in a strong sense. It is motivated by the circle of ideas related to moment problems. It should be noted that this paper includes a representation theorem for algebras of unbounded normal operators similar to the characterization of commutative C^*-algebras, as well as an extension theorem for infinite subnormal families of unbounded operators.

All the contributors to this volume are well-known experts working in the respective areas. The book under review will certainly appeal to a wide audience interested in learning about very active directions of research ranging from linear algebra and operator theory to complex analysis.

Daniel Beltiţă

H. Amman, and J. Escher, *Analysis* II, Birkhäuser-Verlag, Basel, 2008, xii + 400 pp., ISBN 978-3-7643-7472-3.

This is the second volume of the English translation of the second edition of the Analysis course written by Herbert Amman and Joachim Escher, originally published in German by Birkhäuser in 1999. This volume contains three chapters: integral calculus in one variable (Chapter VI), multivariable differential calculus (Chapter VII) and line integrals (Chapter VIII), whose contents we shortly present below.

Chapter VI. First of all, the Cauchy-Riemann integral is defined as a continuous linear extension of the integral of staircase functions. Methods for computing integrals, based on the first fundamental theorem of calculus (Leibniz-Newton formula) are then exposed. The link between sums and integrals is thoroughly studied. The last three sections of the chapter are devoted to an important application of the one dimensional integral calculus, namely, the Fourier series, to a generalization of Cauchy-Riemann integral, namely, the improper integral, and to two of the most important improper integrals, Euler's Gamma and Beta functions.

Chapter VII. The chapter starts with a section on continuous linear maps between Banach spaces and on linear differential equations. The differential of a function that depends on several variables is next introduced as a linear map between Banach spaces. Differentiability criteria and rules for computing differentials are presented. One also defines higher order differentials and one gives their main application, Taylor's formula and a sufficient criterion for local extrema. In this chapter are also proved the main theorems of differential calculus, the inverse function theorem and the implicit function theorem. The latter is used in the study of manifolds embedded in $\mathbb{R}^n$ and of constrained extrema of functions. The chapter also contains a section devoted to Nemytskii operators and the calculus of variations.

Chapter VIII could also be called Line integrals and holomorphic functions since not only line integrals are studied here, but also important theorems on line integrals and holomorphic functions are proved in the second half of this chapter. In the first two sections, the rigorous definition of curves is given and the main characteristics of a curve, curvature and torsion, are defined and studied. Next, important results on line integrals are proved: the Poincaré lemma, the fundamental theorem on line integrals, and the homotopy invariance of line integrals. As we already mentioned, the second half of Chapter VIII can be viewed as a short and comprehensive introduction to complex analysis. The Cauchy integral theorem and formula and the residue theorem are the main results on holomorphic and meromorphic functions proved in this part.

Each chapter contains representative examples and each section ends with a list of proposed exercises. The aim of these exercises is to go deeper into the understanding of the notions and results of that section. Let us finally mention the accurate style and the enlightening comments.

Taking all these into consideration, we warmly recommend this book to both teachers and students. It will help the teachers to improve their courses and the students to better understand what mathematical analysis as well as its relationships with other domains of mathematics: differential equations, differential geometry, and complex analysis.

Mihai Pascu

Goulnara N. Arzhantseva, Laurent Bartholdi, José Burillo, and Enric Ventura (Editors), *Geometric Group Theory: Geneva and Barcelona Conferences*, Trends in Mathematics, Birkhäuser-Verlag, Basel, 2007, 253 pp., ISBN 978-3-7643-8411-1.

In the postface of this book we read: "This volume assembles research papers in geometric and combinatorial group theory. This wide area may be defined as the study of those groups that are defined by their action on a combinatorial or geometric object, in the spirit of Klein's program."

The book is a selection of twelve refereed articles contributed by participants of two related international conferences: *Asymptotic and Probabilistic Methods in Geometric Group Theory* (University of Geneva, June 20th to 25th, 2005) and *Barcelona Conference in Group Theory* (Centre de Recerca Matemàtica in Barcelona, June 28th to July 2nd, 2005).

The book should appeal to researchers in geometric group theory, but also to mathematicians and graduate students who are looking for a direct introduction to active themes of research in this field.

The first article is *Totally disconnected, locally compact groups as geometric objects. A survey of work in progress* by Udo Baumgartner. Such groups usually arise as automorphism groups of discrete geometric objects, as connected, locally finite simplicial complexes. The purpose of the paper is to understand in a geometric context recent contributions to the study of the structure theory of such groups. Let G be a totally disconnected, locally compact group. The departure point of the paper is the introduction of a metric space $\mathcal{B}(G)$ with an isometric action by the group of automorphisms of G. The set of points of $\mathcal{B}(G)$ is made by all compact open subgroups of G. After the definition of a discrete version of a geodesic ray, with each automorphism α of G is associated a geodesic ray in the metric space $\mathcal{B}(G)$, which is the orbit of a compact open group O under iterations of α. Such groups O are called tidy subgroups of G. Further, flat subgroups $\mathcal{H}$ of $\mathrm{Aut}(G)$ are those for which there is a subgroup of G which is tidy for any element of $\mathcal{H}$. The paper continues with a description of various results which relate the algebraic properties of flat subgroups of automorphisms with geometric properties of geodesic rays in the metric space $\mathcal{B}(G)$. We find applications to isometric actions of totally disconnected, locally compact groups on CAT(0) spaces, topological Kac-Moody groups, and contraction groups.

The second article is *Computational explorations in Thompson's group F* by José Burillo, Sean Cleary and Bert Wiest. From its abstract: "Here we describe the results of some computational explorations in Thompson's group F. We describe experiments to estimate the cogrowth of F with respect of its standard finite generating set, designed to address the subtle and difficult question whether or not Thompson's group is amenable." The paper contributes empirical evidence for the most famous open problem concerning Thompson's group. The article is interesting to read at least for understanding how one can explore very abstract mathematical problems by large computer simulations.

The third article is *On the surjunctivity of Artinian linear cellular automata over residually finite groups* by Tullio Ceccherini-Silberstein and Michel Coornaert. From its abstract: "Let M be an Artinian left module over a ring R and let G be a residually finite group. We prove that every injective R-linear cellular automaton $\tau : M^G \to M^G$ is surjective." In symbolic dynamics, cellular automata are morphisms in the category $\mathcal{C}_G$ of G-sets. Generally, an object X in a category $\mathcal{C}$ is incompressible if every endomorphism f of X is surjunctive, that is, f injective implies f surjective. The main result here is an extension of Lawton's surjunctivity theorem.

The fourth article is *Some residually finite groups satisfying laws* by Yves de Cornulier and Avinoam Mann. Its abstract describes precisely the contents: "We give an example of

a residually p-finitely generated group, that satisfies a non-trivial group law, but is not virtually solvable." It follows from the Tits Alternative that if a finitely generated linear group satisfies a nontrivial group law, then it is virtually solvable. The example given in the paper shows that it is not possible to replace linearity by residual finiteness. (Another article dedicated to examples is *"Classifying spaces for wallpaper groups"* by Ramón J. Flores. The main part of the paper deals with the computation of the $B\mathbb{Z}/p$-nullification of the classifying spaces of the seventeen wallpaper groups.)

The sixth article is *A general construction of JSJ decompositions* by Vincent Guirardel and Gilbert Levitt. From its introduction: "JSJ theory has its roots in the work of Jaco-Shalen and Johannson on 3-manifolds. ... Roughly speaking, the main purpose of a JSJ decomposition is to describe all splittings of a given group G over a certain class $\mathcal{A}$ of subgroups." The seventh article is *Décompositions de groupes par produit direct et groupes de Coxeter* by Yves de Cornulier and Pierre de la Harpe, (with an abridged English version at the end of the paper). From its abstract: "We provide examples of groups which are indecomposable by direct product and, more generally, which are uniquely decomposable as direct products of indecomposable groups. Examples include Coxeter groups, for which we give an alternative approach to recent results of L. Paris. For a finitely generated linear group Γ can be the direct product. If, moreover, Γ has a finite centre or a finite abelianization, then it is uniquely decomposable as a direct product of indecomposable groups."

Next article is *Limit groups of equationally Noetherian groups* by Abderezak Ould Houcine. From its introduction: "The purpose of this paper is to see that some known properties of limit groups of free groups or of a torsion-free hyperbolic group can be seen as consequences of the fact that such groups are equationally Noetherian."

This article is followed by a pair of papers by Arye Juhász covering more than a quarter of the book: *Solution of the conjugacy problem and malnormality of subgroups in certain relative small cancellation group presentations and Solution of the membership problem for magnus subgroups in certain one-relator free products.* From the introduction of the first paper by Juhász: "The three fundamental decision problems posed by Max Dehn in 1912 are the word problem, the conjugacy problem and the isomorphism problem. Let G be a group and let u and v be elements of G. The word problem asks for an algorithm for deciding whether $u = v$. The conjugacy problem asks about the existence of an element $g \in G$ which conjugates u to v, i.e., $v = g^{-1}ug$. A solution of the conjugacy problem clearly contains a solution of the word problem. The author considers the word and conjugacy problems in quotients of groups by normal subgroups with solvable word and conjugacy problems. More precisely, the problems mentioned are considered "in quotients of free products, amalgamated free products and HNN-extensions with solvable word and conjugacy problems." It is assumed that "the quotients are taken over sets of relations which satisfy the small cancellation condition V (6)". Lyndon solved the word problem while Schupp solved the conjugacy problems for free presentations which satisfy some small cancellation conditions. The author points out that there are only few results concerning the conjugacy problem for small cancellation quotients of free products, amalgamated free products, and HNN-extensions. In the article are used notation and notions from R.C. Lyndon and P.E. Schupp's, book *Combinatorial Group Theory*, Springer 1977. The membership problem, studied in the second article by Juhász, is a generalization of the word problem. Given generators X, a presentation $\mathcal{R}$ of a group G and a subgroup H of G, the membership problem asks for an algorithm to decide whether a given word on X is an element of H. In this article, the author uses some ideas from a 2006 article by himself, to solve the membership problem for Magnus subgroups in one-relator products with a different small cancellation condition.

This article is followed by "*Conjugacy and centralizers for iwip automorphisms of free groups*" by Martin Lustig. Here, "iwip" means "irreducible with irreducible powers", and an automorphims α of a free group F_N is called iwip if, for any $t \in N$, α^t does not map any non-trivial proper free factor of F_N to a conjugate of itself. From its abstract: "Such automorphisms have many properties analogous to pseudo-Anosov mapping classes on surfaces. ... The goal of this paper is to give a new solution of the conjugacy problem for (outer) iwip automorphisms." The author offers a systematic presentation of things scattered in different parts of the literature. In the first half of the paper we find an extensively written introduction into the subject, which can also be used by non-experts. The solution of the conjugacy problem for iwip automorphisms is a particular case of the solution for the conjugacy problem for automorphisms of a free group, studied in earlier papers by the author.

The last article is *Algebraic extensions in free groups* by Alexei Miasnikov, Enric Ventura and Pascal Weil. From its abstract: "We develop a theory of algebraic extensions for free groups, highlighting the analogies and differences with respect to the corresponding classical field-theoretic notions, and we discuss in detail the notion of algebraic closure. We apply that theory to the study and the computation of certain algebraic properties of subgroups (e.g., being malnormal, pure, inert or compressed, being closed in certain profinite topologies) and the corresponding closure operators." From its introduction: "A well-known result of Nielsen and Schreier states that all subgroups of a free group F are free. A non-specialist in group theory could be tempted to guess from this pleasant result that the lattice of subgroups of F is simple, and easy to understand. This is however far from being the case... Although the lattice of subgroups of free groups was already studied by earlier authors, Serre and Stallings in their seminal 1977 and 1983 papers, introduced a powerful new technique ... It consists in thinking of F as the fundamental group of a bouquet of circles R, and of subgroups of F as covering spaces of R, i.e., some special types of graphs. With this idea in mind, one can understand and prove many properties of the lattice of subgroups of F using graph theory. ... The present paper offers a contribution in this direction".

To conclude this is a very useful book presenting recent results and work in progress in the field of geometric (and combinatorial) group theory. Several articles from the book can be used as introductions into specific research fields. Bibliographies open for the interested reader the path to more information. All articles are research papers, therefore dense and sometimes with a high degree of technicality. Maybe, the most pleasant aspect of the book consists of the interplay between metric geometry, combinatorial geometry and group theory, which appears in every article.

Marius Buliga

Harm Bart, Israel Gohberg, Marinus A. Kaashoek, and André C.M. Ran, *Factorization of Matrix and Operator Functions: The State Space Method*. Operator Theory: Advances and Applications 178, Birkhäuser-Verlag, Basel, 2008, xii + 409 pp.,
ISBN 978-3-7643-8267-4.

To explain the title of the book under review, let us mention that it is devoted to the operator functions that can be represented under the form

$$W(\lambda) = D + C(\lambda I - A)^{-1}B,$$

where λ is a complex variable while A, B, C, and D are Hilbert space operators between suitable spaces. The space where A acts is the state space in the language of system theory.

Every holomorphic matrix function $W(\cdot)$ which is analytic at infinity can be represented under the above form, which is the so-called state space realization of $W(\cdot)$.

The present book has a predecessor in the monograph written by the first three named authors with the title *Minimal Factorization of Matrix and Operator Functions*, Operator Theory: Advances and Applications 1, Birkhäuser Verlag, Basel–Boston–Berlin, 1979. As we learn from the Preface, the present authors are going to publish another book on the state space approach to factorization, emphasizing the canonical factorization, the symmetric one, and the applications to various classes of convolution equations.

The book under review consists of four parts. The first of them, *Motivating problems, systems and realizations*, reviews topics as characteristic operator functions and invariant subspaces, Wiener-Hopf integral operators, block Toeplitz equations, operator nodes, systems, and transfer functions. Several classes of systems are presented (Brodskii Kreĭn, unitary systems, etc.), and one then discusses realizations and linearization of operator functions, algebraic Riccati equations, and applications of the state space method to canonical factorizations. The second part of the book is devoted to the minimal realization and minimal factorization. Part III, *Degree one factors, companion based rational matrix functions, and job scheduling*, concerns decompositions into factors having minimal realizations with 1-dimensional state spaces. Applications to the problem of job scheduling from operations research are included as well. The book concludes with a part devoted to stability of factorization and invariant subspaces. After investigating the stability of spectral divisors, one goes on to a more general situation and one proves that there exist stable factorizations which are not of the spectral type. The theory of divisors of real matrix functions is reviewed, too.

This impressive monograph will certainly prove its value in due time. It aims at a wide audience consisting of students and mathematicians working in operator theory, complex analysis, linear algebra, system theory, network theory, and related areas.

Daniel Beltiţă

Luca Capogna, Donatella Danielli, Scott D. Pauls, and Jeremy T. Tyson, *An Introduction to the Heisenberg Group and the sub-Riemannian Isoperimetric Problem*, Progress in Mathematics 259, Birkhäuser-Verlag, Basel, 2007, xvi + 223 pp.,
ISBN: 978-3-7643-8132-5, 3-7643-8132-9.

It is slightly unusual that the first chapter of a book published in the famous Birkhäuser series Progress in Mathematics opens with a reproduction of a 370 year old engraving followed by the sentence "Fleeing the vengeance of her brother, Dido lands on the coast of North Africa and founds the city of Carthage." And yet this is the case with the book under review, and beginning the chapter in this manner is just one piece of evidence proving that the present authors did every effort to achieve their goal, namely, to provide a gentle introduction to a central area in sub-Riemannian geometric analysis. The whole first chapter of the book is a nice discussion of the isoperimetric problem in its original setting of Euclidean spaces. In particular, three methods of proof are presented for the fact that if A is the area of an open subset of $\mathbb{R}^2$ with finite perimeter L, then $4\pi A \leq L^2$, where the equality holds only for the disk.

Chapter 2 is devoted to an exposition on the sub-Riemannian geometry of the simply connected 3-dimensional Heisenberg group. The topics treated here are the Carnot-Carathéodory distance, geodesics and bubble sets, and the Riemanian approximants to the

Heisenberg group. Chapter 3 describes connections between the Heisenberg geometry and areas like jet spaces, CR geometry, and boundaries of complex hyperbolic spaces. A number of applications to models from engineering and biology are also discussed. The fourth chapter deals with the horizontal sub-Riemannian geometry for the submanifolds of codimension 1 in the Heisenberg group. Chapters 5 and 6 are devoted to discussing some basing ideas for the sub-Riemannian geometric measure theory and function theory: Sobolev spaces, functions of bounded variation, area and co-area formulas, differentiability for Lipschitz functions on Carnot groups, variation formulas for perimeter of surfaces in the Heisenberg groups, quasiconformal mappings and rigidity for lattices in the complex hyperbolic space. Chapter 7 presents two different proofs for Pierre Pansu's theorem on isoperimetric inequalities in the Heisenberg group. The next chapter is devoted to the isoperimetric profile of the Heisenberg group. In the authors' own words, this is "the core of this survey" and describes progress towards solving Pansu's 1982 conjecture on the isoperimetric constant of the Heisenberg group. Best constants for other geometric inequalities for that group are discussed in the final chapter.

The book under review is well written and should not fail to attract the attention of graduate students who wish to initiate themselves in a very active area of research with several interesting unsolved problems. The mathematicians who deal with ideas of differential geometry, Lie theory, geometric measure theory and related topics in geometric analysis will also find that this book is really valuable.

Daniel Beltiţă

Joachim Cuntz, Ralf Meyer, and Jonathan M. Rosenberg, *Topological and Bivariant K-Theory*, Oberwolfach Seminars 36, Birkhäuser, Basel, 2007, xii + 262 pp., ISBN 978-3-7643-8398-5.

The authors of the book under review organized in May 2005 at the Mathematisches Forschungsinstitut Oberwolfach a seminar devoted to the topic of topological K-theory for noncommutative algebras. The present book is an outgrowth of that seminar.

The first chapter includes a discussion of the elementary notions of algebraic K-theory. One then turns to the topic of topological K-theory and presents a new proof (due to the second-named author) of the homotopy invariance of stabilized algebraic K-theory. The Bott periodicity theorem is then proved and the preliminary part of the book concludes by a discussion of the K-theory of crossed products, which includes in particular the Pimsner-Voiculescu exact sequence. The next part of the book addresses the bivariant K-theory for bornological algebras followed by a survey of alternative bivariant K-theories working for more special classes of algebras (Kasparov's KK-theory, the Brown-Douglas-Fillmore-Kasparov Ext, algebraic dual K-theory, homotopy theoretic KK-theory, E-theory). Some applications of the K-theoretic techniques are explained in the last few chapters of the book. The topics discussed here are the twisted K-theory, Thom isomorphism for crossed products by $\mathbb{R}$, some applications to physics, relationship between K-theory and the Atyiah-Singer index theorem, and localization.

To conclude with, we mention that the book under review is to a reasonable extent self-contained. In our opinion, it will certainly prove useful to the students and researchers interested in areas related to K-theory.

Daniel Beltiţă

Karl-Heinz Förster, Peter Jonas, Heinz Langer, and Carsten Trunk (Editors), *Operator Theory in Inner Product Spaces*. Operator Theory: Advances and Applications 175, Birkhäuser-Verlag, Basel, 2007, vi + 240 pp., ISBN 978-3-7643-8269-8.

The book under review consists of a selection of papers from the 4th workshop on operator theory in Krein spaces and applications held at the Technische Universität Berlin, Germany, December 17–19, 2004. Here is the list of the contributions in this volume.

– T.Ya. Azizov and L.I. Soukhotcheva, Linear operators in almost Krein Spaces;

– J. Behrndt, A. Luger and C. Trunk, Generalized resolvents of a class of symmetric operators in Krein spaces;

– J. Behrndt, H. Neidhardt and J. Rehberg, Block operator matrices, optical potentials, trace class perturbations and scattering;

– V. Derkach, S. Hassi and H. de Snoo, Asymptotic expansions of generalized Nevanlinna functions and their spectral properties;

– A. Fleige, A necessary aspect of the generalized Beals condition for the Riesz basis property of indefinite Sturm-Liouville problems;

– K.-H. Förster and B. Nagy, On reducible nonmonic matrix polynomials with general and nonnegative coefficients;

– S. Hassi, H. de Snoo and H. Winkler, On exceptional extensions close to the generalized Friedrichs extension of symmetric operators;

– P. Jonas and H. Langer, On the spectrum of the self-adjoint extensions of a nonnegative linear relation of defect one in a Krein space;

– M. Kaltenbäck and H. Woracek, Canonical differential equations of Hilbert-Schmidt type;

– I. Karabash and A. Kostenko, Spectral analysis of differential operators with indefinite weights and a local point interaction;

– C. Mehl and C. Trunk, Normal matrices in degenerate indefinite inner product spaces;

– V. Pivovarchik, Symmetric Hermite-Biehler polynomials with defect;

– L. Rodman, A Note on indefinite Douglas' lemma;

– A. Sandovici, Some basic properties of polynomials in a linear relation in linear spaces.

These papers address problems belonging to several areas of active research in the theory of Krein spaces and operators thereon, and most of them are authored by mathematicians possessing a great experience in this field. The book will certainly provide a useful tool for researchers working in areas of operator theory ranging from the spectral theory of matrix polynomials to scattering theory and spectral analysis of some classes of differential operators.

Daniel Beltiţă

Bjorn Gustafsson and Alexander Vasili'ev, *Conformal and Potential Analysis in Hele-Shaw Cells*, Advances in Mathematical Fluid Mechanics, Birkhäuser, Basel–Boston–Berlin, 2006, ISBN 3-7643-7703-8, ISBN-10: 3-7643-7703-8, ISBN-13: 978-3-7643-7703-8.

This is a very interesting book about the flow of a viscous fluid in a narrow gap between two parallel plates. An averaging procedure across the gap reduces the Navier-Stokes equations to a linear relation similar to the Darcy law for flow in porous media. The

model was introduced by H.S. Hele-Shaw in 1898. The book presents the historical steps followed by this model: complex variable method (introduced by Polubarinova-Kochina and Gallin), Lovner-Kufarev equation, viscous fingering (discovered by Saffman and Taylor), complex variable method and complex moments (given by Richardson). The book focuses on the geometric function theory and potential theory. Hele-Shaw flows on parameter spaces (Teichmuller spaces) and the relation with string theory are also considered. Some historical details are given about the important contributors to those research directions.

The book contains seven chapters. A description of the model and the Polubarinova-Gallin equations are given in the first chapter. Explicit strong and weak solutions are considered in Chapters 2 and 3. Geometric properties of Hele-Shaw flow are studied in Chapter 4 while capacities and isoperimetric inequalities in Chapter 5. General evolution equations (introduced by Lowner and Kufarev) are studied in Chapter 6. The last chapter deals with the Hele-Shaw evolution and string theory.

The book is useful for researchers and students familiarized with real and complex analysis, conformal mappings theory and fluid mechanics. At the same time, it is an important contribution to in a modern branch of applied mathematics.

Gelu Paşa

Jan Janas, Pavel Kurasov, Ari Laptev, Sergei Naboko, Günter Stolz (Editors), *Operator Theory, Analysis and Mathematical Physics*, Operator Theory: Advances and Applications 174, Birkhäuser-Verlag, Basel, 2007, viii + 257 pp., ISBN 978-3-7643-8134-9.

The Będlewo Conference Center in Poland hosted in July 2004 the International Conference 'Operator Theory and its Applications in Mathematical Physics' (OTAMP 2004), with the proceedings gathered in the volume under review. It is worth mentioning that this was one of the satellite conferences of the 4th European Congress of Mathematics held in 2004 in Stockholm.

The present book consists of the contributions listed below.

– Petru A. Cojuhari, *Finiteness of eigenvalues of the perturbed Dirac operator*;

– M. Combescure, *A mathematical study of quantum revivals and quantum fidelity*;

– P. Exner, T. Ichinose and S. Kondej, *On relations between stable and Zeno dynamics in a leaky graph decay model*;

– R.L. Frank and R.G. Shterenberg, *On the spectrum of partially periodic operators*;

– A.V. Kiselev, *Functional model for singular perturbations of non-self-adjoint operators*;

– J. Michor and G. Teschl, *Trace formulas for Jacobi operators in connection with scattering theory for quasi-periodic background*;

– A.B. Mikhailova, B. Pavlov and V.I. Ryzhii, *Dirichlet-to-Neumann techniques for the plasma-waves in a slot-diode*;

– M. Nowaczyk, *Inverse spectral problem for quantum graphs with rationally dependent edges*;

– V. Ryzhov, *Functional model of a class of non-selfadjoint extensions of symmetric operators*

– H. Schulz-Baldes, *Lyapunov exponents at anomalies of* $\mathrm{SL}(2,\mathbb{R})$*-actions*;

– L.O. Silva, *Uniform and smooth Benzaid-Lutz type theorems and applications to Jacobi matrices*;

– S. Simonov, *An example of spectral phase transition phenomenon in a class of Jacobi matrices with periodically modulated weights*;

– A. Tikhonov, *On connections between factorizations of weighted Schur functions and invariant subspaces.*

As a quick glance at this list of contributions shows, the proceedings of the conference OTAMP 2004 cover a broad range of topics illustrating the usefulness of the operator theoretic methods in several areas of mathematical physics. We believe that the book will prove useful both to experts in operator theory who are interested in the interaction between their own field and theoretical physics, and to students and researchers working in the later field who wish to acquaint themselves with the powerful methods of operator theory.

Daniel Beltiţă

Vladimir Müller, *Spectral Theory of Linear Operators and Spectral Systems in Banach Algebras*, Second Edition, Operator Theory: Advances and Applications 139, Birkhäuser-Verlag, Basel, 2007, viii + 439 pp., ISBN 978-3-7643-8264-3.

Spectral theory is one of the most important domains of modern functional analysis with a wealth of applications in mathematics and physics as well, ranging from matrix theory, complex analysis and differential and integral equations to control theory and quantum physics. This monograph is an axiomatized survey of the major classes of spectra under the unifying concept of regularity. In a Banach algebra A, a regularity R is a subset of A defined in an axiomatic way that enjoys some of the main features of the set of invertible elements of A. These axioms are chosen in such a way so that on one hand, they allow the study of a large class of concrete examples and, on the other hand, are sufficiently strong so that they allow the construction of a consistent theory. A notion of joint regularity is also introduced in order to handle the Taylor spectra. The book has five chapters treating the following topics: Banach algebras, linear operators and their spectra, essential spectrum and perturbations, Taylor spectrum and, finally, orbits and capacity. Each chapter contains a very clever and detailed presentation of the topic with numerous illuminating examples, applications and historical comments. This book is a beautiful and significant contribution to the field of spectral theory.

Bebe Prunaru

Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, Fourth Edition, Birkhäuser, Basel–Boston–Berlin, 2007, xxii+778 pp., ISBN-10: 0-8176-4393-1, ISBN-13: 978-0-8176-4393-5.

This book opens with a selection of quotations from Albert Einstein, Leonardo da Vinci, James Clerk Maxwell, David Hilbert, Bernhard Riemann, Max Planck, Joseph Fourier, Sophus Lie, Vladimir Igorevich Arnold, Pierre Simon de Laplace, and Gösta Mittag-Leffler. In order to convey a flavour of this impressive collection of mathematician is thoughts, maybe it is appropriate to reproduce here the words of Sophus Lie: "Of all the mathematical disciplines, the theory of differential equations is the most important. All branches of physics

pose problems which can be reduced to the integration of differential equations. More generally, the way of explaining all natural phenomena which depend on time is given by the theory of differential equations."

After an introduction including a noteworthy section of historical comments and a discussion of basic concepts and somewhat heuristic principles and ideas, there follows a chapter devoted to first-order, quasi-linear equations and the method of characteristics. The next chapter concerns mathematical models as the vibrating string and membrane, waves in an elastic medium, conduction of heat in solids, and gravitational potentials. One can also find here the classical partial differential equations, as well as the equations called after Burgers, Schrödinger, and Korteweg-de Vries, respectively. The following two chapters are devoted to the classification of second-order linear equations and to the Cauchy problem and the wave equation, respectively. Then there are a chapter on Fourier series and integrals with applications, and a chapter explaining the method of separation of variables, illustrated by many specific examples.

One then turns to eigenvalue problems and special functions: Sturm-Liouville systems, the Bessel equation and functions, the Legendre equation and functions, as well as boundary value problems and Green functions for ordinary differential equations. There follow three chapters concerning higher dimensional boundary value problems, Green functions, and applications. The next chapter is devoted to methods and applications of integral transforms like as Fourier, Laplace, Hankel, and Mellin transforms. A special mention in this context deserves the asymptotic approximation of integrals by the stationary phase method and the discussion of fractional partial differential equations. The following chapter deals with topics in the theory of nonlinear partial differential equations and their applications. A special attention is paid to various nonlinear wave phenomena. The last of the main chapters of the book is devoted to describing numerical and approximation methods. One can thereafter find two chapters including tables of integral transforms and a reminder on special functions, respectively.

Just as the book itself, the individual chapters open with quotations of words belonging to great scientists, which makes the book into a pleasant and instructive reading. At the end of each chapter one can find a list of exercises, for which answers and hints are given at the end of the book. We believe this fourth edition of the book is highly welcome. It will prove useful to a wide audience including in particular students in mathematics, biology, engineering, and other areas where the partial differential equations are a working tool.

Daniel Beltiţă

Albrecht Pietsch, *History of Banach Spaces and Linear Operators*, Birkhäuser, Boston–Basel-Berlin, 2007, xxiii + 855 pp., ISBN-10: 0-8176-4367-2, ISBN-13: 978-8176-4367-6.

"The monographs A.F. Monna, *Functional Analysis in Historical Perspective* (1973), and J. Dieudonné, *History of Functional Analysis* (1981), as well as all articles devoted to the history of functional analysis only deal with the development before 1950. Now, the time has come to cover the second half of the twentieth century, too. I have undertaken this adventure."

These are the words that open the preface of Albrecht Pietsch's book, and every functional analyst who reads them cannot but make haste to learn about the results of this brave enterprise.

The author divides the history of Banach spaces and linear operators as follows: the prenatal period 1900–1920 dominated by the pioneering works of I. Fredholm, D. Hilbert and F. Riesz; the birth in 1920 when S. Banach submitted his thesis; the youth age 1920–1932 when the fundamental principles of functional analysis where discovered; the maturity reached in 1932 with S. Banach's monograph; the post-Banach period 1932–1958 when the classical books by M.M. Day, N. Dunford and J.T. Schwartz (Part I), E. Hillle and R.S. Phillips, and A.E. Taylor were published; and the modern period ranging from 1958 to this day.

Besides the introduction, the book includes eight main chapters, an extensive bibliography, and a chronology ranging from 1901–1902 (A.C. Dixon's theory of equations in infinitely many variables and H. Lebesgue's integral) to the *Handbook of the Geometry of Banach Spaces* edited by W.B. Johnson and J. Lindenstrauss in 2001–2003. The space allowed to the present review is certainly too small to do justice to all the information gathered within the covers of this impressive book. Therefore we have to content ourselves with merely mentioning that after devoting two chapters to discussing the origins of and the basic results in Banach spaces, the author turns to topological concepts (weak topologies) and classical Banach spaces. There follow a chapter describing basic results from the post-Banach period (differential and integral calculus in Banach spaces, spectral theory, operator semigroups, convexity, bases, tensor products and approximation properties), a chapter including selected topics from the modern theory (geometry of Banach spaces, s-numbers and operator ideals, eigenvalue distributions, traces and determinants, interpolation theory, function spaces, probability theory on Banach spaces), and a chapter discussing miscellaneous issues (Banach space theory as a part of mathematics, spaces versus operators, various counterexamples). The last chapter, *Mathematics is made by mathematicians*, is devoted to the mathematicians who worked or are working in the field of Banach spaces.

It is noteworthy that the contributions of the main mathematicians are described throughout the text along with quotations from their own works in their original languages, which really gives this instructive mathematical book the flavour of a historical work. We strongly believe that it can help people working in functional analysis or studying the history of mathematics to better understand their own areas of interest.

Daniel Beltiţă

P. Rife, *Lise Meitner and the Dawn of the Nuclear Age*, Birkhäuser-Verlag, Basel–Boston–Berlin, 2007, xviii + 432 pp., ISBN-10: 0-8176-4559-4.

Lise Meitner may be less known to the public, nevertheless her remarkable trajectory as witness and significant actor of the twentieth century scientific, but also socio-political developments, reveals her as a strong character and model.

Lise Meitner was not recognized for the nuclear fission discovery and correct physical interpretation, the whole credit being taken by Otto Hahn and Fritz Strassmann. It makes a renowned and strong case of a scientist who was deprived of a well-deserved recognition. Otto Hahn alone won the Nobel Prize in 1944 for this discovery. The book shows that this omission is only to be added to the gender and racial prejudices Lise Meitner had to suffer from.

She was the first woman ever attending lectures at the Physics Department of the University of Vienna, where she started her studies. She obtained there her doctoral degree

in physics with a subject on thermal conductivity in non-homogenous bodies. In 1906, Lise Meitner was the second woman in the 500 year history of the Viennese university who got a PhD in physics.

In Berlin, where she moved in 1907 to attend Max Planck's lectures, Lise Meitner succeeded to break the rigid Prussian canons and be a pioneer in two directions. Primarily, she was a woman visible in the field of scientific research at the University of Berlin, where she held the position of Assistant Professor to Max Planck; moreover she was a researcher of the radioactive properties of the elements' components, in the Kaiser Wilhelm Institute of Chemistry in Berlin-Dahlem, from its inception in 1912. At the University of Berlin, she was among the first women in Prussia with full lecturing rights and salary (1926). At the Institute she headed the Physics Department between 1917 and 1938.

Acting in those capacities (as a Professor Assistant and as a researcher), through her research and meticulous experiments, Lise Meitner not only yielded significant results to the scientific world, but also provided evidence for theoretical speculation. While she was a valuable theoretical physicist, she was a master of intuition and interpretation, a first-rate experimentalist. At the Institute, the Meitner-Hahn team became prominent in the field of radioactivity for their flair in the interpretation of the physical (Lise Meitner) and chemical (Otto Hahn) properties of the radioactive substances. Meitner and Hahn carried on their own independent research. However, the achievements which made them famous in the world of physics are those they worked together upon, namely, protactinium discovery and nuclear fission discovery and interpretation.

Lise Meitner precipitately left for Holland to escape the ominous Nazi regime in Germany, in 1938. This abrupt turn in her personal and professional life has been made a matter of debate: was it opportune – when credit on fission discovery was biased towards Otto Hahn – or even was it really needed? Wasnt it too late to leave in 1938, 5 years after National Socialists came to power, in 1933? She feared sometimes that she might have endorsed the regime by her work till her escape from Germany, the more so after she saw the atrocities that happened in the concentration camps.

Rife's book presents the momentous event of the nuclear fission explanation by Lise Meitner and Otto Robert Frisch – her nephew – in 1939, based on the experiments conducted by Hahn and Strassmann and on the droplet model of atom developed by Niels Bohr, in such a manner that it traces its tumultuous history: the joy of discovery, the doubts and hesitation in making it known, the strife to inform the scientific community, the embarrassment of having to retract previously made assertions etc.

In the war years of 1940–1945 Lise Meitner became highly disillusioned over the shift to the "big" science based on expensive technological equipment and huge military funding. She lived the drama of not agreeing to the social contexts in which the scientific results were used. Prejudice and exclusion, denial of her major role in scientific discovery unfortunately accompanied her across the Germany's borders too, in Siegbahn Institute in Stockholm where she was accepted as a researcher, but marginalized (1939–1947).

Her contribution to nuclear fission was a pure scientific insight, not technological as the breakthrough that followed the nuclear fission discovery (this is emphasized in the connection with her being called in *The New York Sun Magazine* "the woman who aided the bomb research", after Hiroshima bombing by the allies). She repeatedly underlined that the use of atomic energy for military purposes was only the first type of usage; creative applications – medicine etc. – were only to follow and she was insistently fighting for the return to the spirit of co-operation among scientists, as it was before the war.

A recurrent theme in the book is Lise Meitner's shy and unassuming presence. She let show her sense of pride very seldom. She was very modest, minimized her qualities

and even her contributions at the beginning of her career, lacked ostentation in asserting her results. Only in her late years, when injustice was just too painful and significant, she bitterly voiced her concerns, in personal letters to Otto Hahn. Her outdated, self-effacing look contrasted with the strong, but gentle role model she played for the young generation of women, taking their chance on the science path. One should not understand that only women were mentored by Lise; some of her brilliant assistants and friends were Max Delbrcke and Carl Von Weiszecker in Berlin and, later in Stockholm, Gudmund Borelius.

Patricia Rife's book has the merit of highlighting more than Lise Meitner's prodigious career path. Figures of mentors for the teams of young researchers and scientists are drawn with pregnancy. Their vision in recognizing exceptional talent but also their limits, as members of a society, submitted to its prescriptions are presented with delicacy and prized objectivity. In Lise Meitner's case this is related to the prejudices against women in science, later as Jewess in science. The same mentors were seeing and supporting – most of the time – clearly that exceptionality should break these unfair canons.

Such mentors were Ludwig Boltzmann and Max Planck for Lise Meitner and Ernest Rutherford for Otto Hahn.

You will read with delight about the charismatic and self conscious Boltzmann – the defender of atomism against "energetics" theory (Wilhelm Ostwald) and positivism (Ernst Mach) – who boldly stated in front of the students that he will not speak about predecessors as he has none; you will witness the extremely tense discussion Max Planck had with Hitler when trying to stop the haemorrhage of scientists form institutes and laboratories provoked by the "principles" of the 3rd Reich (about removal of non-Arian scientists from institutes and universities).

There is a great and tensed description of solidarity around Lise Meitner and the risks taken for her escape from Germany. Along with it you will read also about other examples of harassment Hitler's regime was exercising upon the society and its response to it. Among these you will be impressed by the dignified way Jewish personality recognition could take shape in the years of National Socialism raising (Fritz Haber's funeral ceremony).

Otto Hahn is the other figure which is conspicuous in the book. His portrait is of an outstanding specialist in radiochemistry with personal and team work scientific discoveries (especially with Lise Meitner and later with Fritz Strassmann). His collaboration with Lise Meitner is presented to have had slippages in the attitude towards her, especially after her leaving of Germany. He was sometimes driven by the fact that he was German in the detriment of the principles of justice.

Other prominent figures in the book are Niels Bohr and Albert Einstein. Their portraits are drawn in fine touches. Albert Einstein appears of weird political innocence during the World War I and of steady pacific position all along his life, affirmed during the World War II (the report to President Roosevelt leading to the Manhattan project).

Einstein is well highlighted as the modern and plucky spirit of the theoretical physics, as a pure mathematical construction, opposed to that of the pragmatic, experimental physics supported by National Socialist regime in Germany in the thirties. His attitude and work was seen as an insolent affirmation of the superiority of the Judaic spirit, without any connection to reality and thus to be suppressed.

Niels Bohr appears in the book with his imposing stature, both physically and figuratively, in science, by issuing ideas with strong impact in a modest, but insistent way. He is shown getting involved politically from all his heart from a clear anti-war position (Denmark government warning on German intentions in the nuclear field).

The whole story is told by a historian of science – Patricia Rife – who dedicated 14 years of work to understand Lise Meitner's life and achievements and to identify the crucial

moments of her destiny. The author's approach is like of carving a tapestry out of facts of life, the discoveries in the nuclear physics – around nuclear fission – and the socio-political events as background. In fact, the author mixes interpretations and carefully chosen facts from letters, autobiographies, interviews, other papers of history of science to support them. The story being captivating, one adheres easily to its subjectivity, even if sometimes you could suspect a feminist touch.

The author did not avoid mentioning – and even developing – the scientist's moments of lack of inspiration, necessities of retraction, in an attempt to give a credible portrait of her heroine.

The book is structured in several parts out of which the history itself, related in a breath-taking manner, is following chronologically Lise Meitner's life events against the scientific and historical background. It covers interlaced big themes such as: the scientist's social role and its attitude towards war, gender and racial racism in science, priority credits for sensitive and turbulent issues, development of physical models and theories from laboratory results in the twentieth century, followed by disputes and feverish activities of validation across world laboratories, reflecting the deep division in the scientific world during the ascension of Hitler and the Third Reich.

Each chapter has rich "End Notes" which help to go thoroughly into the historical or scientific context of the quoted assertions. "Chronology" and "List of Awards and Honours" are summaries of the events in the history you have just read about.

One can study Lise Meitner's scientific work looking for the titles in "Publications by Lise Meitner". Otherwise, along the book, the scientific work and the discoveries of what is currently known in nuclear physics are hinted to in an easy to understand way for an undergraduate in physics, mathematics or chemistry.

A very rich bibliography gives the measure of the author's thorough research.

Olea Pascu