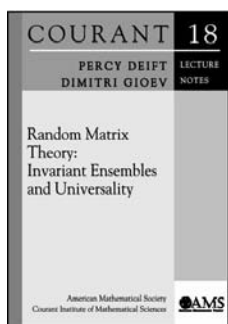


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Algebra and Algebraic Geometry



Random Matrix Theory: Invariant Ensembles and Universality

Percy Deift, *Courant Institute of Mathematical Sciences, New York University, NY*, and Dimitri Gioev, *University of Rochester, NY, and Wilshire Associates Inc., Santa Monica, CA*

This book features a unified derivation of the mathematical theory of the three classical types of invariant random matrix ensembles—orthogonal, unitary, and symplectic. The authors follow the approach of Tracy and Widom, but the exposition here contains a substantial amount of additional material, in particular, facts from functional analysis and the theory of Pfaffians. The main result in the book is a proof of universality for orthogonal and symplectic ensembles corresponding to generalized Gaussian type weights following the authors' prior work. New, quantitative error estimates are derived.

The book is based in part on a graduate course given by the first author at the Courant Institute in fall 2005. Subsequently, the second author gave a modified version of this course at the University of Rochester in spring 2007. Anyone with some background in complex analysis, probability theory, and linear algebra and an interest in the mathematical foundations of random matrix theory will benefit from studying this valuable reference.

This item will also be of interest to those working in probability and discrete mathematics and combinatorics.

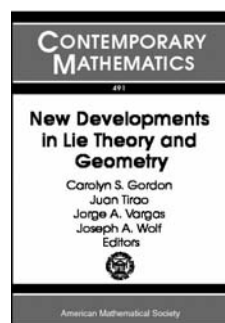
Titles in this series are co-published with the Courant Institute of Mathematical Sciences at New York University.

Contents: *Invariant random matrix ensembles: unified derivation of eigenvalue cluster and correlation functions:* Introduction and examples; Three classes of invariant ensembles; Auxiliary facts from functional analysis, Pfaffians, and three integral identities; Eigenvalue statistics for the three types of ensembles; *Universality*

for orthogonal and symplectic ensembles: Widom's formulae for the $\beta = 1$ and 4 correlation kernels; Large N eigenvalue statistics for the $\beta = 1, 4$ ensembles with monomial potentials: universality; Bibliography; Index.

Courant Lecture Notes, Volume 18

July 2009, 217 pages, Softcover, ISBN: 978-0-8218-4737-4, LC 2009013498, 2000 *Mathematics Subject Classification:* 15A52, 60F05, 05E35, 62E20, 15A90, **AMS members US\$26**, List US\$33, Order code CLN/18



New Developments in Lie Theory and Geometry

Carolyn S. Gordon, *Dartmouth College, Hanover, NH*, Juan Tirao and Jorge A. Vargas, *Universidad Nacional de Cordoba, Argentina*, and Joseph A. Wolf, *University of California, Berkeley, CA*, Editors

This volume is an outgrowth of the Sixth Workshop on Lie Theory and Geometry, held in the province of Córdoba, Argentina in November 2007.

The representation theory and structure theory of Lie groups play a pervasive role throughout mathematics and physics. Lie groups are tightly intertwined with geometry and each stimulates developments in the other. The aim of this volume is to bring to a larger audience the mutually beneficial interaction between Lie theorists and geometers that animated the workshop.

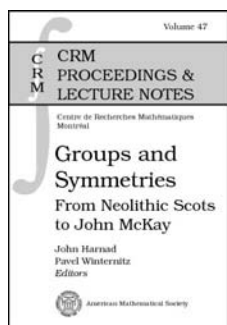
Two prominent themes of the representation theoretic articles are Gelfand pairs and the representation theory of real reductive Lie groups. Among the more geometric articles are an exposition of major recent developments on noncompact homogeneous Einstein manifolds and aspects of inverse spectral geometry presented in settings accessible to readers new to the area.

Contents: J. Lauret, Einstein solvmanifolds and nilsolitons; C. U. Sánchez, Algebraic sets associated to isoparametric submanifolds; L. Ji, Mostow strong rigidity and nonisomorphism for outer automorphism groups of free groups and mapping class groups; R. J. Miatello and J. P. Rossetti, Spectral properties of flat manifolds; P. Gilkey, Heat content, heat trace, and isospectrality; D. Burde, K. Dekimpe, and S. Deschamps, LR-algebras; C. Benson

and **G. Ratcliff**, Combinatorial properties of generalized binomial coefficients; **C. Benson** and **G. Ratcliff**, Spherical functions for the action of a finite unitary group on a finite Heisenberg group; **S. Gurevich** and **R. Hadani**, Application of the Weil representation: Diagonalization of the discrete Fourier transform; **J. A. Wolf**, Infinite dimensional multiplicity free spaces II: Limits of commutative nilmanifolds; **L. Barchini** and **R. Zierau**, Certain components of Springer fibers: algorithms, examples and applications; **E. Galina**, Weighted Vogan diagrams associated to real nilpotent orbits; **M. Colarusso**, The Gelfand-Zeitlin integrable system and its action on generic elements of $\mathfrak{gl}(n)$ and $\mathfrak{so}(n)$; **P. Eberlein** and **M. Jablonski**, Closed orbits of semisimple group actions and the real Hilbert-Mumford function; **N. Andruskiewitsch** and **F. Fantino**, New techniques for pointed Hopf algebras.

Contemporary Mathematics, Volume 491

August 2009, 348 pages, Softcover, ISBN: 978-0-8218-4651-3, LC 2009007622, 2000 *Mathematics Subject Classification*: 22Exx, 43A85, 53Cxx, 53C25, 53C30, 20Gxx, 58J53, **AMS members US\$79**, List US\$99, Order code CONM/491



Groups and Symmetries

From Neolithic Scots to John McKay

John Harnad, *Concordia University, Montreal, QC, Canada*, and **Pavel Winternitz**, *Université de Montréal, Montreal, QC, Canada*, Editors

This volume contains papers presented at a conference held in April 2007 at the CRM in Montreal honouring the remarkable contributions of John McKay over four decades of research. Papers by invitees who were unable to attend the conference are also included.

The papers cover a wide range of topics, including group theory, symmetries, modular functions, and geometry, with particular focus on two areas in which John McKay has made pioneering contributions: “Monstrous Moonshine” and the “McKay Correspondence”. This book will be a valuable reference for graduate students and researchers interested in these and related areas and serve as a stimulus for new ideas.

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

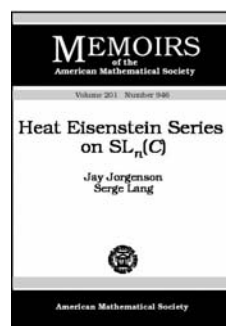
Titles in this series are co-published with the Centre de Recherches Mathématiques.

Contents: **J. McKay**, Introduction and background; **H. Airault**, Symmetric sums associated to the factorization of Grunsky coefficients; **D. Allcock**, A monstrous proposal; **P. Boalch**, Quivers and difference Painlevé equations; **D. X. Charles**, **E. Z. Goren**, and **K. E. Lauter**, Families of Ramanujan graphs and quaternion algebras; **A. Clingher**, **C. F. Doran**, **J. Lewis**, and **U. Whitcher**, Normal forms, K3 surface moduli, and modular parametrizations; **H. Cohn**, Spontaneous generation of Hilbert modular functions; **C. J. Cummins** and **N. S. Haghghi**, On a class of congruence subgroups; **I. V. Dolgachev**, McKay’s correspondence for cocompact discrete subgroups of $SU(1, 1)$; **J. F. Duncan**, Arithmetic groups and the affine E_8 Dynkin diagram; **T. Gannon**, The Galois action on character tables; **N. Ganter**, Hecke operators in equivariant

elliptic cohomology and generalized moonshine; **G. W. Hart**, Sculptural presentation of the icosahedral rotation group; **N. Hitchin**, Spherical harmonics and the iscoahedron; **A. Klimyk** and **J. Patera**, Alternating group and multivariate exponential functions; **J. Morava**, Moonshine elements in elliptic cohomology; **M. R. Murty** and **K. L. Petersen**, The generalized Artin conjecture and arithmetic orbifolds; **I. Nakamura**, McKay correspondence; **V. V. Nikulin**, On ground fields of arithmetic hyperbolic reflection groups; **S. P. Norton**, Moonshine-type functions and the CRM correspondence; **Y. Ohyama**, Monodromy evolving deformations and Halphen’s equation; **D. Zagier**, Integral solutions of Apéry-like recurrence equations.

CRM Proceedings & Lecture Notes, Volume 47

August 2009, 366 pages, Softcover, ISBN: 978-0-8218-4481-6, LC 2009010376, 2000 *Mathematics Subject Classification*: 20D08; 11F03, **AMS members US\$100**, List US\$125, Order code CRMP/47



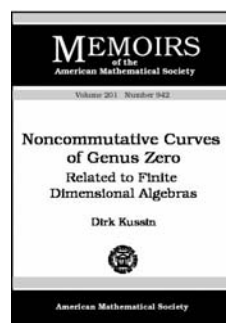
Heat Eisenstein Series on $SL_n(C)$

Jay Jorgenson, *City College of New York, CUNY, NY*, and **Serge Lang**

Contents: Introduction; Notation and terminology; Estimates on SL_n and parabolics; Eisenstein series; Adjointness and inversion relations; Applications of the heat equation; Appendix. The heat kernel; Bibliography; Index.

Memoirs of the American Mathematical Society, Volume 201, Number 946

September 2009, 127 pages, Softcover, ISBN: 978-0-8218-4044-3, 2000 *Mathematics Subject Classification*: 35K05, 58J35, 11F72; 11M36, **Individual member US\$40**, List US\$67, Institutional member US\$54, Order code MEMO/201/946



Noncommutative Curves of Genus Zero

Related to Finite Dimensional Algebras

Dirk Kussin, *Universität Paderborn, Germany*

Contents: Introduction; Background; *Part 1. The homogeneous case:* Graded factoriality; Global and local structure of the sheaf category; Tubular shifts and prime elements; Commutativity and multiplicity freeness; Automorphism groups; *Part 2. The weighted case:* Insertion of weights; Exceptional objects; Tubular exceptional curves; Appendix A. Automorphism groups over the real numbers; Appendix B. The tubular symbols; Bibliography; Index.

Memoirs of the American Mathematical Society, Volume 201, Number 942

September 2009, 128 pages, Softcover, ISBN: 978-0-8218-4400-7, LC 2009019382, 2000 *Mathematics Subject Classification*: 14H45, 16G10; 14H60, 14A22, **Individual member US\$40**, List US\$67, Institutional member US\$54, Order code MEMO/201/942



The Selected Works of Sigurður Helgason

Gestur Ólafsson, *Louisiana State University, Baton Rouge, LA*, and **Henrik Schlichtkrull**, *University of Copenhagen, Denmark*, Editors

Sigurður Helgason is a leading expert in harmonic analysis and integral geometry on symmetric spaces. His work has had, and continues to have, a profound influence on the field. Helgason's work is marked by an interplay of analysis, geometry, and representation theory. The articles collected here cover invariant differential operators, geometric properties of solutions to differential equations on symmetric spaces, double fibrations in integral geometry, spherical functions and spherical transforms, duality for symmetric spaces, representation theory, and the Fourier transform on G/K . The papers are supplemented by an introductory essay by Helgason.

This *Selecta* of Sigurður Helgason's important papers will be a valuable resource to research mathematicians and graduate students.

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

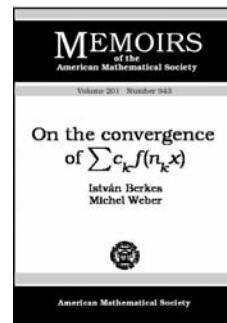
Contents: Multipliers of Banach algebras; Differential operators on homogeneous spaces; Fundamental solutions of invariant differential operators on symmetric spaces; Duality and Radon transform for symmetric spaces; Fundamental solutions of invariant differential operators on symmetric spaces; The Radon transform on Euclidean spaces, compact two-point homogeneous spaces and Grassman manifolds; Radon-Fourier transforms on symmetric spaces and related group representations; A duality in integral geometry on symmetric spaces; Totally geodesic spheres in compact symmetric spaces; An analogue of the Paley-Wiener theorem for the Fourier transform on certain symmetric spaces; (with **A. Korányi**), A Fatou-type theorem for harmonic functions on symmetric spaces; (with **K. Johnson**), The bounded spherical functions on symmetric spaces; Applications of the Radon transform to representations of semisimple Lie groups; A duality for symmetric spaces with applications to group representations; Group representations and symmetric spaces; A formula for the radial part of the Laplace-Beltrami operator; Paley-Wiener theorems and surjectivity of invariant differential operators on symmetric spaces and Lie groups; The surjectivity of invariant differential operators on symmetric spaces I; Eigenspaces of the Laplacian; integral representations and irreducibility; A duality for symmetric spaces with applications to group representations, II. Differential equations and Eigenspace representations; A duality for symmetric spaces with applications to group representations III. Tangent space analysis; (with **F. Gonzalez**), Invariant differential operators on Grassmann manifolds; Value-distribution theory for

holomorphic almost periodic functions; The totally-geodesic Radon transform on constant curvature spaces; Some results on invariant differential operators on symmetric spaces; The flat horocycle transform for a symmetric space; Huygens' principle for wave equations on symmetric spaces; Radon transforms for double fibrations. Examples and viewpoints.; Integral geometry and multitemporal wave equations; (with **H. Schlichtkrull**), The Paley-Wiener space for the multitemporal wave equation; The Abel, Fourier, and Radon transforms on symmetric spaces; The inversion of the x-ray transform on a compact symmetric space.

Collected Works, Volume 22

July 2009, 715 pages, Hardcover, ISBN: 978-0-8218-4753-4, LC 2009010403, 2000 *Mathematics Subject Classification*: 33C67, 46E20, 58J35, 22E30, 43A85, 53C35, **AMS members US\$113**, List US\$141, Order code CWORKS/22

Analysis



On the convergence of $\sum c_k f(n_k x)$

István Berkes, *Graz University of Technology, Austria*, and **Michel Weber**, *Université Louis-Pasteur et C.N.R.S., Strasbourg, France*

Contents: Introduction; Mean convergence; Almost everywhere convergence: Sufficient conditions; Almost everywhere convergence: Necessary conditions; Random sequences; Discrepancy of random sequences $\{S_n x\}$; Some open problems; Bibliography.

Memoirs of the American Mathematical Society, Volume 201, Number 943

September 2009, 72 pages, Softcover, ISBN: 978-0-8218-4324-6, LC 2009019383, 2000 *Mathematics Subject Classification*: 42C15, 42A55, 42A61, 30B50, 11K38, 60G50, **Individual member US\$37**, List US\$62, Institutional member US\$50, Order code MEMO/201/943



A First Course in Sobolev Spaces

Giovanni Leoni, *Carnegie Mellon University, Pittsburgh, PA*

Sobolev spaces are a fundamental tool in the modern study of partial differential equations. In this book, Leoni takes a novel

approach to the theory by looking at Sobolev spaces as the natural development of monotone, absolutely continuous, and BV functions of one variable. In this way, the majority of the text can be read without the prerequisite of a course in functional analysis.

The first part of this text is devoted to studying functions of one variable. Several of the topics treated occur in courses on real analysis or measure theory. Here, the perspective emphasizes their applications to Sobolev functions, giving a very different flavor to the treatment. This elementary start to the book makes it suitable for advanced undergraduates or beginning graduate students. Moreover, the one-variable part of the book helps to develop a solid background that facilitates the reading and understanding of Sobolev functions of several variables.

The second part of the book is more classical, although it also contains some recent results. Besides the standard results on Sobolev functions, this part of the book includes chapters on BV functions, symmetric rearrangement, and Besov spaces.

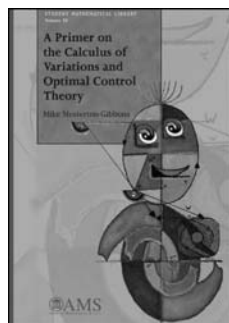
The book contains over 200 exercises.

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

Contents: *Functions of one variable:* Monotone functions; Functions of bounded pointwise variation; Absolutely continuous functions; Curves; Lebesgue–Stieltjes measures; Decreasing rearrangement; Functions of bounded variation and Sobolev functions; *Functions of several variables:* Absolutely continuous functions and change of variables; Distributions; Sobolev spaces; Sobolev spaces: Embeddings; Sobolev spaces: Further properties; Functions of bounded variation; Besov spaces; Sobolev spaces: Traces; Sobolev spaces: Symmetrization; Functional analysis; Measures; The Lebesgue and Hausdorff measures; Notes; Notation and list of symbols; Bibliography; Index.

Graduate Studies in Mathematics, Volume 105

August 2009, 607 pages, Hardcover, ISBN: 978-0-8218-4768-8, LC 2009007620, 2000 *Mathematics Subject Classification:* 46E35; 26A24, 26A27, 26A30, 26A42, 26A45, 26A46, 26A48, 26B30, **AMS members US\$68**, List US\$85, Order code GSM/105



A Primer on the Calculus of Variations and Optimal Control Theory

Mike Mesterton-Gibbons,
Florida State University,
Tallahassee, FL

The calculus of variations is used to find functions that optimize quantities expressed in terms of integrals. Optimal control theory seeks to find functions that minimize cost integrals for systems described by differential equations.

This book is an introduction to both the classical theory of the calculus of variations and the more modern developments of optimal control theory from the perspective of an applied mathematician. It focuses on understanding concepts and how to apply them. The range of potential applications is broad: the calculus of variations and optimal control theory have been widely used in numerous ways in biology, criminology, economics, engineering, finance, management science, and physics.

Applications described in this book include cancer chemotherapy, navigational control, and renewable resource harvesting.

The prerequisites for the book are modest: the standard calculus sequence, a first course on ordinary differential equations, and some facility with the use of mathematical software. It is suitable for an undergraduate or beginning graduate course or for self study. It provides excellent preparation for more advanced books and courses on the calculus of variations and optimal control theory.

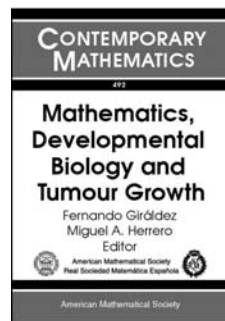
This item will also be of interest to those working in differential equations.

Contents: The Brachistochrone; The fundamental problem. Extremals; The insufficiency of extremality; Important first integrals; The du Bois-Reymond equation; The corner conditions; Legendre’s necessary condition; Jacobi’s necessary condition; Weak versus strong variations; Weierstrass’s necessary condition; The transversality conditions; Hilbert’s invariant integral; The fundamental sufficient condition; Jacobi’s condition revisited; Isoperimetrical problems; Optimal control problems; Necessary conditions for optimality; Time-optimal control; A singular control problem; A biological control problem; Optimal control to a general target; Navigational control problems; State variable restrictions; Optimal harvesting; Afterword; Solutions or hints for selected exercises; Bibliography; Index.

Student Mathematical Library, Volume 50

August 2009, 252 pages, Softcover, ISBN: 978-0-8218-4772-5, LC 2009007701, 2000 *Mathematics Subject Classification:* 49-01, 49K15, 49N05, 49N35; 92-02, 92D50, **AMS members US\$36**, List US\$45, Order code STML/50

Applications



Mathematics, Developmental Biology and Tumour Growth

Fernando Giráldez, *Universitat Pompeu Fabra, Barcelona, Spain,* and **Miguel A. Herrero,** *Universidad Complutense, Madrid, Spain,* Editors

Developmental biology and tumour growth are two important areas of current research where mathematics increasingly provides powerful new techniques and insights. The unfolding complexity of living structures from egg to embryo gives rise to a number of difficult quantitative problems that are ripe for mathematical models and analysis. Understanding this early development process involves the study of pattern formation, which mathematicians view through the lens of dynamical systems. This book addresses several issues in developmental biology, including Notch signalling pathway integration and mesenchymal compartment formation.

Tumour growth is one of the primary challenges of cancer research. Its study requires interdisciplinary approaches involving the close collaboration of mathematicians, biologists and physicians. The summer school addressed angiogenesis, modelling issues arising in

radiotherapy, and tumour growth viewed from the individual cell and the relation to a multiphase-fluid flow picture of that process.

This book is suitable for researchers, graduate students, and advanced undergraduates interested in mathematical methods of developmental biology or tumour growth.

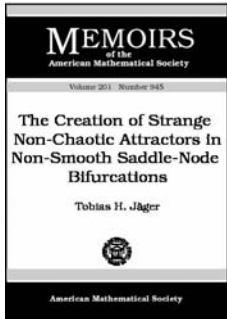
This book is copublished by the Real Sociedad Matemática Española and the American Mathematical Society.

Contents: B. Alsina, A. L. García de Lomana, J. Villá-Freixa, and F. Giráldez, Developmental biology and mathematics: The rules of an embryo; C. G. Arques and M. Torres, From lineage to shape: Modeling dorsal-ventral specification in the developing mouse limb; R. Fior and D. Henrique, Notch-mathics; T. Alarcón, Modelling tumour-induced angiogenesis: A review of individual-based models and multiscale approaches; A. Cappuccio, M. A. Herrero, and L. Nuñez, Tumour radiotherapy and its mathematical modelling; J. Galle and L. Preziosi, Multiphase and individual cell-based models of tumour growth.

Contemporary Mathematics, Volume 492

August 2009, approximately 129 pages, Softcover, ISBN: 978-0-8218-4663-6, LC 2009009818, 2000 *Mathematics Subject Classification*: 34K10, 34K25, 35B40, 35F25, 92C50, **AMS members US\$39**, List US\$49, Order code CONM/492

Differential Equations



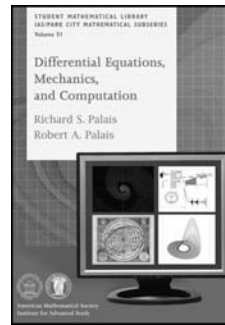
The Creation of Strange Non-Chaotic Attractors in Non-Smooth Saddle-Node Bifurcations

Tobias H. Jäger, *Universität Erlangen-Nürnberg, Germany*

Contents: Introduction; Statement of the main results and applications; Saddle-node bifurcations and sink-source-orbits; The strategy for the construction of the sink-source-orbits; Tools for the construction; Construction of the sink-source orbits: One-sided forcing; Construction of the sink-source-orbits: Symmetric forcing; Bibliography.

Memoirs of the American Mathematical Society, Volume 201, Number 945

September 2009, 106 pages, Softcover, ISBN: 978-0-8218-4427-4, 2000 *Mathematics Subject Classification*: 37D45; 37C60, 37H20, **Individual member US\$40**, List US\$66, Institutional member US\$53, Order code MEMO/201/945



Differential Equations, Mechanics, and Computation

Richard S. Palais, *University of California, Irvine, CA*, and Robert A. Palais, *University of Utah, Salt Lake City, UT*

This book provides a conceptual introduction to the theory of ordinary differential equations, concentrating on the initial value problem for equations of evolution and with applications to the calculus of variations and classical mechanics, along with a discussion of chaos theory and ecological models. It has a careful introduction to the theory of numerical methods with a novel approach to the analysis of errors and stability of various numerical solution algorithms. While the book would be suitable as a textbook for an undergraduate or elementary graduate course in ordinary differential equations, the authors have designed the text also to be useful for motivated students wishing to learn the material on their own or desiring to supplement an ODE textbook being used in a course they are taking with a text offering a more conceptual approach to the subject.

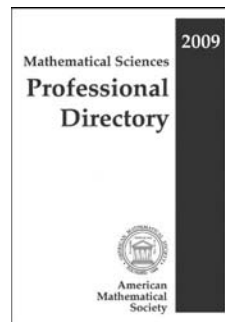
This volume was co-published with the Institute for Advanced Study/Park City Mathematics Institute.

Contents: Introduction; Differential equations and their solutions; Linear differential equations; Second-order ODE and the calculus of variations; Newtonian mechanics; Numerical methods; Linear algebra and analysis; The magic of iteration; Vector fields as differential operators; Coordinate systems and canonical forms; Parametrized curves and arclength; Smoothness with respect to initial conditions; Canonical form for linear operators; Runge-Kutta methods; Multistep methods; Iterative interpolation and its error; Bibliography; Index.

Student Mathematical Library, Volume 51

September 2009, approximately 315 pages, Softcover, ISBN: 978-0-8218-2138-1, LC 2009011294, 2000 *Mathematics Subject Classification*: 34-01, 65-01, 70-01, **AMS members US\$41**, List US\$51, Order code STML/51

General and Interdisciplinary

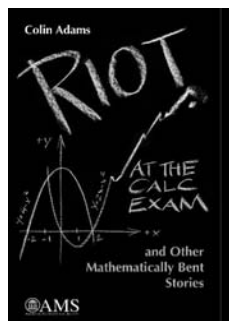


Mathematical Sciences Professional Directory, 2009

This annual directory provides a handy reference to various organizations in the mathematical sciences community. Listed

in the directory are the following: contact (address, phone, fax) info and websites of over thirty professional mathematical organizations; addresses of selected government agencies; academic departments in the mathematical sciences; and alphabetic listings of colleges and universities.

August 2009, 155 pages, Softcover, ISBN: 978-0-8218-4743-5, List US\$55, Institutional member US\$44, Order code PRODIR/2009



Riot at the Calc Exam and Other Mathematically Bent Stories

Colin Adams, *Williams College, Williamstown, MA*

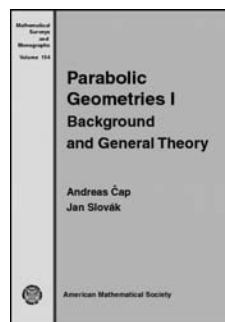
What's so funny about math? Lots! Especially if you're mathematically bent. In the world of Colin Adams, differential equations bring on tears of laughter. Hollywood producers hire algebraic geometers to punch up a script. In this world, math and humor are synonymous. *Riot at the Calc Exam* is a proof of this fact.

A collection of humorous math stories, this book gives a window into mathematics and the culture of mathematicians. Appropriate for mathematicians, math students, math teachers, lay people with an interest in mathematics, and indeed everyone else. This book is a romp through the wild world of mathematics.

Contents: The S. S. Riemann; Pythagoras's darkest hour; Mangum, P. I.; Overcoming math anxiety; A difficult delivery; A proof of God; The red badge of courage; This theorem is big; Journey to the center of mathematics; The theorem blaster; Riot at the calc exam; The mathematical ethicist; Phone interview; The integral: A horror story; The three little pigs; Northnorthwestern State University mathematics department safety manual; Trial and error; Hiring season; Class reunion; Worst-case-scenario survival handbook; Mathematics; Into thin air; Math talk; A deprogrammer's tale; Research announcement; A killer theorem; A subprime lending market primer; Fields medalist stripped; More from the mathematical ethicist; Math fall fashion preview; Dr. Yeckel and Mr. Hide; The Pepsi Putnam challenge; Vital sines; Rumped Stiltsken; **Notes:** Notes for "The S. S. Riemann"; Notes for "Overcoming math anxiety"; Notes for "A difficult delivery"; Notes for "A proof of God"; Notes for "The red badge of courage"; Notes for "Journey to the center of mathematics"; Notes for "The integral: A horror story"; Notes for "The three little pigs"; Notes for "Class reunion"; Notes for "Into thin air"; Notes for "A deprogrammer's tale"; Notes for "Research announcement"; Notes for "Fields medalist stripped"; Notes for "Vital sines"; Notes for "Rumped Stiltsken".

August 2009, 271 pages, Softcover, ISBN: 978-0-8218-4817-3, LC 2009009835, 2000 *Mathematics Subject Classification*: 97A90, 00A05, 00A08, **AMS members US\$26**, List US\$32, Order code MBK/62

Geometry and Topology



Parabolic Geometries I Background and General Theory

Andreas Čap, *Universität Wien, Austria, and International Erwin Schrödinger Institute for Mathematical Physics, Wien, Austria,* and Jan Slovák, *Masaryk University, Brno, Czech Republic*

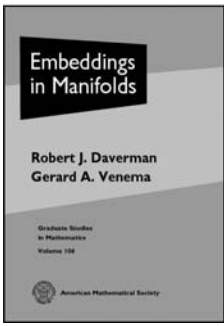
Parabolic geometries encompass a very diverse class of geometric structures, including such important examples as conformal, projective, and almost quaternionic structures, hypersurface type CR-structures and various types of generic distributions. The characteristic feature of parabolic geometries is an equivalent description by a Cartan geometry modeled on a generalized flag manifold (the quotient of a semisimple Lie group by a parabolic subgroup).

Background on differential geometry, with a view towards Cartan connections, and on semisimple Lie algebras and their representations, which play a crucial role in the theory, is collected in two introductory chapters. The main part discusses the equivalence between Cartan connections and underlying structures, including a complete proof of Kostant's version of the Bott-Borel-Weil theorem, which is used as an important tool. For many examples, the complete description of the geometry and its basic invariants is worked out in detail. The constructions of correspondence spaces and twistor spaces and analogs of the Fefferman construction are presented both in general and in several examples. The last chapter studies Weyl structures, which provide classes of distinguished connections as well as an equivalent description of the Cartan connection in terms of data associated to the underlying geometry. Several applications are discussed throughout the text.

Contents: *Background:* Cartan geometries; Semisimple Lie algebras and Lie groups; *General theory:* Parabolic geometries; A panorama of examples; Distinguished connections and curves; Other prolongation procedures; Tables; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 154

August 2009, approximately 634 pages, Hardcover, ISBN: 978-0-8218-2681-2, LC 2009009335, 2000 *Mathematics Subject Classification*: 53C15, 53B15, 53A40, 53A55, 58A32; 53C30, 53D10, 53A30, 58A30, 58J70, **AMS members US\$96**, List US\$120, Order code SURV/154



Embeddings in Manifolds

Robert J. Daverman, *University of Tennessee, Knoxville, TN,*
and Gerard A. Venema, *Calvin College, Grand Rapids, MI*

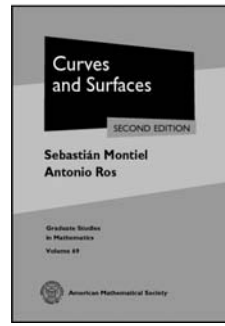
A topological embedding is a homeomorphism of one space onto a subspace of another. The book analyzes how and when objects like polyhedra or manifolds embed in a given higher-dimensional manifold. The main problem is to determine when two topological embeddings of the same object are equivalent in the sense of differing only by a homeomorphism of the ambient manifold. Knot theory is the special case of spheres smoothly embedded in spheres; in this book, much more general spaces and much more general embeddings are considered. A key aspect of the main problem is taming: when is a topological embedding of a polyhedron equivalent to a piecewise linear embedding? A central theme of the book is the fundamental role played by local homotopy properties of the complement in answering this taming question.

The book begins with a fresh description of the various classic examples of wild embeddings (i.e., embeddings inequivalent to piecewise linear embeddings). Engulfing, the fundamental tool of the subject, is developed next. After that, the study of embeddings is organized by codimension (the difference between the ambient dimension and the dimension of the embedded space). In all codimensions greater than two, topological embeddings of compacta are approximated by nicer embeddings, nice embeddings of polyhedra are tamed, topological embeddings of polyhedra are approximated by piecewise linear embeddings, and piecewise linear embeddings are locally unknotted. Complete details of the codimension-three proofs, including the requisite piecewise linear tools, are provided. The treatment of codimension-two embeddings includes a self-contained, elementary exposition of the algebraic invariants needed to construct counterexamples to the approximation and existence of embeddings. The treatment of codimension-one embeddings includes the locally flat approximation theorem for manifolds as well as the characterization of local flatness in terms of local homotopy properties.

Contents: Prequel; Tame and knotted embeddings; Wild and flat embeddings; Engulfing, cellularity, and embedding dimension; Trivial-range embeddings; Codimension-three embeddings; Codimension-two embeddings; Codimension-one embeddings; Codimension-zero embeddings; Bibliography; Selected symbols and abbreviations; Index.

Graduate Studies in Mathematics, Volume 106

September 2009, 474 pages, Hardcover, ISBN: 978-0-8218-3697-2, LC 2009009836, 2000 *Mathematics Subject Classification*: 57N35, 57N30, 57N45, 57N40, 57N60, 57N75, 57N37, 57N70, 57Q35, 57Q30, 57Q45, 57Q40, 57Q60, 57Q55, 57Q37, 57P05, **AMS members US\$60**, List US\$75, Order code GSM/106



Curves and Surfaces Second Edition

Sebastián Montiel and Antonio Ros, *Universidad de Granada, Spain*

This introductory textbook puts forth a clear and focused point of view on the differential geometry of curves and surfaces. Following the modern point of view on differential geometry, the book emphasizes the global aspects of the subject. The excellent collection of examples and exercises (with hints) will help students in learning the material. Advanced undergraduates and graduate students will find this a nice entry point to differential geometry.

In order to study the global properties of curves and surfaces, it is necessary to have more sophisticated tools than are usually found in textbooks on the topic. In particular, students must have a firm grasp on certain topological theories. Indeed, this monograph treats the Gauss–Bonnet theorem and discusses the Euler characteristic. The authors also cover Alexandrov’s theorem on embedded compact surfaces in \mathbb{R}^3 with constant mean curvature. The last chapter addresses the global geometry of curves, including periodic space curves and the four-vertices theorem for plane curves that are not necessarily convex.

Besides being an introduction to the lively subject of curves and surfaces, this book can also be used as an entry to a wider study of differential geometry. It is suitable as the text for a first-year graduate course or an advanced undergraduate course.

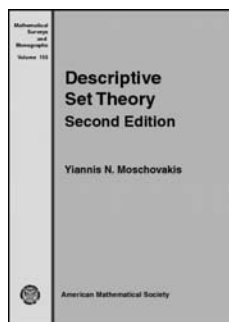
This book is jointly published by the AMS and the Real Sociedad Matemática Española.

Contents: Plane and space curves; Surfaces in Euclidean space; The second fundamental form; Separation and orientability; Integration on surfaces; Global extrinsic geometry; Intrinsic geometry of surfaces; The Gauss–Bonnet theorem; Global geometry of curves; Bibliography; Index.

Graduate Studies in Mathematics, Volume 69

August 2009, 376 pages, Hardcover, ISBN: 978-0-8218-4763-3, LC 2009008149, 2000 *Mathematics Subject Classification*: 53A04, 53A05, 53C40, **AMS members US\$55**, List US\$69, Order code GSM/69.R

Logic and Foundations



Descriptive Set Theory

Second Edition

Yiannis N. Moschovakis,
University of California, Los Angeles, CA, and University of Athens, Greece

Descriptive Set Theory is the study of sets in separable, complete metric spaces that can be defined (or constructed), and so can be expected to have special properties not enjoyed by arbitrary pointsets. This subject was started by the French analysts at the turn of the 20th century, most prominently Lebesgue, and, initially, was concerned primarily with establishing regularity properties of Borel and Lebesgue measurable functions, and analytic, coanalytic, and projective sets. Its rapid development came to a halt in the late 1930s, primarily because it bumped against problems which were independent of classical axiomatic set theory. The field became very active again in the 1960s, with the introduction of strong set-theoretic hypotheses and methods from logic (especially recursion theory), which revolutionized it.

This monograph develops Descriptive Set Theory systematically, from its classical roots to the modern “effective” theory and the consequences of strong (especially determinacy) hypotheses. The book emphasizes the foundations of the subject, and it sets the stage for the dramatic results (established since the 1980s) relating large cardinals and determinacy or allowing applications of Descriptive Set Theory to classical mathematics.

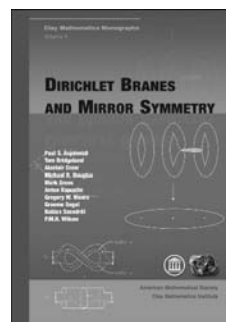
The book includes all the necessary background from (advanced) set theory, logic and recursion theory.

Contents: Introduction; The basic classical notions; κ -Suslin and λ -Borel; Basic notions of the effective theory; Structure theory for pointclasses; The constructible universe; The playful universe; The recursion theorem; Metamathematics; The axiomatics of pointclasses; References; Index.

Mathematical Surveys and Monographs, Volume 155

July 2009, 502 pages, Hardcover, ISBN: 978-0-8218-4813-5, LC 2009011239, 2000 *Mathematics Subject Classification*: 03-02; 03D55, 03E15, 28A05, 54H05, **AMS members US\$92**, List US\$115, Order code SURV/155

Mathematical Physics



Dirichlet Branes and Mirror Symmetry

Paul S. Aspinwall, *Duke University, Durham, NC*, **Tom Bridgeland**, *University of Sheffield, United Kingdom*, **Alastair Craw**, *University of Glasgow, United Kingdom*, **Michael R. Douglas**, *Stony Brook University, NY*, **Mark Gross**, *University of California, San Diego, La Jolla, CA*, **Anton Kapustin**, *California Institute of Technology, Pasadena, CA*, **Gregory W. Moore**, *Rutgers University, Piscataway, NJ*, **Graeme Segal** and **Balázs Szendrői**, *University of Oxford, United Kingdom*, and **P. M. H. Wilson**, *University of Cambridge, United Kingdom*

Research in string theory over the last several decades has yielded a rich interaction with algebraic geometry. In 1985, the introduction of Calabi-Yau manifolds into physics as a way to compactify ten-dimensional space-time has led to exciting cross-fertilization between physics and mathematics, especially with the discovery of mirror symmetry in 1989. A new string revolution in the mid-1990s brought the notion of branes to the forefront. As foreseen by Kontsevich, these turned out to have mathematical counterparts in the derived category of coherent sheaves on an algebraic variety and the Fukaya category of a symplectic manifold.

This has led to exciting new work, including the Strominger-Yau-Zaslow conjecture, which used the theory of branes to propose a geometric basis for mirror symmetry, the theory of stability conditions on triangulated categories, and a physical basis for the McKay correspondence. These developments have led to a great deal of new mathematical work.

One difficulty in understanding all aspects of this work is that it requires being able to speak two different languages, the language of string theory and the language of algebraic geometry. The 2002 Clay School on Geometry and String Theory set out to bridge this gap, and this monograph builds on the expository lectures given there to provide an up-to-date discussion including subsequent developments. A natural sequel to the first Clay monograph on Mirror Symmetry, it presents the new ideas coming out of the interactions of string theory and algebraic geometry in a coherent logical context. We hope it will allow students and researchers who are familiar with the language of one of the two fields to gain acquaintance with the language of the other.

The book first introduces the notion of Dirichlet brane in the context of topological quantum field theories, and then reviews the basics of string theory. After showing how notions of branes arose in string theory, it turns to an introduction to the algebraic geometry, sheaf theory, and homological algebra needed to define and work with derived categories. The physical existence conditions for branes are then discussed and compared in the context of mirror symmetry, culminating in Bridgeland’s definition of stability structures, and its applications to the McKay correspondence and quantum geometry. The book continues with detailed treatments of the Strominger-Yau-Zaslow conjecture, Calabi-Yau metrics and

homological mirror symmetry, and discusses more recent physical developments.

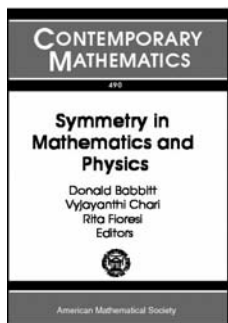
This book is suitable for graduate students and researchers with either a physics or mathematics background, who are interested in the interface between string theory and algebraic geometry.

Titles in this series are co-published with the Clay Mathematics Institute (Cambridge, MA).

Contents: Overview and physical background; D-branes and K-theory in 2D topological field theory; Open strings and Dirichlet branes; Representation theory, homological algebra and geometry; Dirichlet branes and stability conditions; The Strominger-Yau-Zaslow picture of mirror symmetry; Metric aspects of Calabi-Yau manifolds; The mathematics of homological mirror symmetry; Bibliography; Index.

Clay Mathematics Monographs, Volume 4

July 2009, approximately 684 pages, Hardcover, ISBN: 978-0-8218-3848-8, LC 2009014258, 2000 *Mathematics Subject Classification*: 14J32, 18E30, 53D12, 53D40, 53D45, 53C38, 53C29, 53C25, 81T30, 81T40, 81T45, 81T75, **AMS members US\$87**, List US\$109, Order code CMIM/4



Symmetry in Mathematics and Physics

Donald Babbitt, *University of California, Los Angeles, CA*,
Vyjayanthi Chari, *University of California, Riverside, CA*,
and **Rita Fiorese**, *Universita di Bologna, Italy*, Editors

The articles in this volume mainly grew out of talks given at a conference held at UCLA in January 2008, which honored V. S. Varadarajan on his 70th birthday. The main theme of the conference was symmetry in mathematics and physics, areas of mathematics and mathematical physics in which Varadarajan has made significant contributions during the past 50 years. Very early in his career he also worked and made significant contributions in the areas of probability and the foundations of quantum mechanics.

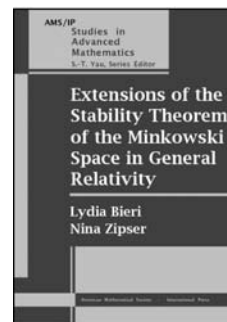
Topics covered by the articles in this volume are probability, quantum mechanics, symmetry (broadly interpreted in mathematics and physics), finite and infinite dimensional Lie groups and Lie algebras and their representations, super Lie groups and supergeometry (relatively new but active and important fields at the interface between mathematics and physics), and supersymmetry. The latter topic takes on a special importance since one of the first experiments at the Large Hadron Collider at CERN will be a test of whether supersymmetry exists in the world of elementary particles. A reprint of an exposition of supersymmetry by one of its founders, B. Zumino, appears in this volume.

Contents: *Probability*: **S. R. S. Varadhan**, The role of weak convergence in probability theory; *Foundations of quantum mechanics*: **E. G. Beltrametti**, Statistical models on a simplex; *Quantum error correcting codes*: **K. R. Parthasarathy**, Quantum error correcting codes and Weyl commutation relations; *Finite and infinite dimensional Lie groups and algebras and their representations*: **V. Chari**, **R. J. Dolbin**, and **T. Ridenour**, Ideals in parabolic subalgebras of simple Lie algebras; **C. H. Conley**, Quantizations of modules of differential operators; **I. Dimitrov**

and **M. Roth**, Geometric realization of PRV components and the Littlewood-Richardson cone; **S. Jijo** and **V. S. Sunder**, Kaç algebras, quantum doubles and planar algebras; **B. Kostant** and **N. Wallach**, On a theorem of Rane Brylinski; **H. Salmasian**, Conjugacy of maximal toral subalgebras of direct limits of loop algebras; **N. Wallach** and **O. Yacobi**, A multiplicity formula for tensor products of SL_2 modules and an explicit Sp_{2n} to $Sp_{2n-2} \times Sp_2$ branching formula; *Super Lie groups and supergeometry*: **L. Balduzzi**, **C. Carmeli**, and **G. Cassinelli**, Super G -spaces; **L. Balduzzi**, **C. Carmeli**, and **R. Fiorese**, Quotients in supergeometry; **M. A. Lledó** and **J. A. López**, Special geometry of $D=4, 5$ supersymmetry; *Supersymmetry*: **S. Ferrara** and **A. Marrani**, Symmetric spaces in supergravity; **M. K. Gaillard**, Symmetry and superstring phenomenology; **B. Zumino**, Supersymmetry: A personal view.

Contemporary Mathematics, Volume 490

August 2009, 251 pages, Softcover, ISBN: 978-0-8218-4731-2, LC 2009004434, 2000 *Mathematics Subject Classification*: 16Sxx, 17Bxx, 20Gxx, 32Cxx, 51Bxx, 60Fxx, 81Pxx, 81Txx, 81-02, **AMS members US\$63**, List US\$79, Order code CONM/490



Extensions of the Stability Theorem of the Minkowski Space in General Relativity

Lydia Bieri and **Nina Zipser**,
Harvard University, Cambridge, MA

This book consists of two independent works: *Part I* is "Solutions of the Einstein Vacuum Equations", by Lydia Bieri. *Part II* is "Solutions of the Einstein-Maxwell Equations", by Nina Zipser.

A famous result of Christodoulou and Klainerman is the global nonlinear stability of Minkowski spacetime. In this book, Bieri and Zipser provide two extensions to this result. In the first part, Bieri solves the Cauchy problem for the Einstein vacuum equations with more general, asymptotically flat initial data, and describes precisely the asymptotic behavior. In particular, she assumes less decay in the power of r and one less derivative than in the Christodoulou-Klainerman result. She proves that in this case, too, the initial data, being globally close to the trivial data, yields a solution which is a complete spacetime, tending to the Minkowski spacetime at infinity along any geodesic. In contrast to the original situation, certain estimates in this proof are borderline in view of decay, indicating that the conditions in the main theorem on the decay at infinity on the initial data are sharp.

In the second part, Zipser proves the existence of smooth, global solutions to the Einstein-Maxwell equations. A nontrivial solution of these equations is a curved spacetime with an electromagnetic field. To prove the existence of solutions to the Einstein-Maxwell equations, Zipser follows the argument and methodology introduced by Christodoulou and Klainerman. To generalize the original results, she needs to contend with the additional curvature terms that arise due to the presence of the electromagnetic field F ; in her case the Ricci curvature of the spacetime is not identically zero but rather represented by a quadratic in the components of F . In particular the Ricci curvature is a constant multiple of the stress-energy tensor for F . Furthermore, the traceless part of the

Riemann curvature tensor no longer satisfies the homogeneous Bianchi equations but rather inhomogeneous equations including components of the spacetime Ricci curvature. Therefore, the second part of this book focuses primarily on the derivation of estimates for the new terms that arise due to the presence of the electromagnetic field.

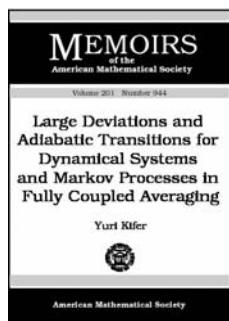
Titles in this series are co-published with International Press, Cambridge, MA.

Contents: *Solutions of the Einstein vacuum equations*, by Lydia Bierl: Introduction; Preliminary tools; Main theorem; Comparison; Error estimates; Second fundamental form k : estimates for the components of k ; Second fundamental form χ : estimating χ and ζ ; Uniformization theorem; χ on the surfaces S -changes in r and s ; The last slice; Curvature tensor-components; Uniformization theorem: standard situation, cases 1 and 2; Bibliography; Index; *Solutions of the Einstein-Maxwell equations*, by Nina Zipser: Introduction; Norms and notation; Existence theorem; The electromagnetic field; Error estimates for F ; Interior estimates for F ; Comparison theorem for the Weyl tensor; Error estimates for W ; Second fundamental form; The lapse function; Optical function; Conclusion; Bibliography; Index.

AMS/IP Studies in Advanced Mathematics, Volume 45

July 2009, 491 pages, Hardcover, ISBN: 978-0-8218-4823-4, LC 2009008908, 2000 *Mathematics Subject Classification*: 83C05; 58J45, 53C80, **AMS members US\$95**, List US\$119, Order code AMSIP/45

Probability



Large Deviations and Adiabatic Transitions for Dynamical Systems and Markov Processes in Fully Coupled Averaging

Yuri Kifer, *Hebrew University, Jerusalem, Israel*

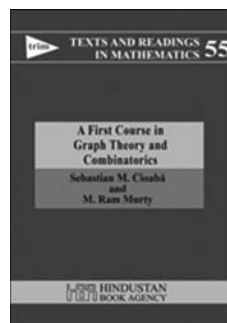
Contents: Part 1. Hyperbolic Fast Motions; Part 2. Markov Fast Motions; Bibliography; Index.

Memoirs of the American Mathematical Society, Volume 201, Number 944

September 2009, 129 pages, Softcover, ISBN: 978-0-8218-4425-0, LC 2009019381, 2000 *Mathematics Subject Classification*: 34C29; 37D20, 60F10, 60J25, **Individual member US\$40**, List US\$67, Institutional member US\$54, Order code MEMO/201/944

New AMS-Distributed Publications

Discrete Mathematics and Combinatorics



A First Course in Graph Theory and Combinatorics

Sebastian M. Cioabă and M. Ram Murty, *Queen's University, Kingston, Ontario, Canada*

The concept of a graph is fundamental in mathematics since it conveniently encodes diverse relations and facilitates combinatorial analysis of many complicated counting problems. In this book, the authors have traced the origins of graph theory from its humble beginnings of recreational mathematics to its modern setting for modeling communication networks as is evidenced by the World Wide Web graph used by many Internet search engines.

This book is an introduction to graph theory and combinatorial analysis. It is based on courses given by the second author at Queen's University at Kingston, Ontario, Canada between 2002 and 2008. The courses were aimed at students in their final year of their undergraduate program.

A publication of Hindustan Book Agency. Distributed on an exclusive basis by the AMS in North America. Online bookstore rights worldwide.

Contents: Basic notions of graph theory; Recurrence relations; The principle of inclusion and exclusion; Matrices and graphs; Trees; Möbius inversion and graph colouring; Enumeration under group action; Matching theory; Block designs; Planar graphs; Edges and cycles; Regular graphs; Hints; Bibliography; Index.

Hindustan Book Agency

May 2009, 186 pages, Hardcover, ISBN: 978-81-85931-98-2, 2000 *Mathematics Subject Classification*: 05-01, **AMS members US\$30**, List US\$38, Order code HIN/42

General and Interdisciplinary



Sixth International Congress on Industrial and Applied Mathematics

Zürich, Switzerland,
July 16–20, 2007

Rolf Jeltsch, *ETH Zürich, Switzerland*, and Gerhard Wanner, *Université de Genève, Switzerland*, Editors

The International Council for Industrial and Applied Mathematics (ICIAM) is the worldwide organization of societies which are dedicated primarily or significantly to applied and/or industrial mathematics. The ICIAM Congresses, held every four years, are run under the auspices of the Council with the aim to advance the applications of mathematics in all parts of the world. The Sixth ICIAM Congress was held in Zürich, Switzerland, July 16–20, 2007, and was attended by more than 3000 scientists from 47 countries.

This volume collects the invited lectures of this Congress, the appreciations of the ICIAM Prize winners' achievements, and the Euler Lecture celebrating the 300th anniversary of Euler. The authors of these papers are leading researchers in their fields, rigorously selected by a distinguished international program committee. The book presents an overview of contemporary applications of mathematics, new perspectives, and open problems. Topics embrace analysis of and numerical methods for:

- linear and nonlinear partial differential equations
- multiscale modeling
- nonlinear problems involving integral operators
- controllability and observability
- asymptotic solutions of Hamilton–Jacobi equations
- contact problems in solid mechanics
- topology optimization of structures
- dissipation inequalities in systems theory
- greedy algorithms
- sampling in function space
- order-value optimization
- parabolic partial differential equations and deterministic games

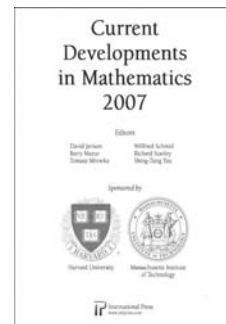
Moreover, particular applications involve risk in financial markets, radar imaging, brain dynamics, and complex geometric optics applied to acoustics and electromagnetics.

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

Contents: *Invited Lectures:* G. Allaire, F. Jouve, and N. Van Goethem, A level set method for the numerical simulation of damage evolution; C. Ebenbauer, T. Raff, and F. Allgöwer, Dissipation inequalities in systems theory: An introduction and recent results; L. Caffarelli, Some nonlinear problems involving non-local diffusions; C. Canuto, High-order methods for PDEs: Recent advances and new perspectives; M. Cheney, Radar imaging; A. Cohen, Adaptive approximations by greedy algorithms; Weinan

E, Multiscale analysis of density functional theory; M. Fortin, C. Robitaille, A. Fortin, and A. Rezgui, Frictional contact in solid mechanics; R. Glowinski, Numerical methods for fully nonlinear elliptic equations; H. Ishii, Asymptotic solutions of Hamilton–Jacobi equations for large time and related topics; B. Keyfitz, Hyperbolic conservation laws. Past and future; R. Kohn and S. Serfaty, Second-order PDE and deterministic games; T. Li, Controllability and observability: From ODEs to quasilinear hyperbolic systems; J. Martínez, Order-value optimization and new applications; C. Schütte, F. Noe, E. Meerbach, P. Metzner, and C. Hartmann, Conformation dynamics; A. Beskos and A. Stuart, MCMC methods for sampling function space; I. Tsuda, Chaotic itinerancy reality in the dynamic brain—episodic memory formation; G. Uhlmann, Visibility and invisibility; J. Xu, Optimal algorithms for discretized partial differential equations; *Euler Special Lecture:* W. Gautschi, Leonhard Euler: His life, the man, and his works.

June 2009, 530 pages, Hardcover, ISBN: 978-3-03719-056-2, 2000 *Mathematics Subject Classification:* 00Bxx, **AMS members US\$118**, List US\$148, Order code EMSICIAM/2007



Current Developments in Mathematics, 2007

Barry Mazur, Wilfried Schmid, and Shing-Tung Yau, *Harvard University, Cambridge, MA*, and David Jerison, Tomasz Mrowka, and Richard P. Stanley, *Massachusetts Institute of Technology, Cambridge, MA*, Editors

The Current Developments in Mathematics (CDM) conference is an annual seminar, jointly hosted by Harvard University and the Massachusetts Institute of Technology, and devoted to surveying the most recent developments in mathematics. In choosing speakers, the hosts take a broad look at the field of geometry and select geometers who transcend classical perceptions within their field. All speakers are prominent specialists in the fields of algebraic geometry, mathematical physics, and other areas. International Press is pleased to present the full contents of these proceedings in the CDM book series.

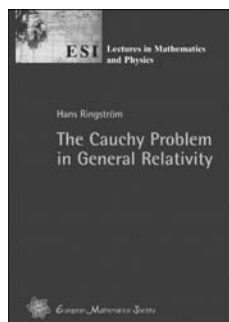
A publication of International Press. Distributed worldwide by the American Mathematical Society.

Contents: B. Green, Three topics in additive prime number theory; Y. Kawamata, Finite generation of a canonical ring; J. Li, Recent progress in GW-invariants of Calabi–Yau threefolds; D. H. Phong and J. Sturm, Lectures on stability and constant scalar curvature; Y.-T. Siu, Techniques for the analytic proof of the finite generation of the canonical ring; C. H. Taubes, Notes on the Seiberg–Witten equations, the Weinstein conjecture and embedded contact homology.

International Press

April 2009, 245 pages, Softcover, ISBN: 978-1-57146-134-6, 2000 *Mathematics Subject Classification:* 00Bxx, **AMS members US\$38**, List US\$48, Order code INPR/82

Mathematical Physics



The Cauchy Problem in General Relativity

Hans Ringström, *KTH Royal Institute of Technology, Stockholm, Sweden*

The general theory of relativity is a theory of manifolds equipped with Lorentz metrics and fields which describe the matter content. Einstein's equations equate the Einstein tensor (a curvature

quantity associated with the Lorentz metric) with the stress energy tensor (an object constructed using the matter fields). In addition, there are equations describing the evolution of the matter. Using symmetry as a guiding principle, one is naturally led to the Schwarzschild and Friedmann-Lemaître-Robertson-Walker solutions, modelling an isolated system and the entire universe respectively. In a different approach, formulating Einstein's equations as an initial value problem allows a closer study of their solutions.

This book first provides a definition of the concept of initial data and a proof of the correspondence between initial data and development. It turns out that some initial data allow non-isometric maximal developments, complicating the uniqueness issue. The second half of the book is concerned with this and related problems, such as strong cosmic censorship.

The book presents complete proofs of several classical results that play a central role in mathematical relativity but are not easily accessible to those without prior background in the subject. Prerequisites are a good knowledge of basic measure and integration theory as well as the fundamentals of Lorentz geometry. The necessary background from the theory of partial differential equations and Lorentz geometry is included.

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

Contents: Introduction; Outline; *Part I. Background from the theory of partial differential equations:* Functional analysis; The Fourier transform; Sobolev spaces; Sobolev embedding; Symmetric hyperbolic systems; Linear wave equations; Local existence, non-linear wave equations; *Part II. Background in geometry, global hyperbolicity and uniqueness:* Basic Lorentz geometry; Characterizations of global hyperbolicity; Uniqueness of solutions to linear wave equations; *Part III. General relativity:* The constraint equations; Local existence; Cauchy stability; Existence of a maximal globally hyperbolic development; *Part IV. Pathologies, strong cosmic censorship:* Preliminaries; Constant mean curvature; Initial data; Einstein's vacuum equations; Closed universe recollapse; Asymptotic behaviour; LRS Bianchi class A solutions; Existence of extensions; Existence of inequivalent extensions; Appendices; Bibliography; Index.

ESI Lectures in Mathematics and Physics, Volume 6

June 2009, 307 pages, Softcover, ISBN: 978-3-03719-053-1, 2000 *Mathematics Subject Classification:* 83-02, 83C75, **AMS members US\$46**, List US\$58, Order code EMSESILEC/6

Number Theory

Number Theory and Applications

Proceedings of the International Conferences on Number Theory and Cryptography

S. D. Adhikari and **B. Ramakrishnan**,
Harish-Chandra Research Institute, Allahabad, India,
Editors

This collection of articles contains the proceedings of the two international conferences (on Number Theory and Cryptography) held at the Harish-Chandra Research Institute. In recent years the interest in number theory has increased due to its applications in areas like error-correcting codes and cryptography. These proceedings contain papers in various areas of number theory, such as combinatorial, algebraic, analytic and transcendental aspects, arithmetic algebraic geometry, as well as graph theory and cryptography. While some papers do contain new results, several of the papers are expository articles that mention open questions, which will be useful to young researchers.

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Contents: **R. Balasubramanian, G. Garg, and C. E. Veni Madhavan**, Analysis of the lattice sieve 1; **I. Baoulina**, On the number of solutions to the equation $(x_1 + \dots + x_n)^m = ax_1 \dots x_n$ over the finite field F_q for $\gcd(m - n, q - 1) = 7$ and $\gcd(m - n, q - 1) = 14$; **Y. J. Choie, A. Sankaranarayanan, and J. Sengupta**, On the sign changes of Hecke eigenvalues; **A. Dubickas**, Distribution of some sequences modulo 1; **S. Ganguly**, Large sieves and cusp forms of weight one; **G. Grekos**, Open problems on densities; **A. Hoshi and K. Miyake**, A geometric framework for the subfield problem of generic polynomials via Tschirnhausen transformation; **I. Kátai**, On q -additive and q -multiplicative functions; **M. R. Murty**, Variations of the Sato-Tate conjecture; **D. S. Nagaraj and P. Sastry**, On the determination of Diophantine triples; **A. M. Raigorodskii and O. I. Rubanov**, On the clique and the chromatic numbers of high-dimensional distance graphs; **A. Saikia**, On units generated by Euler systems; **N. Saradha and R. Thangadurai**, Pillai's problem on consecutive integers; **W. A. Schmid**, Characterization of class groups of Krull monoids via their systems of sets of lengths: A status report; **W. M. Schmidt**, Diophantine approximation by numbers of small height; **J.-H. Yang**, Theory of the Siegel modular variety.

Hindustan Book Agency

June 2009, 290 pages, Hardcover, ISBN: 978-81-85931-97-5, 2000 *Mathematics Subject Classification:* 05C15, 05C80, 05D10, 11A25, 11B05, 11D09, 11F66, 11F72, 11G25, 11J17, 11K06, 11M41, 11N69, 11R16, 11R18, 11R27, 11Y05, 12E25, 14K10, **AMS members US\$42**, List US\$52, Order code HIN/43