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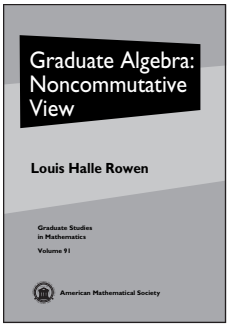
Algebra and Algebraic Geometry



Graduate Algebra: Noncommutative View

Louis Halle Rowen, *Bar-Ilan University, Ramat Gan, Israel*

This book is a companion volume to *Graduate Algebra: Commutative View* (published as volume 73 in this series). The main and most important feature of the book is that it presents a unified approach to many important topics, such as group theory, ring theory, Lie algebras, and gives conceptual proofs of many basic results of noncommutative algebra. There are also a number of major results in noncommutative algebra that are usually found only in technical works, such as Zelmanov's proof of the restricted Burnside problem in group theory, word problems in groups, Tits's alternative in algebraic groups, PI algebras, and many of the roles that Coxeter diagrams play in algebra.

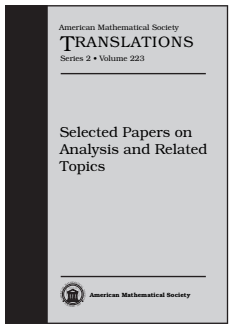
The first half of the book can serve as a one-semester course on noncommutative algebra, whereas the remaining part of the book describes some of the major directions of research in the past 100 years. The main text is extended through several appendices, which permits the inclusion of more advanced material, and numerous exercises. The only prerequisite for using the book is an undergraduate course in algebra; whenever necessary, results are quoted from *Graduate Algebra: Commutative View*.

Contents: *The structure of rings:* Fundamental concepts in ring theory; Semisimple modules and rings and the Wedderburn-Artin theorem; The Jacobson program applied to left Artinian rings; Noetherian rings and the role of prime rings; Algebras in terms of generators and relations; Tensor products; Exercises–Part IV; *Representations of groups and Lie algebras:* Group representations and group algebras; Characters of finite groups; Lie algebras and other nonassociative algebras; Dynkin diagrams (Coxeter-Dynkin graphs and Coxeter groups); Exercises–Part V; *Representable algebras:* Polynomial identities and representable algebras; Central simple algebras and the Brauer group; Homological algebra and categories of modules; Hopf algebras; Exercises–Part VI; Bibliography; Index.

Graduate Studies in Mathematics, Volume 91

June 2008, approximately 613 pages, Hardcover, ISBN: 978-0-8218-4153-2, 2000 *Mathematics Subject Classification:* 16-01, 17-01; 17Bxx, 20Cxx, 20Fxx, **AMS members US$68**, List US$85, Order code GSM/91

Analysis



Selected Papers on Analysis and Related Topics

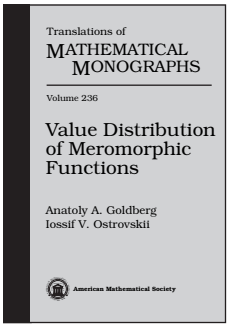
This volume contains translations of papers that originally appeared in the Japanese journal *Sugaku*. The papers range over a variety of topics, including operator algebras, analysis, and statistics.

This volume is suitable for graduate students and research mathematicians interested in analysis and its applications.

Contents: **M. Takesaki**, Entrance to operator algebras; **M. Izumi**, Classification of $C*$-algebras; **A. Miyachi**, Weighted Hardy spaces and Jacobi series; **S. Igari**, Legacy of J. Marcinkiewicz to real analysis in the 20th century; **H. Tanaka**, The Kakeya conjecture; **T. Kumagai**, Recent developments of analysis on fractals; **S. Akiyama**, Symbolic dynamical system and number theoretical tilings; **N. Obata**, Notions of independence in quantum probability and spectral analysis of graphs; **K. Tanaka**, On various applications of the wavelet analysis to statistics; **H. Tanaka**, Bhattacharyya type inequalities.

American Mathematical Society Translations—Series 2, Volume 223

July 2008, approximately 194 pages, Hardcover, ISBN: 978-0-8218-3928-7, 2000 *Mathematics Subject Classification:* 46-06, **AMS members US$79**, List US$99, Order code TRANS2/223



Value Distribution of Meromorphic Functions

Anatoly A. Goldberg, *Bar-Ilan University, Ramat Gan, Israel*, and **Iossif V. Ostrovskii**, *Bilkent University, Ankara, Turkey*

This book contains a comprehensive exposition of the Nevanlinna theory of meromorphic functions of one complex variable, with detailed study of deficiencies, value distribution, and asymptotic properties of meromorphic functions.

A self-contained exposition of the inverse problem for meromorphic functions of finite order with finitely many deficiencies is given in full detail. Many results included in the book belong to the authors and were previously available only in journal articles.

The main body of the book is a translation of the Russian original published in 1970, which has been one of the most popular sources in this field since then. New references and footnotes related to recent achievements in the topics considered in the original edition have been added and a few corrections made. A new Appendix with a survey of the results obtained after 1970 and extensive bibliography has been written by Alexandre Eremenko and James K. Langley for this English edition.

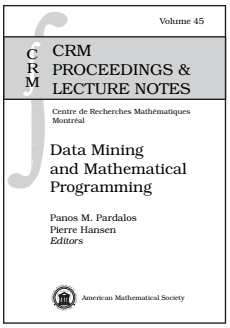
The only prerequisite for understanding material of this book is an undergraduate course in the theory of functions of one complex variable.

Contents: Characteristics of the behavior of a meromorphic function and the first fundamental theorem; Meromorphic functions of finite order; The second fundamental theorem; Deficient values; Asymptotic properties of meromorphic functions and deficiencies; Value distribution with respect to the arguments; Applications of Riemann surfaces to value distribution; On the magnitude of an entire function; Notes; A survey of some results after 1970; Bibliography; Author index; Subject index; Notation index.

Translations of Mathematical Monographs, Volume 236

June 2008, approximately 505 pages, Hardcover, ISBN: 978-0-8218-4265-2, 2000 *Mathematics Subject Classification:* 30D30, 30D35; 30D20, 30D15, **AMS members US$103**, List US$129, Order code MMONO/236

Applications



Data Mining and Mathematical Programming

Panos M. Pardalos, *University of Florida, Gainesville, FL*, and **Pierre Hansen**, *HEC Montréal, QC, Canada*, Editors

Data mining aims at finding interesting, useful or profitable information in very large databases. The enormous increase in the size of available scientific and commercial databases (data avalanche) as well as the continuing and exponential growth in performance of present day computers make data mining a very active field. In many cases, the burgeoning volume of data sets has grown so large that it threatens to overwhelm rather than enlighten scientists. Therefore, traditional methods are revised and streamlined, complemented by many new methods to address challenging new problems. Mathematical Programming plays a key role in this endeavor. It helps us to formulate precise objectives (e.g., a clustering criterion or a measure of discrimination) as well as the constraints imposed on the solution (e.g., find a partition, a covering or a hierarchy in clustering). It also provides powerful mathematical tools to build highly performing exact or approximate algorithms.

This book is based on lectures presented at the workshop on "Data Mining and Mathematical Programming" (October 10–13, 2006, Montreal) and will be a valuable scientific source of information to faculty, students, and researchers in optimization, data analysis and data mining, as well as people working in computer science, engineering and applied mathematics.

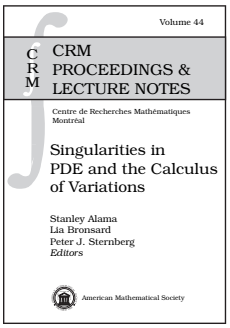
Titles in this series are co-published with the Centre de Recherches Mathématiques.

Contents: E. Carrizosa, Support vector machines and distance minimization; **H. Chen** and **J. Peng**, 0-1 semidefinite programming for graph-cut clustering: Modelling and approximation; **Z. Csizmadia**, **P. L. Hammer**, and **B. Vizvári**, Artificial attributes in analyzing biomedical databases; **Y.-J. Fan**, **C. Iyigun**, and **W. A. Chaovalitwongse**, Recent advances in mathematical programming for classification and cluster analysis; **P. G. Georgiev**, Nonlinear skeletons of data sets and applications—Methods based on subspace clustering; **M. R. Guarracino**, **S. Cuciniello**, **D. Feminiano**, **G. Toraldo**, and **P. M. Pardalos**, Current classification algorithms for biomedical applications; **G. Kunapuli**, **K. P. Bennett**, **J. Hu**, and **J.-S. Pang**, Bilevel model selection for support vector machines; **V. Makarenkov**, **A. Boc**, **A. Boubacar Diallo**, and **A. Baniré Diallo**, Algorithms for detecting complete and partial horizontal gene transfers: Theory and practice; **O. L. Mangasarian** and **E. W. Wild**, Nonlinear knowledge in kernel machines; **F. Murtagh**, Ultrametric embedding: Application to data fingerprinting and to fast data clustering; **O. Seref**, **O. E. Kundakcioglu**, and **P. M. Pardalos**, Selective linear and nonlinear classification.

CRM Proceedings & Lecture Notes, Volume 45

May 2008, 234 pages, Softcover, ISBN: 978-0-8218-4352-9, LC 2008002772, 2000 *Mathematics Subject Classification:* 68R01, 68P01, 68P10, 90-08, 90C09, 90C27, **AMS members US$68**, List US$85, Order code CRMP/45

Differential Equations



Singularities in PDE and the Calculus of Variations

Stanley Alama and **Lia Bronsard**, *McMaster University, Hamilton, ON, Canada*, and **Peter J. Sternberg**, *Indiana University, Bloomington, IN*, Editors

This book contains papers presented at the "Workshop on Singularities in PDE and the Calculus of Variations" at the CRM in July 2006. The main theme of the meeting was the formation of geometrical singularities in PDE problems with a variational formulation. These equations typically arise in some applications (to physics, engineering, or biology, for example) and their resolution often requires a combination of methods coming from areas such as functional and harmonic analysis, differential geometry and geometric measure theory. Among the PDE problems discussed were: the Cahn-Hilliard model of phase transitions and domain walls; vortices in Ginzburg-Landau type models for superconductivity and superfluidity; the Ohna-Kawasaki model for di-block copolymers; models of image enhancement; and Monge-Ampère functions. The articles give a sampling of problems and methods in this diverse area of mathematics, which touches a large part of modern mathematics and its applications.

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

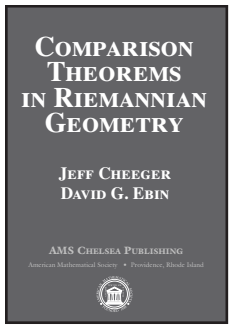
Titles in this series are co-published with the Centre de Recherches Mathématiques.

Contents: E. R. Alvarez-Buylla, **M. Benítez**, **A. Chaos**, **Y. Cortés**, **G. Escalera-Santos**, **C. Espinosa**, and **P. Padilla**, Variational problems arising in biology; **F. Béthuel**, **G. Orlandi**, and **D. Smets**, On the Cauchy problem for phase and vortices in the parabolic Ginzburg-Landau equation; **R. Choksi**, Nonlocal Cahn-Hilliard and isoperimetric problems: Periodic phase separation induced by competing long- and short-range interactions; **T. Giorgi** and **H. Jadallah**, On a generalized Ginzburg-Landau energy for superconducting/normal composite materials; **M. Guan**, **S. Gustafson**, **K. Kang**, and **T.-P. Tsai**, Global questions for map evolution equations; **R. Ignat**, Pohožaev-type identities for an elliptic equation; **R. L. Jerrard**, Some remarks on Monge-Ampère functions; **B. Kawohl**, Variational versus pde-based approaches in mathematical image processing; **M. Kurzke** and **D. Spirn**, On the energy of a Chern-Simons-Higgs vortex lattice; **A. Malchiodi**, Some recent results about a class of singularly perturbed elliptic equations; **V. Millot**, The dipole problem for $H^{1/2}(\mathbb{S}^2;\mathbb{S}^1)$-maps and application; **A. Montero**, Hodge decompositions, Γ-convergence and the Gross-Pitaevskii energy; **Y. Morita**, Bifurcation of vortex solutions to a Ginzburg-Landau equation in an annulus; **X. Ren**, An Allen-Cahn type problem with curvature modification; **M. G. Westdickenberg**, Rare events, action minimization, and sharp interface limits; **W. P. Ziemer**, The Gauss-Green theorem for weakly differentiable vector fields.

CRM Proceedings & Lecture Notes, Volume 44

May 2008, 267 pages, Softcover, ISBN: 978-0-8218-4350-5, LC 2008060012, 2000 *Mathematics Subject Classification:* 35J50, 47J30, **AMS members US$79**, List US$99, Order code CRMP/44

Geometry and Topology



Comparison Theorems in Riemannian Geometry

Jeff Cheeger, *New York University-Courant Institute, NY*, and **David G. Ebin**, *State University of New York at Stony Brook, NY*

... this is a wonderful book, full of fundamental techniques and ideas.

– Robert L. Bryant, Director of the Mathematical Sciences Research Institute

Cheeger and Ebin's book is a truly important classic monograph in Riemannian geometry, with great continuing relevance.

– Rafe Mazzeo, Stanford University

The central theme of this book is the interaction between the curvature of a complete Riemannian manifold and its topology and global geometry.

The first five chapters are preparatory in nature. They begin with a very concise introduction to Riemannian geometry, followed by an exposition of Toponogov's theorem—the first such treatment in a book in English. Next comes a detailed presentation of homogeneous spaces in which the main goal is to find formulas for their curvature. A quick chapter of Morse theory is followed by one on the injectivity radius.

Chapters 6–9 deal with the most relevant contributions to the subject in the years 1959 to 1974. These include the pinching (or sphere) theorem, Berger's theorem for symmetric spaces, the differentiable sphere theorem, the structure of complete manifolds of non-negative curvature, and finally, results about the structure of complete manifolds of non-positive curvature. Emphasis is given to the phenomenon of rigidity, namely, the fact that new topological types can appear when assumptions on the curvature are relaxed from strict to weak inequalities, but only in a restricted way, which usually involves an isometry.

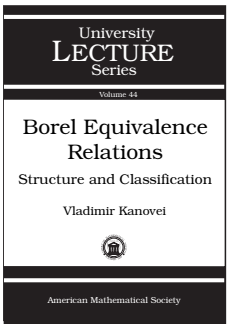
Much of the material, particularly the last four chapters, was essentially state-of-the-art when the book first appeared in 1975. Since then, the subject has exploded, but the material covered in the book still represents an essential prerequisite for anyone who wants to work in the field.

Contents: Basic concepts and results; Toponogov's theorem; Homogeneous spaces; Morse theory; Closed geodesics and the cut locus; The sphere theorem and its generalizations; The differentiable sphere theorem; Complete manifolds of nonnegative curvature; Compact manifolds of nonpositive curvature; Bibliography; Additional bibliography; Index.

AMS Chelsea Publishing

May 2008, 161 pages, Hardcover, ISBN: 978-0-8218-4417-5, LC 2007052113, 2000 *Mathematics Subject Classification:* 53C20; 58E10, **AMS members US$32**, List US$35, Order code CHEL/365.H

Logic and Foundations



Borel Equivalence Relations

Structure and Classification

Vladimir Kanovei, *Institute for Information Transmission Problems, Moscow, Russia*

Over the last 20 years, the theory of Borel equivalence relations and related topics have been very active areas of research in set theory and have important interactions with other fields of mathematics, like ergodic theory and topological dynamics, group theory, combinatorics, functional analysis, and model theory. The book presents, for the first time in mathematical literature, all major aspects of this theory and its applications.

This book should be of interest to a wide spectrum of mathematicians working in set theory as well as the other areas mentioned. It provides a systematic exposition of results that so far have been only available in journals or are even unpublished. The book presents unified and in some cases significantly streamlined proofs of several difficult results, especially dichotomy theorems. It has rather minimal overlap with other books published in this subject.

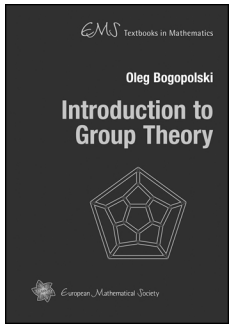
Contents: Introduction; Descriptive set theoretic background; Some theorems of descriptive set theory; Borel ideals; Introduction to equivalence relations; Borel reducibility of equivalence relations; "Elementary" results; Introduction to countable equivalence relations; Hyperfinite equivalence relations; More on countable equivalence relations; The 1st and 2nd dichotomy theorems; Ideal $\mathcal{I}_1$ and the equivalence relation E_1; Actions of the infinite symmetric group; Turbulent group actions; The ideal $\mathcal{I}_3$ and the equivalence relation E_3; Summable equivalence relations; c_0-equalities; Pinned equivalence relations; Reduction of Borel equivalence relations to Borel ideals; On Cohen and Gandy–Harrington forcing over countable models; Bibliography; Index.

University Lecture Series, Volume 44

July 2008, approximately 236 pages, Softcover, ISBN: 978-0-8218-4453-3, LC 2007060598, 2000 *Mathematics Subject Classification:* 03E15, **AMS members US$36**, List US$45, Order code ULECT/44

New AMS-Distributed Publications

Algebra and Algebraic Geometry



Introduction to Group Theory

Oleg Bogopolski, *Technische Universität Dortmundt, Germany*

This book quickly introduces beginners to general group theory and then focuses on three main themes:

- finite group theory, including sporadic groups
- combinatorial and geometric group theory, including the Bass–Serre theory of groups acting on trees
- the theory of train tracks by Bestvina and Handel for automorphisms of free groups

With its many examples, exercises, and full solutions to selected exercises, this text provides a gentle introduction that is ideal for self-study and an excellent preparation for applications. A distinguished feature of the presentation is that algebraic and geometric techniques are balanced. The beautiful theory of train tracks is illustrated by two nontrivial examples.

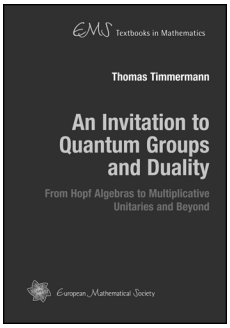
Presupposing only a basic knowledge of algebra, the book is addressed to anyone interested in group theory: from advanced undergraduate and graduate students to specialists.

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

Contents: Introduction to finite group theory; Introduction to combinatorial group theory; Automorphisms of free groups and train tracks; Appendix. The Perron–Frobenius Theorem; Solutions to selected exercises; Bibliography; Index.

EMS Textbooks in Mathematics

March 2008, 187 pages, Hardcover, ISBN: 978-3-03719-041-8, 2000 *Mathematics Subject Classification:* 20-01, 20D08, 20E05, 20E06, 20E08, 20F28, **AMS members US$38**, List US$48, Order code EMSTEXT/6



An Invitation to Quantum Groups and Duality

From Hopf Algebras to Multiplicative Unitaries and Beyond

Thomas Timmermann, *University of Münster, Matematisches Institut, Germany*

This book provides an introduction to the theory of quantum groups with emphasis on their duality and on the setting of operator algebras.

Part I of the text presents the basic theory of Hopf algebras, Van Daele's duality theory of algebraic quantum groups, and Woronowicz's compact quantum groups, staying in a purely algebraic setting. Part II focuses on quantum groups in the setting of operator algebras. Woronowicz's compact quantum groups are treated in the setting of C^*-algebras, and the fundamental multiplicative unitaries of Baaj and Skandalis are studied in detail. An outline of Kustermans' and Vaes' comprehensive theory of locally compact quantum groups completes this part. Part III leads to selected topics, such as coactions, Baaj-Skandalis-duality, and approaches to quantum groupoids in the setting of operator algebras.

The book is addressed to graduate students and non-experts from other fields. Only basic knowledge of (multi-) linear algebra is required for the first part, while the second and third part assume some familiarity with Hilbert spaces, C^*-algebras, and von Neumann algebras.

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

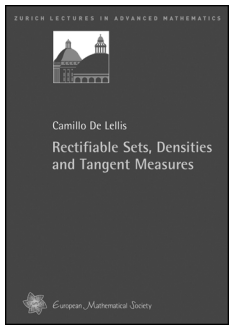
A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: *Part I. From groups to quantum groups:* Hopf algebras; Multiplier Hopf algebras and their duality; Algebraic compact quantum groups; *Part II. Quantum groups and C^*-/von Neumann bialgebras:* First definitions and examples; C^*-algebraic compact quantum groups; Examples of compact quantum groups; Multiplicative unitaries; Locally compact quantum groups; *Part III. Selected topics:* Coactions on C^*-algebras, reduced crossed products, and duality; Pseudo-multiplicative unitaries on Hilbert spaces; Pseudo-multiplicative unitaries on C^*-modules; Appendix; Bibliography; Symbol Index; Index.

EMS Textbooks in Mathematics

February 2008, 427 pages, Hardcover, ISBN: 978-3-03719-043-2, 2000 *Mathematics Subject Classification:* 16W30, 46-01, 46L55, 22A22, 22D25, 22D35, 46L10, **AMS members US$62**, List US$78, Order code EMSTEXT/5

Analysis



Rectifiable Sets, Densities and Tangent Measures

Camillo De Lellis, *University of Zürich, Zurich, Switzerland*

The characterization of rectifiable sets through the existence of densities is a pearl of geometric measure theory. The difficult proof, due to Preiss, relies on many beautiful and deep ideas and novel techniques. Some of them have already proven useful in other contexts, whereas others have not yet been exploited. These notes give a simple and short presentation of the former and provide some perspective of the latter.

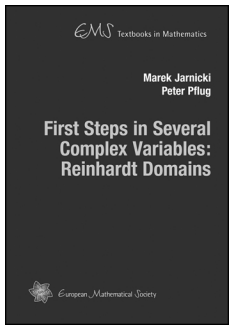
This text emerged from a course on rectifiability given at the University of Zürich. It is addressed both to researchers and students; the only prerequisite is a solid knowledge in standard measure theory. The first four chapters give an introduction to rectifiable sets and measures in Euclidean spaces, covering classical topics such as the area formula, the theorem of Marstrand and the most elementary rectifiability criterions. The fifth chapter is dedicated to a subtle rectifiability criterion due to Marstrand and generalized by Mattila, and the last three focus on Preiss' result. The aim is to provide a self-contained reference for anyone interested in an overview of this fascinating topic.

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

Contents: Introduction; Notation and preliminaries; Marstsand's Theorem and tangent measures; Rectifiability; The Marstrand–Mattila rectifiability criterion; An overview of Preiss' proof; Moments and uniqueness of the tangent measure at infinity; Flat versus curved at infinity; Flatness at infinity implies flatness; Open problems; Appendix A. Proof of Theorem 3.11; Appendix B. Gaussian integrals; Bibliography; Index.

Zurich Lectures in Advanced Mathematics

March 2008, 134 pages, Softcover, ISBN: 978-3-03719-044-9, 2000 *Mathematics Subject Classification:* 28A75, 26B15, 49Q15, 49Q20, **AMS members US$27**, List US$34, Order code EMSZLEC/7



First Steps in Several Complex Variables: Reinhardt Domains

Marek Jarnicki, *Jagiellonian University, Kraków, Poland*, and **Peter Pflug**, *University of Oldenburg, Germany*

This book provides a comprehensive introduction to the field of several complex variables in the setting of a very special but basic class of domains, the so-called Reinhardt domains. In this way the reader

may learn much about this area without encountering too many technical difficulties.

Chapter 1 describes the fundamental notions and the phenomenon of simultaneous holomorphic extension. Chapter 2 presents a fairly complete discussion of biholomorphisms of bounded (complete) Reinhardt domains in the two dimensional case. The third chapter gives a classification of Reinhardt domains of existence for the most important classes of holomorphic functions. The last chapter deals with invariant functions and gives explicit calculations of many of them on certain Reinhardt domains. Numerous exercises are included to help the readers with their understanding of the material. Further results and open problems are added which may be useful as seminar topics.

The primary aim of this book is to introduce students or non-experts to some of the main research areas in several complex variables. The book provides a friendly invitation to this field as the only prerequisite is a basic knowledge of analysis.

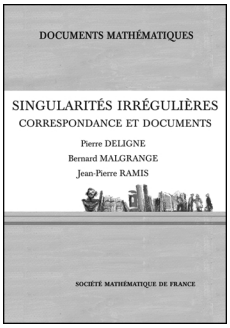
A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: Reinhardt domains; Biholomorphisms of Reinhardt domains; Reinhardt domains of existence of special classes of holomorphic functions; Holomorphically contractible families on Reinhardt domains; Bibliography; Symbols; List of symbols; Subject index.

EMS Textbooks in Mathematics

March 2008, 367 pages, Hardcover, ISBN: 978-3-03719-049-4, 2000 *Mathematics Subject Classification:* 32-01, 32A05, 32A07, 32A10, 32D05, 32E05, 32F45, **AMS members US$62**, List US$78, Order code EMSTEXT/7

Differential Equations



Singularités Irrégulières

Correspondance et Documents

Pierre Deligne, *Institute for Advanced Study, Princeton, NJ*, **Bernard Malgrange**, *Université Grenoble I, St. Martin d'Heres, France*, and **Jean-Pierre Ramis**, *Université Toulouse, France*

The letters collected in this volume concern the irregular singularities of linear differential equations: irregularity, asymptotic expansions, Stokes sheaves, Gevrey analogues, moduli problems, multisummability, Galois and wild fundamental groups, vanishing cycles, Fourier transforms. Most of these letters were written by the authors during the period 1976–1991. Four previously unpublished texts have been added to this correspondence.

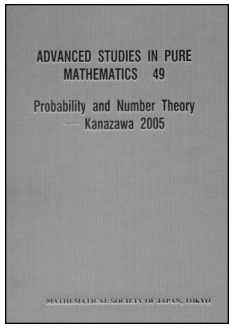
A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: Introduction; Correspondance; Textes; Notes.

Documents Mathématiques, Number 5

November 2007, 188 pages, Hardcover, ISBN: 978-2-85629-241-9, 2000 *Mathematics Subject Classification:* 34Mxx, 12H05, 32G20, **Individual member US$61**, List US$68, Order code SMFDM/5

Number Theory



Probability and Number Theory—Kanazawa 2005

Shigeki Akiyama, *Niigata University, Japan*, **Kohji Matsumoto**, *Nagoya University, Japan*, **Leo Murata**, *Meijigakuin University, Japan*, and **Hiroshi Sugita**, *Osaka University, Japan*, Editors

This volume is the proceedings of the International Conference on Probability and Number Theory held at Kanazawa, Japan, in June 2005 and includes several survey articles on probabilistic number theory and research papers on various recent topics around the border area between probability theory and number theory. This volume is useful for all researchers and graduate students who are interested in probability theory and number theory.

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

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