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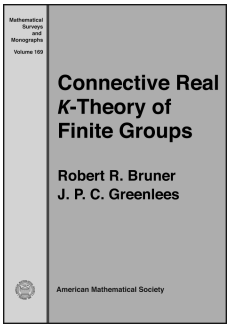
Algebra and Algebraic Geometry



Connective Real K-Theory of Finite Groups

Robert R. Bruner, *Wayne State University, Detroit, MI*, and **J. P. C. Greenlees**, *University of Sheffield, UK*

This book is about equivariant real and complex topological K-theory for finite groups. Its main focus is on the study of real connective K-theory including $ko^*(BG)$ as a ring and $ko_*(BG)$ as a module over it. In the course of their study the authors define equivariant versions of connective KO-theory and connective K-theory with reality, in the sense of Atiyah, which give well-behaved, Noetherian, uncompleted versions of the theory. They prove local cohomology and completion theorems for these theories, giving a means of calculation as well as establishing their formal credentials. In passing from the complex to the real theories in the connective case, the authors describe the known failure of descent and explain how the η-Bockstein spectral sequence provides an effective substitute.

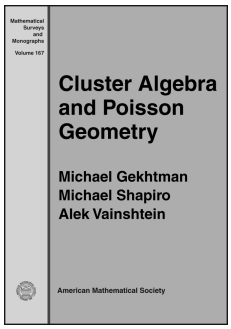
This formal framework allows the authors to give a systematic calculation scheme to quantify the expectation that $ko^*(BG)$ should be a mixture of representation theory and group cohomology. It is characteristic that this starts with $ku^*(BG)$ and then uses the local cohomology theorem and the Bockstein spectral sequence to calculate $ku_*(BG)$, $ko^*(BG)$, and $ko_*(BG)$. To give the skeleton of the answer, the authors provide a theory of ko-characteristic classes for representations, with the Pontrjagin classes of quaternionic representations being the most important.

Building on the general results, and their previous calculations, the authors spend the bulk of the book giving a large number of detailed calculations for specific groups (cyclic, quaternion, dihedral, A_4, and elementary abelian 2-groups). The calculations illustrate the richness of the theory and suggest many further lines of investigation. They have been applied in the verification of the Gromov-Lawson-Rosenberg conjecture for several new classes of finite groups.

Contents: Introduction; K-theory with reality; Descent, twisting and periodicity; The Bockstein spectral sequence; Characteristic classes; Examples for cohomology; Examples for homology; Dihedral groups; The ko-cohomology of elementary abelian 2-groups; The ko-homology of elementary abelian groups (BSS); The structure of TO; The ko-homology of elementary abelian groups (LCSS); Ext charts; Conventions; Indices; Bibliography.

Mathematical Surveys and Monographs, Volume 169

November 2010, 318 pages, Hardcover, ISBN: 978-0-8218-5189-0, LC 2010032901, 2000 *Mathematics Subject Classification:* 19L41, 19L47, 19L64, 55N15, 55N91, 13D45; 13D02, 20C15, 20G05, 20J06, 53C21, 55T15, 55U20, **AMS members US$73.60**, List US$92, Order code SURV/169



Cluster Algebra and Poisson Geometry

Michael Gekhtman, *University of Notre Dame, IN*, **Michael Shapiro**, *Michigan State University, East Lansing, MI*, and **Alek Vainshtein**, *University of Haifa, Mount Carmel, Israel*

Cluster algebras, introduced by Fomin and Zelevinsky in 2001, are commutative rings with unit and no zero divisors equipped with a distinguished family of generators (cluster variables) grouped in overlapping subsets (clusters) of the same cardinality (the rank of the cluster algebra) connected by exchange relations. Examples of cluster algebras include coordinate rings of many algebraic varieties that play a prominent role in representation theory, invariant theory, the study of total positivity, etc. The theory of cluster algebras has witnessed a spectacular growth, first and foremost due to the many links to a wide range of subjects including representation theory, discrete dynamical systems, Teichmüller theory, and commutative and non-commutative algebraic geometry.

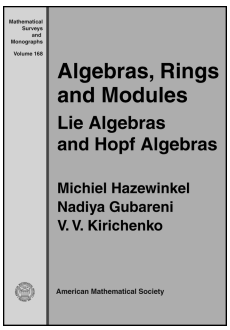
This book is the first devoted to cluster algebras. After presenting the necessary introductory material about Poisson geometry and Schubert varieties in the first two chapters, the authors introduce cluster algebras and prove their main properties in Chapter 3. This chapter can be viewed as a primer on the theory of cluster algebras. In the remaining chapters, the emphasis is made on geometric aspects of the cluster algebra theory, in particular on its relations to Poisson geometry and to the theory of integrable systems.

This item will also be of interest to those working in geometry and topology.

Contents: Preliminaries; Basic examples: Rings of functions on Schubert varieties; Cluster algebras; Poisson structures compatible with the cluster algebra structure; The cluster manifold; Pre-symplectic structures compatible with the cluster algebra structure; On the properties of the exchange graph; Perfect planar networks in a disk and Grassmannians; Perfect planar networks in an annulus and rational loops in Grassmannians; Generalized Bäcklund-Darboux transforms for Coxeter-Toda flows from a cluster algebra perspective; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 167

November 2010, approximately 251 pages, Hardcover, ISBN: 978-0-8218-4972-9, LC 2010029529, 2000 *Mathematics Subject Classification:* 13F60, 53D17; 05E40, 14M15, 16T30, **AMS members US$65.60**, List US$82, Order code SURV/167



Algebras, Rings and Modules

Lie Algebras and Hopf Algebras

Michiel Hazewinkel, **Nadiya Gubareni**, *Technical University of Częstochowa, Poland*, and **V. V. Kirichenko**, *Kiev National Taras Shevchenko University, Ukraine*

The main goal of this book is to present an introduction to and applications of the theory of Hopf algebras. The authors also discuss some important aspects of the theory of Lie algebras.

The first chapter can be viewed as a primer on Lie algebras, with the main goal to explain and prove the Gabriel–Bernstein–Gelfand–Ponomarev theorem on the correspondence between the representations of Lie algebras and quivers; this material has not previously appeared in book form.

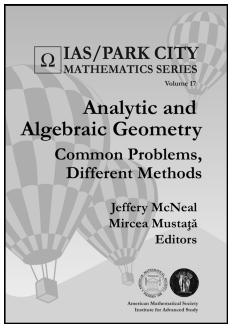
The next two chapters are also "primers" on coalgebras and Hopf algebras, respectively; they aim specifically to give sufficient background on these topics for use in the main part of the book. Chapters 4–7 are devoted to four of the most beautiful Hopf algebras currently known: the Hopf algebra of symmetric functions, the Hopf algebra of representations of the symmetric groups (although these two are isomorphic, they are very different in the aspects they bring to the forefront), the Hopf algebras of the nonsymmetric and quasisymmetric functions (these two are dual and both generalize the previous two), and the Hopf algebra of permutations. The last chapter is a survey of applications of Hopf algebras in many varied parts of mathematics and physics.

Unique features of the book include a new way to introduce Hopf algebras and coalgebras, an extensive discussion of the many universal properties of the functor of the Witt vectors, a thorough discussion of duality aspects of all the Hopf algebras mentioned, emphasis on the combinatorial aspects of Hopf algebras, and a survey of applications already mentioned. The book also contains an extensive (more than 700 entries) bibliography.

Contents: Lie algebras and Dynkin diagrams; Coalgebras: Motivation, definitions, and examples; Bialgebras and Hopf algebras. Motivation, definitions, and examples; The Hopf algebra of symmetric functions; The representations of the symmetric groups from the Hopf algebra point of view; The Hopf algebra of noncommutative symmetric functions and the Hopf algebra of quasisymmetric functions; The Hopf algebra of permutations; Hopf algebras: Applications in and interrelations with other parts of mathematics and physics; Index.

Mathematical Surveys and Monographs, Volume 168

November 2010, 411 pages, Hardcover, ISBN: 978-0-8218-5262-0, LC 2010030618, 2000 *Mathematics Subject Classification:* 16W30, 05E05, 20C30, 16G20, 17B37, 20G42, 14L05, 81R50, 16W35, 17Bxx; 05E10, 58B34, 81R60, 81R12, 82C20, **AMS members US$82.40**, List US$103, Order code SURV/168



Analytic and Algebraic Geometry

Common Problems, Different Methods

Jeffery McNeal, *Ohio State University, Columbus, OH*, and **Mircea Mustaţă**, *University of Michigan, Ann Arbor, MI*, Editors

Analytic and algebraic geometers often study the same geometric structures but bring different methods to bear on them. While this dual approach has been spectacularly successful at solving problems, the language differences between algebra and analysis also represent a difficulty for students and researchers in geometry, particularly complex geometry.

The PCMI program was designed to partially address this language gulf, by presenting some of the active developments in algebraic and analytic geometry in a form suitable for students on the "other side" of the analysis-algebra language divide. One focal point of the summer school was multiplier ideals, a subject of wide current interest in both subjects.

The present volume is based on a series of lectures at the PCMI summer school on analytic and algebraic geometry. The series is designed to give a high-level introduction to the advanced techniques behind some recent developments in algebraic and analytic geometry. The lectures contain many illustrative examples, detailed computations, and new perspectives on the topics presented, in order to enhance access of this material to non-specialists.

This item will also be of interest to those working in geometry and topology.

Titles in this series are co-published with the Institute for Advanced Study/Park City Mathematics Institute. Members of the Mathematical Association of America (MAA) and the National Council of Teachers of Mathematics (NCTM) receive a 20% discount from list price.

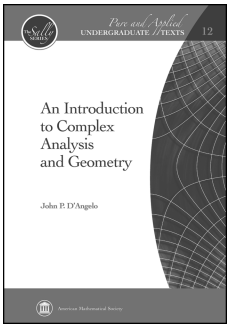
Contents: **J. McNeal** and **M. Mustaţă**, Introduction; **B. Berndtsson**, An introduction to things $\overline{\partial}$; **J. P. D'Angelo**, Real and complex geometry meet the Cauchy-Riemann equations; **D. Varolin**, Thee variations on a theme in complex analytic geometry; **J.-P. Demailly**, Structure theorems for projective and Kähler varieties; **M. Păun**, Lecture notes on rational polytopes and finite generation; **M. Mustaţă**, Introduction to resolution of singularities; **R. Lazarsfeld**, A short course on multiplier ideals; **J. Kollár**, Exercises in the birational geometry of algebraic varieties; **C. D. Hacon**, Higher dimensional minimal model program for varieties of

log general type; **A. Corti**, **P. Hacking**, **J. Kollár**, **R. Lazarsfeld**, and **M. Mustaţă**, Lectures on flips and minimal models.

IAS/Park City Mathematics Series, Volume 17

November 2010, 583 pages, Hardcover, ISBN: 978-0-8218-4908-8, LC 2010029457, 2000 *Mathematics Subject Classification:* 14E15, 14E30, 14F18, 32W05, 53C21, **AMS members US$79.20**, List US$99, Order code PCMS/17

Analysis



An Introduction to Complex Analysis and Geometry

John P. D'Angelo, *University of Illinois, Urbana, IL*

An Introduction to Complex Analysis and Geometry provides the reader with a deep appreciation of complex analysis and how this subject fits into mathematics. The book developed from courses given in the Campus Honors Program at the University of Illinois Urbana-Champaign. These courses aimed to share with students the way many mathematics and physics problems magically simplify when viewed from the perspective of complex analysis. The book begins at an elementary level but also contains advanced material.

The first four chapters provide an introduction to complex analysis with many elementary and unusual applications. Chapters 5 through 7 develop the Cauchy theory and include some striking applications to calculus. Chapter 8 glimpses several appealing topics, simultaneously unifying the book and opening the door to further study.

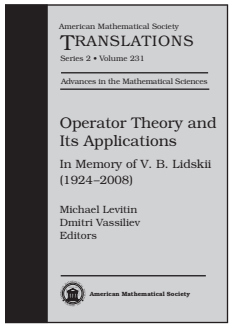
The 280 exercises range from simple computations to difficult problems. Their variety makes the book especially attractive.

A reader of the first four chapters will be able to apply complex numbers in many elementary contexts. A reader of the full book will know basic one complex variable theory and will have seen it integrated into mathematics as a whole. Research mathematicians will discover several novel perspectives.

Contents: From the real numbers to the complex numbers; Complex numbers; Complex numbers and geometry; Power series expansions; Complex differentiation; Complex integration; Applications of complex integration; Additional topics; Bibliography; Index.

Pure and Applied Undergraduate Texts, Volume 12

January 2011, approximately 170 pages, Hardcover, ISBN: 978-0-8218-5274-3, LC 2010029859, 2000 *Mathematics Subject Classification:* 30-00, 30-01, 51-01, 51M99, 26-01, 40-01, **AMS members US$45.60**, List US$57, Order code AMSTEXT/12



Operator Theory and Its Applications

In Memory of V. B. Lidskii (1924–2008)

Michael Levitin, *Reading University, United Kingdom*, and **Dmitri Vassiliev**, *University College London, United Kingdom*, Editors

This book is a collection of articles devoted to the theory of linear operators in Hilbert spaces and its applications. The subjects covered range from the abstract theory of Toeplitz operators to the analysis of very specific differential operators arising in quantum mechanics, electromagnetism, and the theory of elasticity; the stability of numerical methods is also discussed. Many of the articles deal with spectral problems for not necessarily selfadjoint operators. Some of the articles are surveys outlining the current state of the subject and presenting open problems.

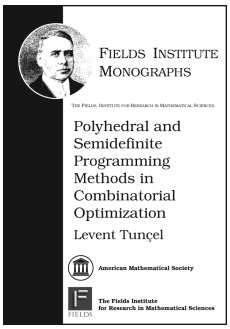
This item will also be of interest to those working in differential equations.

Contents: **M. Levitin** and **D. Vassiliev**, Victor Borisovich Lidskii (1924–2008); **I. Gohberg**, In memory of Victor Borisovich Lidskii (1924–2008); List of publications by V. B. Lidskii; **R. Bañuelos**, **T. Kulczycki**, **I. Polterovich**, and **B. Siudeja**, Eigenvalue inequalities for mixed Steklov problems; **M. Sh. Birman** and **T. A. Suslina**, The analog of the limiting absorption principle in homogenization of periodic elliptic operators; **L. Boulton**, **M. Levitin**, and **M. Marletta**, On a class of nonselfadjoint periodic boundary value problems with discrete real spectrum; **N. Dencker**, Spectral instability of semiclassical operators; **J. Fleckinger** and **N. Wei**, Estimates of solutions to some weighted systems defined on $\mathbb{R}^N$; **P. Kuchment** and **B.-S. Ong**, On guided electromagnetic waves in photonic crystal waveguides; **A. Laptev** and **F. Portmann**, Spectral inequalities for a class of nonellilptic operators; **M. Levitin**, **A. V. Sobolev**, and **D. Sobolev**, On the near periodicity of eigenvalues of Toeplitz matrices; **V. Maz′ya**, **A. Movchan**, and **M. Nieves**, Green's kernels for transmission problems in bodies with small inclusions; **S. Morozov**, **L. Parnovski**, and **I. Pchelintseva**, Lower bound on the density of states for periodic Schrödinger operators; **E. Shargorodsky**, On some open problems in spectral theory.

American Mathematical Society Translations—Series 2 (*Advances in the Mathematical Sciences*), Volume 231

December 2010, 180 pages, Hardcover, ISBN: 978-0-8218-5272-9, LC 91-640741, 2000 *Mathematics Subject Classification:* 01A70, 35P05, 35P15, 35Q40, 35Q60, 35Q74, 47A10, 47B35, 47E05, 47G30, **AMS members US$79.20**, List US$99, Order code TRANS2/231

Applications



Polyhedral and Semidefinite Programming Methods in Combinatorial Optimization

Levent Tunçel, *University of Waterloo, ON, Canada*

Since the early 1960s, polyhedral methods have played a central role in both the theory and practice of combinatorial optimization. Since the early 1990s, a new technique, semidefinite programming, has been increasingly applied to some combinatorial optimization problems. The semidefinite programming problem is the problem of optimizing a linear function of matrix variables, subject to finitely many linear inequalities and the positive semidefiniteness condition on some of the matrix variables. On certain problems, such as maximum cut, maximum satisfiability, maximum stable set and geometric representations of graphs, semidefinite programming techniques yield important new results. This monograph provides the necessary background to work with semidefinite optimization techniques, usually by drawing parallels to the development of polyhedral techniques and with a special focus on combinatorial optimization, graph theory and lift-and-project methods. It allows the reader to rigorously develop the necessary knowledge, tools and skills to work in the area that is at the intersection of combinatorial optimization and semidefinite optimization.

A solid background in mathematics at the undergraduate level and some exposure to linear optimization are required. Some familiarity with computational complexity theory and the analysis of algorithms would be helpful. Readers with these prerequisites will appreciate the important open problems and exciting new directions as well as new connections to other areas in mathematical sciences that the book provides.

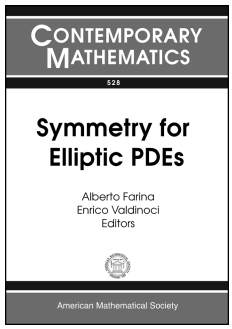
Titles in this series are co-published with The Fields Institute for Research in Mathematical Sciences (Toronto, Ontario, Canada).

Contents: Introduction; Duality theory; Ellipsoid method; Primal-dual interior-point methods; Approximation algorithms based on SDP; Geometric representations of graphs; Lift-and-project procedures for combinatorial optimization problems; Lift-and-project ranks for combinatorial optimzation; Successive convex relaxation methods; Connections to other areas of mathematics; An application to discrepancy theory; SDP representability; Bibliography; Index.

Fields Institute Monographs, Volume 27

November 2010, 219 pages, Hardcover, ISBN: 978-0-8218-3352-0, LC 2010031316, 2000 *Mathematics Subject Classification:* 90C22, 90C27, 15A39, 52A41, 65Y20, 05C69, 90C05, 90C25, 90C51, 68Q25, **AMS members US$61.60**, List US$77, Order code FIM/27

Differential Equations



Symmetry for Elliptic PDEs

Alberto Farina, *Université de Picardie Jules Verne, Amiens, France*, and **Enrico Valdinoci**, *Università Di Roma Tor Vergata, Rome, Italy*, Editors

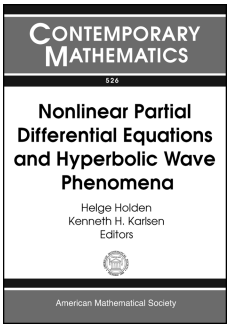
This volume contains contributions from the INdAM School on Symmetry for Elliptic PDEs, which was held May 25–29, 2009, in Rome, Italy. The school marked "30 years after a conjecture of De Giorgi, and related problems" and provided an opportunity for experts to discuss the state of the art and open questions on the subject.

Motivated by the classical rigidity properties of the minimal surfaces, De Giorgi proposed the study of the one-dimensional symmetry of the monotone solutions of a semilinear, elliptic partial differential equation. Impressive advances have recently been made in this field, though many problems still remain open. Several generalizations to more complicated operators have attracted the attention of pure and applied mathematicians, both for their important theoretical problems and for their relation, among others, with the gradient theory of phase transitions and the dynamical systems.

Contents: **F. Demengel** and **I. Birindelli**, One-dimensional symmetry for solutions of Allen Cahn fully nonlinear equations; **E. Lanconelli**, Maximum principles and symmetry results in sub-Riemannian settings; **L. Dupaigne**, Symétrie: Si, mais seulement si?; **O. Savin**, Minimal surfaces and minimizers of the Ginzburg-Landau energy; **I. E. Verbitsky**, Green's function estimates for some linear and nonlinear elliptic problems; **L. Montoro** and **B. Sciunzi**, Monotonicity of the solutions of quasilinear elliptic equations in the half-plane with a changing sign nonlinearity; **F. Ferrari**, Some inequalities associated with semilinear elliptic equations with variable coefficients and applications; **L. Dupaigne** and **Y. Sire**, A Liouville theorem for non local elliptic equations; **M. del Pino**, **M. Kowalczyk**, and **J. Wei**, On a conjecture by De Giorgi in dimensions 9 and higher.

Contemporary Mathematics, Volume 528

November 2010, 137 pages, Softcover, ISBN: 978-0-8218-4804-3, LC 2010021638, 2000 *Mathematics Subject Classification:* 35-06, 35J61, 35J20, 35J62, **AMS members US$47.20**, List US$59, Order code CONM/528



Nonlinear Partial Differential Equations and Hyperbolic Wave Phenomena

Helge Holden, *Norwegian University of Science and Technology, Trondheim, Norway, and University of Oslo, Norway*, and **Kenneth H. Karlsen**, *University of Oslo, Norway*, Editors

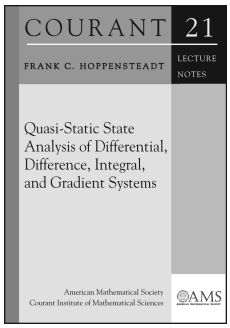
This volume presents the state of the art in several directions of research conducted by renowned mathematicians who participated in the research program on Nonlinear Partial Differential Equations at the Centre for Advanced Study at the Norwegian Academy of Science and Letters, Oslo, Norway, during the academic year 2008–09.

The main theme of the volume is nonlinear partial differential equations that model a wide variety of wave phenomena. Topics discussed include systems of conservation laws, compressible Navier-Stokes equations, Navier-Stokes-Korteweg type systems in models for phase transitions, nonlinear evolution equations, degenerate/mixed type equations in fluid mechanics and differential geometry, nonlinear dispersive wave equations (Korteweg-de Vries, Camassa-Holm type, etc.), and Poisson interface problems and level set formulations.

Contents: D. Amadori and **W. Shen**, A hyperbolic model of granular flow; **Y. Brenier**, Hilbertian approaches to some non-linear conservation laws; **J. A. Carrillo** and **S. Lisini**, On the asymptotic behavior of the gradient flow of a polyconvex functional; **G. G.-Q. Chen**, On degenerate partial differential equations; **N. Costanzino** and **H. K. Jenssen**, Symmetric solutions to multi-dimensional conservation laws; **P. D'Ancona**, **D. Foschi**, and **S. Selberg**, Product estimates for wave-Sobolev spaces in 2 + 1 and 1 + 1 dimensions; **I. Egorova** and **G. Teschl**, On the Cauchy problem for the modified Korteweg-de Vries equation with steplike finite-gap initial data; **E. Feireisl**, Asymptotic analysis in thermodynamics of viscous fluids; **C. Guan**, **K. H. Karlsen**, and **Z. Yin**, Well-posedness and blow-up phenomena for a modified two-component Camassa-Holm equation; **H. Kalisch** and **N. T. Nguyen**, Instability of solitary waves for a nonlinearly dispersive equation; **P. G. LeFloch**, Kinetic relations for undercompressive shock waves. Physical, mathematical, and numerical issues; **H. Liu** and **Z. Yin**, Global regularity, and wave breaking phenomena in a class of nonlocal dispersive equations; **S. Mishra** and **E. Tadmor**, Potential based, constraint preserving, genuinely multi-dimensional schemes for systems of conservation laws; **C. Rohde**, A local and low-order Navier-Stokes-Korteweg system; **D. Serre**, Local existence for viscous system of conservation laws: H^s-data with $s > 1 + d/2$; **J. D. Towers**, Finite difference methods for discretizing singular source terms in a Poisson interface problem.

Contemporary Mathematics, Volume 526

October 2010, 389 pages, Softcover, ISBN: 978-0-8218-4976-7, LC 2010014967, 2000 *Mathematics Subject Classification:* 35L65, 35Q30, 35G25, 35J70, 35K65, 35B65, 39A14, 35B25, 35L05, 65M08, **AMS members US$92**, List US$115, Order code CONM/526



Quasi-Static State Analysis of Differential, Difference, Integral, and Gradient Systems

Frank C. Hoppensteadt, *Courant Institute of Mathematical Sciences, New York University, NY*

This book is based on a course on advanced topics in differential equations given in Spring 2010 at the Courant Institute of Mathematical Sciences. It describes aspects of mathematical modeling, analysis, computer simulation, and visualization in the mathematical sciences and engineering that involve singular perturbations. There is a large literature devoted to singular perturbation methods for ordinary and partial differential equations, but there are not many studies that deal with difference equations, Volterra integral equations, and purely nonlinear gradient systems where there is no dominant linear part. Designed for a one-semester course for students in applied mathematics, it is the purpose of this book to present sufficient rigorous methods and examples to position the reader to investigate singular perturbation problems in such equations.

This item will also be of interest to those working in probability and applications.

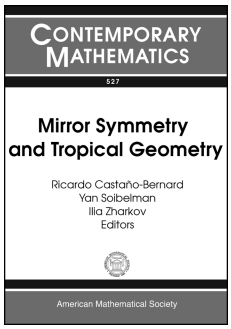
Titles in this series are co-published with the Courant Institute of Mathematical Sciences at New York University.

Contents: *Averaging methods:* Introduction to Part 1; Averaging differential equations; Difference equations; Averaging over random noise; *Boundary layer methods:* Introduction to Part 2; Asymptotic stability and singular perturbations; QSSA for boundary layer problems; Other singular perturbation problems; Appendix: Circuit theory; Bibliography; Index.

Courant Lecture Notes, Volume 21

November 2010, 163 pages, Softcover, ISBN: 978-0-8218-5269-9, LC 2010029102, 2000 *Mathematics Subject Classification:* 34-XX, 37-XX, 39-XX, 45-XX, 60-XX, 92-XX, **AMS members US$24.80**, List US$31, Order code CLN/21

Mathematical Physics



Mirror Symmetry and Tropical Geometry

Ricardo Castaño-Bernard, **Yan Soibelman**, and **Ilia Zharkov**, *Kansas State University, Manhattan, KS*, Editors

This volume contains contributions from the NSF-CBMS Conference on Tropical Geometry and Mirror Symmetry, which was held from December 13–17, 2008 at Kansas State University in Manhattan, Kansas.

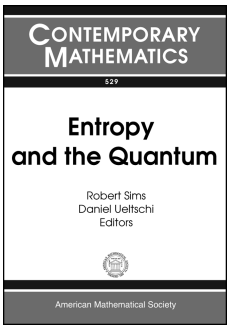
It gives an excellent picture of numerous connections of mirror symmetry with other areas of mathematics (especially with algebraic and symplectic geometry) as well as with other areas of mathematical physics. The techniques and methods used by the authors of the volume are at the frontier of this very active area of research.

This item will also be of interest to those working in algebra and algebraic geometry.

Contents: C. F. Doran and **A. Y. Novoseltsev**, Closed form expressions of Hodge numbers of complete intersection Calabi-Yau threefolds in toric varieties; **K. Fukaya**, **Y.-G. Oh**, **H. Ohta**, and **K. Ono**, Anchored Lagrangian submanifolds and their Floer theory; **M. Kontsevich** and **Y. Soibelman**, Motivic Donaldson-Thomas invariants: Summary of results; **D. R. Morrison**, On the structure of supersymmetric T^3 fibrations; **H. Ruddat**, Log Hodge groups on a toric Calabi-Yau degeneration; **I. Zharkov**, Tropical theta characteristics.

Contemporary Mathematics, Volume 527

November 2010, 168 pages, Softcover, ISBN: 978-0-8218-4884-5, LC 2010017905, 2000 *Mathematics Subject Classification:* 14J32, 14T05, 53D37, 53D40, 14N35, 32S35, 58A14, 14M25, 52B70, **AMS members US$55.20**, List US$69, Order code CONM/527



Entropy and the Quantum

Robert Sims, *University of Arizona, Tucson, AZ*, and **Daniel Ueltschi**, *University of Warwick, Coventry, United Kingdom*, Editors

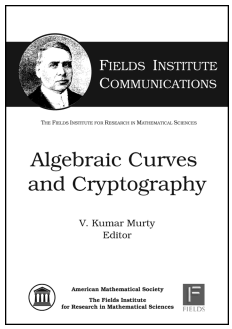
These lecture notes provide a pedagogical introduction to quantum mechanics and to some of the mathematics that has been motivated by this field. They are a product of the school "Entropy and the Quantum", which took place in Tucson, Arizona, in 2009. They have been written primarily for young mathematicians, but they will also prove useful to more experienced analysts and mathematical physicists. In the first contribution, William Faris introduces the mathematics of quantum mechanics. Robert Seiringer and Eric Carlen review certain recent developments in stability of matter and analytic inequalities, respectively. Bruno Nachtergaele and Robert Sims review locality results for quantum systems, and Christopher King deals with additivity conjectures and quantum information theory. The final article, by Christian Hainzl, describes applications of analysis to the Shandrasekhar limit of stellar masses.

Contents: W. G. Faris, Outline of quantum mechanics; **R. Seiringer**, Inequalities for Schrödinger operators and applications to the stability of matter problem; **E. Carlen**, Trace inequalities and quantum entropy: An introductory course; **B. Nachtergaele** and **R. Sims**, Lieb-Robinson bounds in quantum many-body physics; **C. King**, Remarks on the additivity conjectures for quantum channels; **C. Hainzl**, On the static and dynamical collapse of white dwarfs.

Contemporary Mathematics, Volume 529

December 2010, 202 pages, Softcover, ISBN: 978-0-8218-5247-7, LC 2010024656, 2000 *Mathematics Subject Classification:* 15A90, 47A63, 81P45, 81Q10, 81Q15, 81V17, 82C10, 82C20, 94A40, **AMS members US$55.20**, List US$69, Order code CONM/529

Number Theory



Algebraic Curves and Cryptography

V. Kumar Murty, *University of Toronto, ON, Canada*, Editor

It is by now a well-known paradigm that public-key cryptosystems can be built using finite Abelian groups and that algebraic geometry provides a supply of such groups through Abelian varieties over finite fields. Of special interest are the Abelian varieties that are Jacobians of algebraic curves. All of the articles in this volume are centered on the theme of point counting and explicit arithmetic on the Jacobians of curves over finite fields. The topics covered include Schoof's ℓ-adic point counting algorithm, the p-adic algorithms of Kedlaya and Denef-Vercauteren, explicit arithmetic on the Jacobians of C_{ab} curves and zeta functions.

This volume is based on seminars on algebraic curves and cryptography held at the GANITA Lab of the University of Toronto during 2001–2008. The articles are mostly suitable for independent study by graduate students who wish to enter the field, both in terms of introducing basic material as well as guiding them in the literature. The literature in cryptography seems to be growing at an exponential rate. For a new entrant into the subject, navigating through this ocean can seem quite daunting. In this volume, the reader is steered toward a discussion of a few key ideas of the subject, together with some brief guidance for further reading. It is hoped that this approach may render the subject more approachable.

This item will also be of interest to those working in algebra and algebraic geometry.

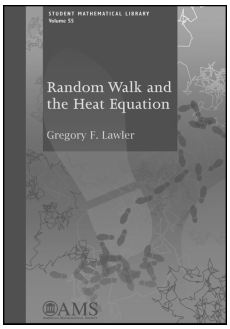
Titles in this series are co-published with the Fields Institute for Research in Mathematical Sciences (Toronto, Ontario, Canada).

Contents: V. K. Murty, An overview of algebraic curves and cryptography; **N. Thériault**, Schoof's point counting algorithm; **Z. Ashraf**, **A. Juma**, and **P. Sastry**, Report on the Denef-Vercauteren/Kedlaya algorithm; **M. Radi-Benjelloun**, An introduction to Gröbner bases; **F. Izadi**, C_{ab} curves and arithmetic on their Jacobians; **K. W. Shum**, The zeta functions of two Garcia-Stichtenoth towers; Bibliography; Index.

Fields Institute Communications, Volume 58

November 2010, 133 pages, Hardcover, ISBN: 978-0-8218-4311-6, LC 2010035455, 2000 *Mathematics Subject Classification:* 11T55, 11T71, 11G10, 14G50, **AMS members US$63.20**, List US$79, Order code FIC/58

Probability



Random Walk and the Heat Equation

Gregory F. Lawler, *University of Chicago, IL*

The heat equation can be derived by averaging over a very large number of particles. Traditionally, the resulting PDE is studied as a deterministic equation, an approach that has brought many significant results and a deep understanding of the equation and its solutions. By studying the heat equation by considering the individual random particles, however, one gains further intuition into the problem. While this is now standard for many researchers, this approach is generally not presented at the undergraduate level. In this book, Lawler introduces the heat equation and the closely related notion of harmonic functions from a probabilistic perspective.

The theme of the first two chapters of the book is the relationship between random walks and the heat equation. The first chapter discusses the discrete case, random walk and the heat equation on the integer lattice, and the second chapter discusses the continuous case, Brownian motion and the usual heat equation. Relationships are shown between the two. For example, solving the heat equation in the discrete setting becomes a problem of diagonalization of symmetric matrices, which becomes a problem in Fourier series in the continuous case. Random walk and Brownian motion are introduced and developed from first principles. The latter two chapters discuss different topics: martingales and fractal dimension, with the chapters tied together by one example, a random Cantor set.

The idea of this book is to merge probabilistic and deterministic approaches to heat flow. It is also intended as a bridge from undergraduate analysis to graduate and research perspectives. The book is suitable for advanced undergraduates, particularly those considering graduate work in mathematics or related areas.

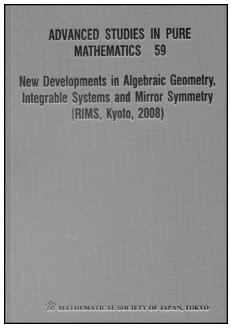
Contents: Random walk and discrete heat equation; Brownian motion and the heat equation; Martingales; Fractal dimension; Suggestions for further reading.

Student Mathematical Library, Volume 55

December 2010, 156 pages, Softcover, ISBN: 978-0-8218-4829-6, LC 2010031593, 2000 *Mathematics Subject Classification:* 60-01, 60G50, 60J65, 60G42, 35K05, 28A80, **AMS members US$23.20**, List US$29, Order code STML/55

New AMS-Distributed Publications

Algebra and Algebraic Geometry



New Developments in Algebraic Geometry, Integrable Systems and Mirror Symmetry (RIMS, Kyoto, 2008)

Masa-Hiko Saito, *Kobe University, Japan*, **Shinobu Hosono**, *University of Tokyo, Japan*, and **Kōta Yoshioka**, *Kobe University, Japan*, Editors

In the last two decades, many important developments and interactions in algebraic geometry and integrable systems have arisen from ideas in mirror symmetry.

The conference "New Developments in Algebraic Geometry, Integrable Systems and Mirror Symmetry" was held at RIMS, Kyoto University on January 7–11, 2008, to explore recent developments and interactions in various mathematical fields, such as algebraic geometry, integrable systems, Gromov-Witten theory and symplectic geometry and, in particular, to explore the developments and interactions coming from ideas in mirror symmetry. This volume is the outcome of that conference and consists of twelve contributed papers by invited speakers. Readers will find beneficial expositions on various aspects and interesting interactions in these mathematical fields.

This item will also be of interest to those working in differential equations.

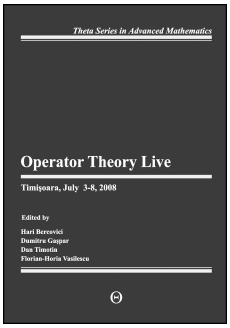
Published for the Mathematical Society of Japan by Kinokuniya, Tokyo, and distributed worldwide, except in Japan, by the AMS.

Contents: **K. Chan** and **N. C. Leung**, On SYZ mirror transformations; **A. R. Hodge** and **M. Mulase**, Hitchin integrable systems, deformations of spectral curves, and KP-type equations; **S. Hosono**, BCOV ring and holomorphic anomaly equation; **H. Iritani**, Ruan's conjecture and integral structures in quantum cohomology; **B. Kim**, Logarithmic stable maps; **T. Nakatsu** and **K. Takasaki**, Integrable structure of melting crystal model with external potentials; **N. A. Nekrasov**, Two dimensional topological strings and gauge theory; **R. Pandharipande** and **A. Zinger**, Enumerative geometry of Calabi–Yau 5-folds; **C. Sabbah**, Fourier–Laplace transform of a variation of polarized complex Hodge structure, II; **J. Stienstra**, Computation of principal $\mathcal{A}$-determinants through dimer dynamics; **A. Takahashi**, Weighted projective lines associated to regular systems of weights of dual type; **Y. Toda**, Generating functions of stable pair invariants via wall-crossings in derived categories.

Advanced Studies in Pure Mathematics, Volume 59

August 2010, 451 pages, Hardcover, ISBN: 978-4-931469-62-4, 2000 *Mathematics Subject Classification:* 14Nxx; 14Dxx, 14Hxx, 14Jxx, 35Qxx, 53Dxx, **AMS members US$60.80**, List US$76, Order code ASPM/59

Analysis



Operator Theory Live

Timişoara, July 3–8, 2008

Hari Bercovici, *Indiana University, Bloomington, IN*, **Dumitru Gaspar**, *West University of Timişoara, Romania*, **Dan Timotin**, *Romanian Academy, Bucharest, Romania*, and **Florian-Horia Vasilescu**, *University of Lille I, Villeneuve d'Ascq, France*, Editors

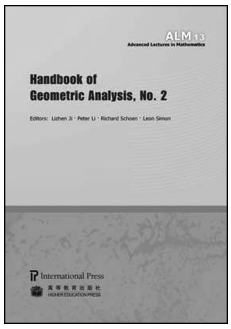
The volume represents the proceedings of the 22nd International Conference on Operator Theory, held in Timişoara, Romania, from July 3 to July 8, 2008. It includes a survey on Carleson measures and composition operators, as well as eighteen papers containing original research on a large variety of topics: single operator theory, Banach algebras, C^*-algebras, von Neumann algebras, moment problems, differential and integral operators, noncommutative probability, and spectral theory.

A publication of the Theta Foundation. Distributed worldwide, except in Romania, by the AMS.

Contents: P. Albayrak and **F. Çeliker**, On invariant ideals on locally convex solid Riesz spaces; **C. Benhida** and **D. Timotin**, Automorphism invariance properties for certain families of multioperators; **H. Bercovici** and **L. Kérchy**, Spectral behaviour of C_{10}-contractions; **M. R. Buneci**, Haar systems for double groupoids; **G. Cassier** and **J. Verliat**, Stability for some operator classes by Aluthge transform; **K. R. Davidson** and **E. G. Katsoulis**, Biholomorphisms of the unit ball of $\mathbb{C}^n$ and semicrossed products; **J. Janas**, Asymptotic of solutions of some linear difference equations and applications to unbounded Jacobi matrices; **A. Juratoni**, On operator representations of weak*-Dirichlet algebras; **L. D. Lemle**, L^∞-uniqueness for one-dimensional diffusions; **L. Lemnete-Ninulescu**, Positive-definite operator-valued functions and the moment problem; **F. Pop** and **R. R. Smith**, On the cohomology groups of certain type I von Neumann algebras with coefficients in $K(H)$; **M. Popa**, Non-crossing linked partitions and multiplication of free random variables; **G. T. Prăjitură**, The geometry of an orbit; **H. Queffélec**, Carleson measures and composition operators; **M. Şabac**, Commuting systems of bounded operators, factorizations, and spectral correspondence; **A. Skripka**, On the centralizer of a one-parameter representation; **S. M. Stoian**, Spectrum of bounded operators on locally convex spaces; **C. Stoica** and **M. Megan**, Nonuniform behaviors for skew-evolution semiflows in Banach spaces; **L. Suciu** and **N. Suciu**, Selection of semispectral measures for bicontractions.

International Book Series of Mathematical Texts

June 2010, 229 pages, Hardcover, ISBN: 978-973-87899-6-8, 2000 *Mathematics Subject Classification:* 00B25, 46-06, 47-06, **AMS members US$44.80**, List US$56, Order code THETA/15



Handbook of Geometric Analysis

Number 2

Lizhen Ji, *University of Michigan, Ann Arbor, MI*, **Peter Li**, *University of California, Irvine, CA*, and **Richard Schoen** and **Leon Simon**, *Stanford University, CA*, Editors

Geometric analysis combines differential equations and differential geometry, an important aspect of which is to solve geometric problems by studying differential equations. Besides some known linear differential operators such as the Laplace operator, many differential equations arising from differential geometry are nonlinear. A particularly important example is the Monge-Ampère equation. Applications to geometric problems have also motivated new methods and techniques in differential equations. The field of geometric analysis is broad and has had many striking applications.

This handbook of geometric analysis—the second to be published in the ALM series—provides introductions to and surveys of important topics in geometric analysis and their applications to related fields. It can be used as a reference by graduate students and researchers.

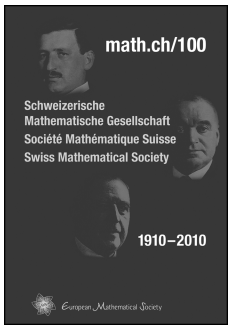
A publication of International Press. Distributed worldwide by the American Mathematical Society.

Contents: A. Grigor'yan, Heat kernels on metric measure spaces with regular volume growth; **B. H. Lian** and **B. Song**, A convexity theorem and reduced Delzant spaces; **B. H. Lian** and **K. Liu**, Localization and some recent applications; **C.-C. M. Liu**, Gromov-Witten invariants of toric Calabi-Yau threefolds; **J. Loftin**, Survey on affine spheres; **X. Rong**, Convergence and collapsing theorems in Riemannian geometry; **C.-L. Terng**, Geometric transformations and soliton equations; **D. Yang**, Affine integral geometry from a differentiable viewpoint; **S.-K. Yeung**, Classification of fake projective planes.

International Press

August 2010, 431 pages, Softcover, ISBN: 978-1-57146-204-6, 2000 *Mathematics Subject Classification:* 01-02, 53-06, 58-06, **AMS members US$52**, List US$65, Order code INPR/91

General Interest



math.ch/100

Schweizerische Mathematische Gesellschaft, Société Mathématique Suisse, Swiss Mathematical Society, 1910–2010

Bruno Colbois, *University of Neuchâtel, Switzerland*, **Christine Riedtmann**, *University of Bern, Switzerland*, and **Viktor Schroeder**, *University of Zürich, Switzerland*, Editors

This book includes twenty-three essays that celebrate the 100th anniversary of the Swiss Mathematical Society. The life and work of outstanding mathematicians, extraordinary conferences held in Switzerland, such as the three International Congresses of Mathematicians, and the influence of women in Swiss mathematics are among the topics. The articles, which include many photographs, give a vivid picture of 100 years of mathematical life in Switzerland.

A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: M. Plancherel, Mathématiques et mathématiciens en Suisse (1850–1950); **E. Neuenschwander**, 100 Jahre Schweizerische Mathematische Gesellschaft; **C. Blatter**, Ein Mathematikstudium in den Fünfzigerjahren; **J. J. Burckhardt**, Herausgegeben und ergänzt von *Adolf Th. Schnyder* Andreas Speiser (1885–1970); **P. Buser**, Heinz Huber und das Längenspektrum; **S. Chatterji** and **M. Ojanguren**, A glimpse of the de Rham era; **J. Descloux** and **D. de Werra**, Les mathématiques appliquées à l'École polytechnique de Lausanne; **S. Eliahou**, **P. de la Harpe**, **J.-C. Hausmann**, and **C. Weber**, Michel Kervaire (1927–2007); **W. Gautschi**, Alexander M. Ostrowski (1893–1986): His life, work, and students; **M. H. Gutknecht**, Numerical analysis in Zurich—50 years ago; **A. Haefliger**, Armand Borel (1923–2003); **F. Hirzebruch**, Bericht über meine Zeit in der Schweiz in den Jahren (1948–1950); **N. Hungerbühler** and **M. Schmutz**, Michel Plancherel, une vie pour les mathématiques et pour le prochain; **H. Kleisli**, Zur Geschichte des Mathematischen Instituts der Universität Freiburg (Schweiz); **J. Kramer**, Martin Eichler—Leben und Werk; **P. Mani**, Mathematik an der Universität Bern im neunzehnten und zwanzigsten Jahrhundert; **M. Raussen** and **A. Valette**, An interview with Beno Eckmann; **C. Riedtmann**, Wege von Frauen: Mathematikerinnen in der Schweiz; **A. M. Robert**, L'Institut de mathématiques de Neuchâtel (1950–90); **U. Stammbach**, Hermann Weyl, Heinz Hopf und das Jahr 1930 an der ETH; **K. Strebel**, Rolf Nevanlinna in Zurich; **C. Weber**, Quelques souvenirs sur le troisième cycle romand de mathématiques et le séminaire des Plans-sur-Bex; **E. Zehnder**, Jürgen Moser (1928–1999).

August 2010, 528 pages, Hardcover, ISBN: 978-3-03719-089-0, 2000 *Mathematics Subject Classification:* 00B30, **AMS members US$70.40**, List US$88, Order code EMSMATH