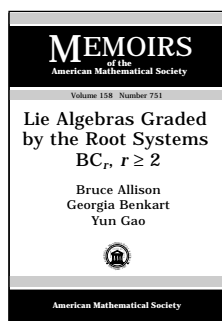


# New Publications Offered by the AMS

## Algebra and Algebraic Geometry



### Lie Algebras Graded by the Root Systems $BC_r$ , $r \geq 2$

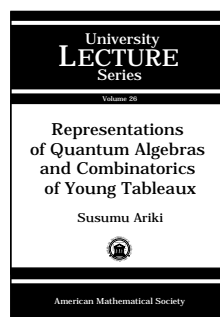
**Bruce Allison**, *University of Alberta, Edmonton, AB, Canada*, **Georgia Benkart**, *University of Wisconsin, Madison*, and **Yun Gao**, *York University, Toronto, ON, Canada*

**Contents:** Introduction; The  $\mathfrak{g}$ -module decomposition of a  $BC_r$ -graded Lie algebra,  $r \geq 3$  (excluding type  $D_3$ ); Models for  $BC_r$ -graded Lie algebras,  $r \geq 3$  (excluding type  $D_3$ ); The  $\mathfrak{g}$ -module decomposition of a  $BC_r$ -graded Lie algebra with grading subalgebra of type  $B_2$ ,  $C_2$ ,  $D_2$ , or  $D_3$ ; Central extensions, derivations and invariant forms; Models of  $BC_r$ -graded Lie algebras with grading subalgebra of type  $B_2$ ,  $C_2$ ,  $D_2$ , or  $D_3$ ; Appendix: Peirce decompositions in structurable algebras; References.

**Memoirs of the American Mathematical Society**, Volume 158, Number 751

July 2002, 158 pages, Softcover, ISBN 0-8218-2811-8, LC 2002018394, 2000 *Mathematics Subject Classification*: 17B20, 17B70, 17B25, 17B65, **Individual member \$32**, List \$53, Institutional member \$42, Order code MEMO/158/751N

### Independent Study



### Representations of Quantum Algebras and Combinatorics of Young Tableaux

**Susumu Ariki**, *RIMS, Kyoto University, Japan*

This book contains most of the nonstandard material necessary to get acquainted with this new rapidly developing area. It can be used as a

good entry point into the study of representations of quantum groups.

Among several tools used in studying representations of quantum groups (or quantum algebras) are the notions of Kashiwara's crystal bases and Lusztig's canonical bases. Mixing both approaches allows us to use a combinatorial approach to representations of quantum groups and to apply the theory to representations of Hecke algebras.

The primary goal of this book is to introduce the representation theory of quantum groups using quantum groups of type  $A_{r-1}^{(1)}$  as a main example. The corresponding combinatorics, developed by Misra and Miwa, turns out to be the combinatorics of Young tableaux.

The second goal of this book is to explain the proof of the (generalized) Leclerc-Lascoux-Thibon conjecture. This conjecture, which is now a theorem, is an important breakthrough in the modular representation theory of the Hecke algebras of classical type.

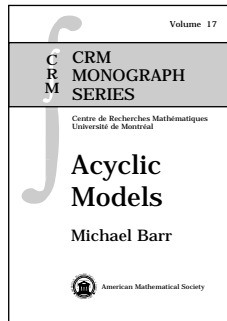
The book is suitable for graduate students and research mathematicians interested in representation theory of algebraic groups and quantum groups, the theory of Hecke algebras, algebraic combinatorics, and related fields.

**Contents:** Introduction; The Serre relations; Kac-Moody Lie algebras; Crystal bases of  $U_{\nu}$ -modules; The tensor product of crystals; Crystal bases of  $U_{\nu}$ ; The canonical basis; Existence and uniqueness (part I); Existence and uniqueness (part II); The Hayashi realization; Description of the crystal graph of  $V(\Lambda)$ ; An overview of the application to Hecke algebras; The Hecke

algebra of type  $G(m, 1, n)$ ; The proof of Theorem 12.5; Reference guide; Bibliography; Index.

University Lecture Series, Volume 26

July 2002, 158 pages, Softcover, ISBN 0-8218-3232-8, LC 2002025869, 2000 *Mathematics Subject Classification*: 05E10, 17B37, 17B67, 20C08; 14M15, 16D90, 16G20, 20C33, All AMS members \$25, List \$31, Order code ULECT/26N



## Acyclic Models

**Michael Barr, Peter Redpath**  
*Emeritus Professor of Pure Mathematics, McGill University, Montreal, QC, Canada*

Acyclic models is a method heavily used to analyze and compare various homology and cohomology theories appearing in topology and algebra. This book is the first attempt to put together in a concise form this impor-

tant technique and to include all the necessary background.

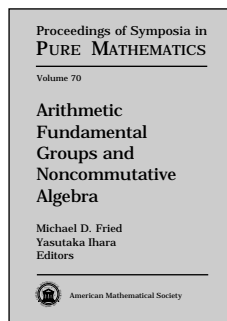
It presents a brief introduction to category theory and homological algebra. The author then gives the background of the theory of differential modules and chain complexes over an abelian category to state the main acyclic models theorem, generalizing and systemizing the earlier material. This is then applied to various cohomology theories in algebra and topology.

The volume could be used as a text for a course that combines homological algebra and algebraic topology. Required background includes a standard course in abstract algebra and some knowledge of topology. The volume contains many exercises. It is also suitable as a reference work for researchers.

**Contents:** Categories; Abelian categories and homological algebra; Chain complexes and simplicial objects; Triples à la mode de Kan; The main acyclic models theorem; Cartan-Eilenberg Cohomology; Other applications in algebra; Applications in topology; Bibliography; Index.

CRM Monograph Series, Volume 17

July 2002, 179 pages, Hardcover, ISBN 0-8218-2877-0, LC 2002021460, 2000 *Mathematics Subject Classification*: 18G60, All AMS members \$39, List \$49, Order code CRMM/17N



## Arithmetic Fundamental Groups and Noncommutative Algebra

**Michael D. Fried, University of California, Irvine, and Yasutaka Ihara, RIMS, Kyoto University, Japan, Editors**

The arithmetic and geometry of moduli spaces and their fundamental groups are a very active research area. This book offers a complete overview of developments made over the last decade.

The papers in this volume examine the geometry of moduli spaces of curves with a function on them. The main players in Part 1 are the absolute Galois group  $G_{\mathbb{Q}}$  of the algebraic numbers and its close relatives. By analyzing how  $G_{\mathbb{Q}}$  acts on fundamental groups defined by Hurwitz moduli problems, the authors achieve a grand generalization of Serre's program from the 1960s.

Papers in Part 2 apply  $\theta$ -functions and configuration spaces to the study of fundamental groups over positive characteristic fields. In this section, several authors use Grothendieck's famous lifting results to give extensions to wildly ramified covers. Properties of the fundamental groups have brought collaborations between geometers and group theorists. Several Part 3 papers investigate new versions of the genus 0 problem. In particular, this includes results severely limiting possible monodromy groups of sphere covers. Finally, Part 4 papers treat Deligne's theory of Tannakian categories and arithmetic versions of the Kodaira-Spencer map.

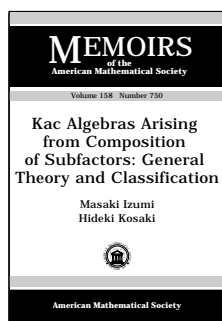
This volume is geared toward graduate students and research mathematicians interested in arithmetic algebraic geometry.

This item will also be of interest to those working in number theory.

**Contents:**  $G_{\mathbb{Q}}$  action on moduli spaces of covers: **P. Dèbes**, Descent theory for algebraic covers; **J. S. Ellenberg**, Galois invariants of dessins d'enfants; **H. Nakamura**, Limits of Galois representations in fundamental groups along maximal degeneration of marked curves, II; **P. Bailey** and **M. D. Fried**, Hurwitz monodromy, spin separation and higher levels of a modular tower; **S. Wewers**, Field of moduli and field of definition of Galois covers; **Y. Ihara**, Some arithmetic aspects of Galois actions on the pro- $p$  fundamental group of  $\mathbb{P}^1 - \{0, 1, \infty\}$ ; **R. T. Sharifi**, Relationships between conjectures on the structure of pro- $p$  Galois groups unramified outside  $p$ ; **H. Nakamura** and **Z. Wojtkowiak**, On explicit formulae for  $l$ -adic polylogarithms; *Curve covers in positive characteristic:* **A. Tamagawa**, Fundamental groups and geometry of curves in positive characteristic; **M. Raynaud**, Sur le groupe fondamental d'une courbe complète en caractéristique  $p > 0$ ; **M. D. Fried** and **A. Mézard**, Configuration spaces for wildly ramified covers; **M. A. Garuti**, Linear systems attached to cyclic inertia; **R. Guralnick** and **K. F. Stevenson**, Prescribing ramification; *Special groups for covers of the punctured sphere:* **S. S. Abhyankar** and **D. Harbater**, Desingularization and modular Galois theory; **D. Frohardt**, **R. Guralnick**, and **K. Magaard**, Genus 0 actions of groups of Lie rank 1; **H. Völklein**, Galois realizations of profinite projective linear groups; *Fundamental groupoids and Tannakian categories:* **S. Gelaki**, Semisimple triangular Hopf algebras and Tannakian categories; **P. H. Hải**, On a theorem of Deligne on characterization of Tannakian categories; **S. Mochizuki**, A survey of the Hodge-Arakelov theory of elliptic curves I.

Proceedings of Symposia in Pure Mathematics, Volume 70

August 2002, 569 pages, Hardcover, ISBN 0-8218-2036-2, LC 2002021586, 2000 *Mathematics Subject Classification*: 20F34, 14E20, 14F35, 12F12, 20C15, 20D06, 14E20, 14H30, 11R32, 16W30, Individual member \$74, List \$124, Institutional member \$99, Order code PSPUM/70N



## Kac Algebras Arising from Composition of Subfactors: General Theory and Classification

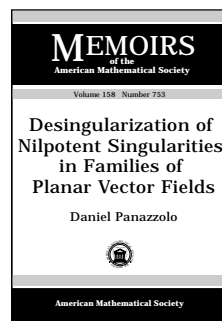
Masaki Izumi, *Kyoto University, Japan*, and Hideki Kosaki, *Kyushu University, Fukuoka, Japan*

**Contents:** Introduction; Actions of matched pairs; Cocycles attached to the pentagon equation; Multiplicative unitary; Kac algebra structure; Group-like elements; Examples of finite-dimensional Kac algebras; Inclusions with the Coxeter-Dynkin graph  $D_6^{(1)}$  and the Kac-Paljutkin algebra; Structure theorems; Classification of certain Kac algebras; Classification of Kac algebras of dimension 16; Group extensions of general Kac algebras; 2-cocycles of Kac algebras; Classification of Kac algebras of dimension 24; Bibliography; Index.

**Memoirs of the American Mathematical Society**, Volume 158, Number 750

July 2002, 198 pages, Softcover, ISBN 0-8218-2935-1, LC 2002018393, 2000 *Mathematics Subject Classification*: 46L37; 46L89, 16W30, **Individual member \$35**, List \$58, Institutional member \$46, Order code MEMO/158/750N

July 2002, approximately 144 pages, Softcover, ISBN 0-8218-2098-2, LC 2002019351, 2000 *Mathematics Subject Classification*: 32Axx, **All AMS members \$23**, List \$29, Order code MMONO/211N



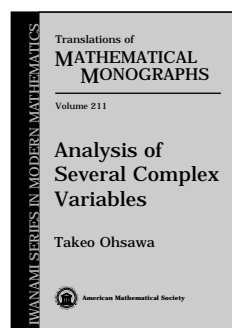
## Desingularization of Nilpotent Singularities in Families of Planar Vector Fields

Daniel Panazzolo, *Instituto de Matemática e Estatística, São Paulo, Brazil*

**Contents:** Introduction; Background material; Nilpotent families and trivialization; Desingularization of Nilpotent singularities; The proof of the desingularization theorem; Applications; Bibliography.

**Memoirs of the American Mathematical Society**, Volume 158, Number 753

July 2002, 108 pages, Softcover, ISBN 0-8218-2927-0, LC 2002018392, 2000 *Mathematics Subject Classification*: 32S45; 58K60, 14E15, **Individual member \$29**, List \$49, Institutional member \$39, Order code MEMO/158/753N



## Analysis of Several Complex Variables

Takeo Ohsawa, *Nagoya University, Japan*

One of the approaches to the study of functions of several complex variables is to use methods originating in real analysis. In this concise book, the author gives a lucid presentation of how these methods produce a variety

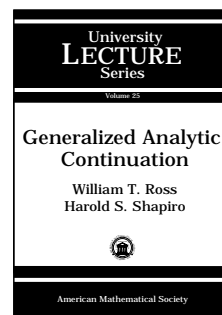
of global existence theorems in the theory of functions (based on the characterization of holomorphic functions as weak solutions of the Cauchy-Riemann equations).

Emphasis is on recent results, including an  $L^2$  extension theorem for holomorphic functions, that have brought a deeper understanding of pseudoconvexity and plurisubharmonic functions. Based on Oka's theorems and his schema for the grouping of problems, the book covers topics at the intersection of the theory of analytic functions of several variables and mathematical analysis.

It is assumed that the reader has a basic knowledge of complex analysis at the undergraduate level. The book would make a fine supplementary text for a graduate-level course on complex analysis.

**Contents:** Holomorphic functions; Rings of holomorphic functions and  $\bar{\partial}$  cohomology; Pseudoconvexity and plurisubharmonic functions;  $L^2$  estimates and existence theorems; Solutions of the extension and division problems; Bergman kernels; Bibliography; Index.

**Translations of Mathematical Monographs (Iwanami Series in Modern Mathematics)**, Volume 211



## Generalized Analytic Continuation

William T. Ross, *University of Richmond, VA*, and Harold S. Shapiro, *Royal Institute of Technology, Stockholm, Sweden*

The theory of generalized analytic continuation studies continuations of meromorphic functions in situations where traditional theory says there is a

*natural boundary*. This broader theory touches on a remarkable array of topics in classical analysis, as described in the book. The authors use the strong analogy with the summability of divergent series to motivate the subject. In this vein, for instance, theorems can be described as being "Abelian" or "Tauberian". The introductory overview carefully explains the history and context of the theory. The book addresses the following questions: (1) When can we say, in some reasonable way, that component functions of a meromorphic function on a disconnected domain, are "continuations" of each other? (2) What role do such "continuations" play in certain aspects of approximation theory and operator theory?

The authors begin with a review of the works of Poincaré, Borel, Wolff, Walsh, and Gončar, on continuation properties of "Borel series" and other meromorphic functions that are limits of rapidly convergent sequences of rational functions. They then move on to the work of Tumarkin, who looked at the continuation properties of functions in the classical Hardy space of the disk in terms of the concept of "pseudocontinuation". Tumarkin's work was seen in a different light by Douglas, Shapiro, and Shields in their discovery of a characterization of the cyclic vectors for the backward shift operator on

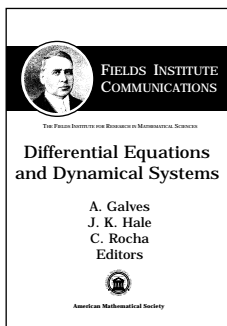
the Hardy space. The authors cover this important concept of "pseudocontinuation" quite thoroughly since it appears in many areas of analysis. They also add a new and previously unpublished method of "continuation" to the list, based on formal multiplication of trigonometric series, which can be used to examine the backward shift operator on many spaces of analytic functions. The book attempts to unify the various types of "continuations" and suggests some interesting open questions.

**Contents:** Overview; Notation and preliminaries; The Poincaré example; Borel's ideas and their later development; Gončar continuation; Pseudocontinuation; A continuation involving almost periodic functions; Continuation by formal multiplication of series; Generalized analytic continuation; List of symbols; Bibliography; Index.

University Lecture Series, Volume 25

April 2002, 149 pages, Softcover, ISBN 0-8218-3175-5, LC 2002018463, 2000 *Mathematics Subject Classification:* 30B40, 47B38, 30B30, 30E10; 47B38, 47A16, 47A10, All AMS members \$25, List \$31, Order code ULECT/25N

## Differential Equations



## Differential Equations and Dynamical Systems

A. Galves, *Universidade de São Paulo, Brazil*, J. K. Hale, *Georgia Institute of Technology, Atlanta*, and C. Rocha, *Instituto Superior Técnico, Lisbon, Portugal*, Editors

This volume contains contributed papers authored by participants of a Conference on Differential Equations and Dynamical Systems which was held at the Instituto Superior Técnico (Lisbon, Portugal). The conference brought together a large number of specialists in the area of differential equations and dynamical systems and provided an opportunity to celebrate Professor Waldyr Oliva's 70th birthday, honoring his fundamental contributions to the field. The volume constitutes an overview of the current research over a wide range of topics, extending from qualitative theory for (ordinary, partial or functional) differential equations to hyperbolic dynamics and ergodic theory.

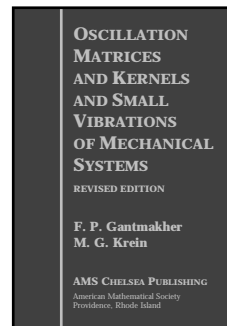
**Contents:** J. F. Alves and J. Sousa Ramos, Total variations and semiconjugacy; J. M. Arrieta, N. Cónsul, and A. Rodríguez-Bernal, Pattern formation from boundary reaction; B. S. Bardin and S. D. Furta, Asymptotics of periodic travelling waves of an infinite beam on a nonlinear elastic support; L. Barreira and B. Saussol, Variational principles for hyperbolic flows; P. Collet, Extensive quantities for infinite systems; N. Cónsul and S. M. Oliva, Synchronization in herbivorous population models with diffusion and delays; P. D. Cordaro, Approximate solutions in locally integrable structures; E. de Faria, Aspects of rigidity and universality in one-dimensional dynamics; T. Faria and W. Huang, Stability of periodic solutions arising

from Hopf bifurcation for a reaction-diffusion equation with time delay; J. M. Ferreira, On the stability and oscillatory behavior of a retarded functional equation; B. Fiedler, C. Rocha, D. Salazar, and J. Solà-Morales, Dynamics of piecewise-autonomous bistable parabolic equations; G. Gallavotti, Intermittency and time arrow in statistical mechanics and turbulence; J. K. Hale and G. Raugel, Galerkin methods and regularity; A. Jacquemard and M.-A. Teixeira, A note on rigid decompositions of reversible mappings; L. A. C. Ladeira, S. H. J. Nicola, and P. Z. Táboas, Periodic solutions of an impulsive differential system with delay: An  $L^p$  approach; B. Lani-Wayda, Representing Poincaré maps by return times; J. Llibre, J. Sotomayor, and M. Zhitomirskii, Impasse bifurcations of constrained systems; L. de Loura, Multipole series and differential equations; N. Martins and J. Sousa Ramos, Cuntz-Krieger algebras arising from linear mod one transformations; F. Mercuri, P. Piccione, and D. V. Tausk, Ordinary differential equations of Morse-Sturm type; W. M. Oliva, Morse-Smale semiflows, openness and  $A$ -stability; P. Piccione and D. V. Tausk, Constrained Lagrangians and degenerate Hamiltonians on manifolds: An index theorem; R. Severino and J. Sousa Ramos, Symbolic dynamics in nonlinear boundary value problems; L. Silva and J. Sousa Ramos, A genealogy for kneading sequences of two-piecewise monotonous maps of the interval.

Fields Institute Communications, Volume 31

June 2002, 353 pages, Hardcover, ISBN 0-8218-2860-6, LC 2002018561, 2000 *Mathematics Subject Classification:* 37-XX; 34-XX, 35-XX, Individual member \$59, List \$99, Institutional member \$79, Order code FIC/31N

Independent Study



## Oscillation Matrices and Kernels and Small Vibrations of Mechanical Systems

Revised Edition

F. P. Gantmacher and M. G. Krein

From a review of the Russian Edition:

*The authors develop in this significant book an extensive theory relating largely to sets of characteristic functions ... The book is characterized throughout by a clear style, by a wealth of results, and by a close union between the mathematical and the dynamical aspects of the investigation.*

—*Mathematical Reviews*

Fifty years after the original Russian Edition, this classic Chelsea publication is finally available in English for the general mathematical audience. This book lays the foundation of what later became "Krein's Theory of String". The original ideas stemming from mechanical considerations are developed with exceptional clarity. A unique feature is that it can be read profitably by both research mathematicians and engineers.

The authors study in depth small oscillations of one-dimensional continua with finite or infinite number of degrees of freedom. They single out an algebraic property responsible for the qualitative behavior of eigenvalues and eigenfunctions of one-dimensional continua and introduce a subclass of totally

positive matrices, which they call oscillatory matrices, as well as their infinite-dimensional generalization and oscillatory kernels. Totally positive matrices play an important role in several areas of modern mathematics, but this book is the only source that explains their simple and intuitively appealing relation to mechanics.

There are two supplements contained in the book, "A Method of Approximate Calculation of Eigenvalues and Eigenvectors of an Oscillatory Matrix", and Krein's famous paper which laid the groundwork for the broad research area of the inverse spectral problem: "On a Remarkable Problem for a String with Beads and Continued Fractions of Stieltjes".

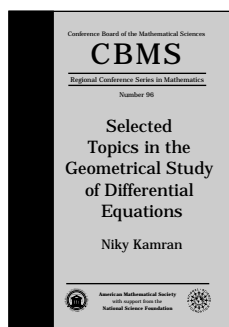
The exposition is self-contained. The first chapter presents all necessary results (with proofs) on the theory of matrices which are not included in a standard linear algebra course. The only prerequisite in addition to standard linear algebra is the theory of linear integral equations used in Chapter 5. The book is suitable for graduate students, research mathematicians and engineers interested in ordinary differential equations, integral equations, and their applications.

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

**Contents:** Introduction; Review of matrices and quadratic forms; Oscillatory matrices; Small oscillations of mechanical systems with  $n$  degrees of freedom; Small oscillations of mechanical systems with an infinite number of degrees of freedom; Sign-definite matrices; A method of approximate calculation of eigenvalues and eigenvectors of an oscillatory matrix; On a remarkable problem for a string with beads and continued fractions of Stieltjes; Remarks; References; Index.

**AMS Chelsea Publishing**

July 2002, 310 pages, Hardcover, ISBN 0-8218-3171-2, LC 2002021449, 2000 *Mathematics Subject Classification*: 34C10, 45A05; 70Jxx, **All AMS members \$49**, List \$54, Order code CHEL/345.HN



## Selected Topics in the Geometrical Study of Differential Equations

**Niky Kamran, McGill University, Montreal, QC, Canada**

The geometrical study of differential equations has a long and distinguished history, dating back to the classical investigations of Sophus Lie, Gaston Darboux, and Elie Cartan. Currently, these ideas occupy a central position in several areas of pure and applied mathematics, including the theory of completely integrable evolution equations, the calculus of variations, and the study of conservation laws. In this book, the author gives an overview of a number of significant ideas and results developed over the past decade in the geometrical study of differential equations.

Topics covered in the book include symmetries of differential equations and variational problems, the variational bi-complex and conservation laws, geometric integrability for hyperbolic equations, transformations of submanifolds and systems of

conservation laws, and an introduction to the characteristic cohomology of differential systems.

The exposition is sufficiently elementary so that non-experts can understand the main ideas and results by working independently. The book is also suitable for graduate students and researchers interested in the study of differential equations from a geometric perspective. It can serve nicely as a companion volume to *The Geometrical Study of Differential Equations*, Volume 285 in the AMS Contemporary Mathematics series.

**Contents:** Differential equations and their geometry; External and generalized symmetries; Internal, external and generalized symmetries; Transformations of surfaces; Transformations of submanifolds; Hamiltonian systems of conservation laws; The variational bi-complex; The inverse problem of the calculus of variations; Conservation laws and Darboux integrability; Characteristic cohomology of differential systems; Bibliography.

**CBMS Regional Conference Series in Mathematics**, Number 96

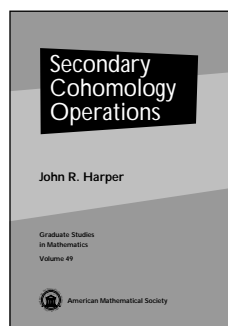
July 2002, 115 pages, Softcover, ISBN 0-8218-2639-5, LC 2002066482, 2000 *Mathematics Subject Classification*: 58A20, 58J70, 58J72, 58J10, 58E30, 58E40, 35L65, 35L60, **All AMS members \$20**, List \$25, Order code CBMS/96N

## Geometry and Topology

Available in Hardcover and Softcover

Recommended Text

Independent Study



## Secondary Cohomology Operations

**John R. Harper, University of Rochester, NY**

Although the theory and applications of secondary cohomology operations are an important part of an advanced graduate-level algebraic topology course, there are few books on the

subject. The AMS now fills that gap with the publication of the present volume.

The author's main purpose in this book is to develop the theory of secondary cohomology operations for singular cohomology theory, which is treated in terms of elementary constructions from general homotopy theory. Among many applications considered are the Hopf invariant one theorem (for all primes  $p$ , including  $p = 2$ ), Browder's theorem on higher Bockstein operations, and cohomology theory of Massey-Peterson fibrations.

Numerous examples and exercises help readers to gain a working knowledge of the theory. A summary of more advanced parts of the core material is included in the first chapter. Prerequisite is basic algebraic topology, including the Steenrod operations.

The book is geared toward graduate students and research mathematicians interested in algebraic topology and can be used for self-study or as a textbook for an advanced course on the topic. It is available in both hardcover and softcover editions.

**Contents:** Review of primary operations; Segue to secondary operations; Fundamental constructions; Secondary cohomology operations; Calculations with secondary operations; The Hopf invariant; The cohomology structure of universal examples; Bibliography; Index.

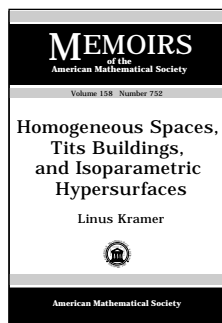
**Graduate Studies in Mathematics, Volume 49**

**Hardcover:**

August 2002, 268 pages, ISBN 0-8218-3198-4, LC 2002023236, 2000 *Mathematics Subject Classification:* 55-01, 55S05, 55S10, 55S20, 55S45, 55P99, **All AMS members \$51**, List \$64, Order code GSM/49

**Softcover:**

August 2002, 268 pages, ISBN 0-8218-3270-0, LC 2002023236, 2000 *Mathematics Subject Classification:* 55-01, 55S05, 55S10, 55S20, 55S45, 55P99, **All AMS members \$39**, List \$49, Order code GSM/49.SN



## Homogeneous Spaces, Tits Buildings, and Isoparametric Hypersurfaces

Linus Kramer, *Universität Würzburg, Germany*

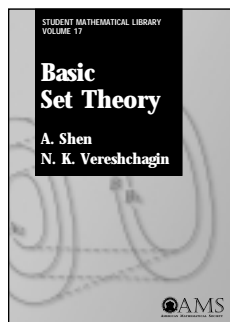
**Contents:** The Leray-Serre spectral sequence; Ranks of homotopy groups; Some homogeneous spaces; Representations of compact Lie groups; The case when  $G$  is simple; The case when  $G$  is semisimple; Homogeneous compact quadrangles; Homogeneous focal manifolds; Bibliography.

**Memoirs of the American Mathematical Society, Volume 158, Number 752**

July 2002, 114 pages, Softcover, ISBN 0-8218-2906-8, LC 2002018395, 2000 *Mathematics Subject Classification:* 51Hxx, 53Cxx; 51E12, 57T15, **Individual member \$30**, List \$50, Institutional member \$40, Order code MEMO/158/752N

## Logic and Foundations

Recommended Text



## Basic Set Theory

A. Shen, *Institute of Problems of Information Transmission, Moscow Independent University, Moscow, Russia*, and N. K. Vereshchagin, *Institute of Problems of Information Transmission, Moscow State Lomonosov University, Moscow, Russia*

The main notions of set theory (cardinals, ordinals, transfinite induction) are fundamental to all mathematicians, not only to those who specialize in mathematical logic or set-theoretic topology. Basic set theory is generally given a brief overview in

courses on analysis, algebra, or topology, even though it is sufficiently important, interesting, and simple to merit its own leisurely treatment.

This book provides just that: a leisurely exposition for a diversified audience. It is suitable for a broad range of readers, from undergraduate students to professional mathematicians who want to finally find out what transfinite induction is and why it is always replaced by Zorn's Lemma.

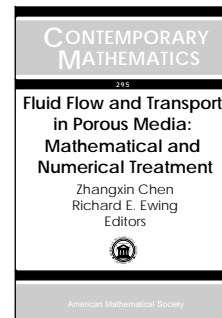
The text introduces all main subjects of "naive" (nonaxiomatic) set theory: functions, cardinalities, ordered and well-ordered sets, transfinite induction and its applications, ordinals, and operations on ordinals. Included are discussions and proofs of the Cantor-Bernstein Theorem, Cantor's diagonal method, Zorn's Lemma, Zermelo's Theorem, and Hamel bases. With over 150 problems, the book is a complete and accessible introduction to the subject.

**Contents:** Sets and their cardinalities; Ordered sets; Bibliography; Index; Glossary.

**Student Mathematical Library, Volume 17**

August 2002, approximately 128 pages, Softcover, ISBN 0-8218-2731-6, LC 2002066533, 2000 *Mathematics Subject Classification:* 03-01, 03Exx, **All AMS members \$17**, List \$21, Order code STML/17N

## Mathematical Physics



## Fluid Flow and Transport in Porous Media: Mathematical and Numerical Treatment

Zhangxin Chen, *Southern Methodist University, Dallas, TX*, and Richard E. Ewing, *Texas A & M University, College Station*, Editors

*College Station, Editors*

This volume contains research papers written and edited by prominent researchers working with the mathematical and numerical treatment of fluid flow and transport in porous media.

Papers are based on talks given at a 2001 Joint AMS-IMS-SIAM Summer Research Conference held at Mount Holyoke College (South Hadley, MA). Topics cover a variety of subjects such as network flow modeling, contemporary numerical methods, parallel computation, optimization, multiscale phenomena, upscaling, uncertainty reduction, well treatment, and media characterization.

The material addresses many problems originating from the applied geosciences and focuses on their common state-of-the-art mathematical and numerical treatment. This work is particularly pertinent to those working in oil exploration and other industrial applications.

The book serves as an excellent reference work for all geoscientists, mathematicians, physicists, and engineers working in this research area.

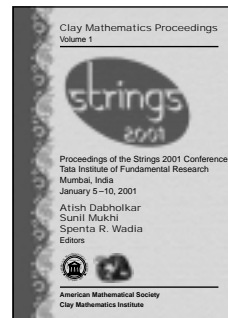
This item will also be of interest to those working in applications.

**Contents:** **J. Aarnes** and **M. S. Espedal**, A new approach to upscaling for two-phase flow in heterogeneous porous media; **C. Alboin**, **J. Jaffré**, **J. E. Roberts**, and **C. Serres**, Modeling fractures as interfaces for flow and transport in porous media; **M. Al-Lawatia** and **H. Wang**, A family of higher-order Eulerian-Lagrangian localized adjoint methods for advection-diffusion equations; **C. Almeida**, **J. Douglas, Jr.**, **F. Pereira**, **L. C. Roman**, and **L.-M. Yeh**, Algorithmic aspects of a locally conservative Eulerian-Lagrangian method for transport-dominated diffusive systems; **I. Berre**, **H. K. Dahle**, **K. H. Karlsen**, and **H. F. Nordhaug**, A streamline front tracking method for two- and three-phase flow including capillary forces; **S. Bitterlich** and **P. Knabner**, Adaptive and formfree identification of nonlinearities in fluid flow from column experiments; **A. Bourgeat**, Overall behaviour of fractured porous media versus fractures' size and permeability ratio; **M. A. Celia** and **A. J. Guswa**, Hysteresis and upscaling in two-phase flow through porous media; **B. M. Chen-Charpentier** and **H. V. Kojouharov**, Simulation of biobarrier-protozoa interaction in porous media; **H. Chen**, **Z. Chen**, **G. Huan**, and **Z. Wang**, Mixed discontinuous FE methods and their applications to two-phase flow in porous media; **Z. Chen**, **Y. Cui**, and **Q. Jiang**, Two-phase immiscible flow with the viscous drag in naturally fractured reservoirs; **Z. Chen**, **G. Huan**, and **B. Li**, Mixed finite element methods for multiphase flow in petroleum reservoirs with multiple wells; **C. C. Douglas**, **G. Haase**, and **M. Iskandarani**, An acceleration procedure for the spectral element ocean model formulation of the shallow water equations; **J. Douglas, Jr.**, **F. Pereira**, and **L.-M. Yeh**, Relations between phase mobilities and capillary pressures for two-phase flows in fractured media; **J. Douglas, Jr.** and **A. M. Spagnuolo**, Parameter estimates for high-level nuclear transport in fractured porous media; **D. B. Duncan** and **Y. Qiu**, Overlapping grids for welltest analysis; **R. E. Ewing**, Upscaling of biological processes and multiphase flow in porous media; **R. E. Ewing**, **J. Wang**, **S. L. Weekes**, and **Y. Yang**, A numerical simulation of multi-component gas flow in porous media by projection methods; **X. Feng**, Recent developments on modeling and analysis of flow of miscible fluids in porous media; **J. Glimm**, **Y.-h. Lee**, and **K. Ye**, A simple model for scale up error; **J. Glimm**, **X. L. Li**, and **Y. Liu**, Conservative front tracking in one space dimension; **N. Herrmann**, BEM with collocation for the heat equation with Neumann and mixed boundary values; **G. Huan**, **Z. Chen**, and **B. Li**, Applications of the control volume function approximation method to reservoir simulations; **K. D. Jarman** and **T. F. Russell**, Analysis of 1-D moment equations for immiscible flow; **D. L. Kern**, **J. J. Westman**, and **F. B. Hanson**, Locally optimal pumping and treatment rates in uncertain environments; **D. Y. Kwak**, A general multigrid framework for a class of perturbed problems; **B. Li**, **Z. Chen**, and **G. Huan**, Modeling horizontal wells using hybrid grids in reservoir simulations; **J. Li**, A multiblock mixed finite element method for 2D and 3D elliptic problems on mixed unstructured grids and its parallelization; **W. B. Lindquist**, Network flow model studies and 3D pore structure; **Q. Liu**, **P. Shen**, and **P. Yang**, Pore scale network modelling of gas slippage in tight porous media; **Q. Lie**, **J. Wang**, **P. Yang**, and **P. Shen**, The calculation of relative permeability by history matching and Beth network model; **A. A. Merrikh**, **J. L. Lage**, and **A. A. Mohamad**, Comparison between pore-level and porous medium models for natural convection in a non-homogeneous enclosure; **A. Narasimhan** and **J. L. Lage**, New models for predicting temperature-dependent viscous effects on flow

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**Strings 2001**

**Atish Dabholkar, Sunil Mukhi, and Spenta R. Wadia, Tata Institute of Fundamental Research, Mumbai, India, Editors**

String theory, sometimes called the "Theory of Everything", has the potential to provide answers to key questions involving quantum gravity, black holes, supersymmetry, cosmology, singularities and the symmetries of nature.

This multi-authored book summarizes the latest results across all areas of string theory from the perspective of world-renowned experts, including Michael Green, David Gross, Stephen Hawking, John Schwarz, Edward Witten and others.

The book comes out of the "Strings 2001" conference, organized by the Tata Institute for Fundamental Research (Mumbai, India), the Abdus Salam ICTP (Trieste, Italy), and the Clay Mathematics Institute (Cambridge, MA, USA). Individual articles discuss the study of D-branes, black holes, string dualities, compactifications, Calabi-Yau manifolds, conformal field theory, noncommutative field theory, string field theory, and string phenomenology. Numerous references provide a path to previous findings and results.

Written for physicists and mathematicians interested in string theory, the volume is a useful resource for any graduate student or researcher working in string theory, quantum field theory, or related areas.

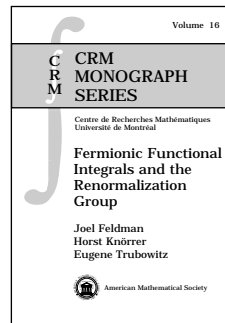
Titles in this series are published by the AMS for the Clay Mathematics Institute (Cambridge, MA).

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## Fermionic Functional Integrals and the Renormalization Group

**Joel Feldman**, *University of British Columbia, Vancouver, BC, Canada*, and  
**Horst Knörrer** and  
**Eugene Trubowitz**, *Eidgen Technische Hochschule, Zürich, Switzerland*

This book, written by well-known experts in the field, offers a concise summary of one of the latest and most significant developments in the theoretical analysis of quantum field theory.

The renormalization group is the name given to a technique for analyzing the qualitative behavior of a class of physical systems by iterating a map on the vector space of interactions for the class. In a typical nonrigorous application of this technique, one assumes, based on one's physical intuition, that only a certain finite dimensional subspace (usually of dimension three or less) is important. The material in this book concerns a technique for justifying this approximation in a broad class of fermionic models used in condensed matter and high energy physics.

This volume is based on the Aisenstadt Lectures given by Joel Feldman at the Centre de Recherches Mathématiques (Montréal, Canada). It is suitable for graduate students and research mathematicians interested in mathematical physics. Included are many problems and solutions.

**Contents:** Fermionic functional integrals; Fermionic expansions; Appendix A. Infinite-dimensional Grassman algebras; Appendix B. Pfaffians; Appendix C. Propagator bounds; Appendix D. Problem solutions; Bibliography.

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