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Algebra and Algebraic Geometry

The Endoscopic Classification of Representations
James Arthur, University of Toronto, ON, Canada

Within the Langlands program, endoscopy is a fundamental process for relating automorphic representations of one group with those of another. In this book, Arthur establishes an endoscopic classification of automorphic representations of orthogonal and symplectic groups $G$. The representations are shown to occur in families (known as global $L$-packets and $A$-packets), which are parametrized by certain self-dual automorphic representations of an associated general linear group $GL(N)$. The central result is a simple and explicit formula for the multiplicity in the automorphic discrete spectrum of $G$ for any representation in a family.

The results of the volume have already had significant applications: to the local Langlands correspondence, the construction of unitary representations, the existence of Whittaker models, the analytic behaviour of Langlands $L$-functions, the spectral theory of certain locally symmetric spaces, and to new phenomena for symplectic epsilon-factors. One can expect many more. In fact, it is likely that both the results and the techniques of the volume will have applications to almost all sides of the Langlands program.

The methods are by comparison of the trace formula of $G$ with its stabilization (and a comparison of the twisted trace formula of $GL(N)$ with its stabilization, which is part of work in progress by Moeglin and Waldspurger). This approach is quite different from methods that are based on $L$-functions, converse theorems, or the theta correspondence. The comparison of trace formulas in the volume ought to be applicable to a much larger class of groups. Any extension at all will have further important implications for the Langlands program.

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

Contents: Parameters; Local transfer; Global stabilization; The standard model; A study of critical cases; The local classification; Local nontempered representations; The global classification; Inner forms; Bibliography; Index.

Colloquium Publications, Volume 61


Noncommutative Birational Geometry, Representations and Combinatorics

Arkady Berenstein, University of Oregon, Eugene, OR, and Vladimir Retakh, Rutgers University, Piscataway, NJ, Editors

This volume contains the proceedings of the AMS Special Session on Noncommutative Birational Geometry, Representations and Cluster Algebras, held from January 6–7, 2012, in Boston, MA.

The papers deal with various aspects of noncommutative birational geometry and related topics, focusing mainly on structure and representations of quantum groups and algebras, braided algebras, rational series in free groups, Poisson brackets on free algebras, and related problems in combinatorics.

This volume is useful for researchers and graduate students in mathematics and mathematical physics who want to be introduced to different areas of current research in the new area of noncommutative algebra and geometry.

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

Contents: R. Bacher and C. Reutenauer, The number of right ideals of given codimension over a finite field; Y. Bazlov and A. Berenstein, Cocycle twists and extensions of braided doubles; A. Berenstein and J. Greenstein, Quantum Chevalley groups; A. Berenstein, V. Retakh, C. Reutenauer, and D. Zeilberger, The reciprocal of $\sum_{a,b} a^b$ for non-commuting $a$ and $b$, Catalan numbers and non-commutative quadratic equations; A. Carroll and J. Weyman, Semi-invariants for gentle algebras; S. Gautam and V. T. Laredo, Monodromy of the trigonometric Casimir connection for $sl_2$; A. Lauve and C. Reutenauer, Rational series in the free group and the Connes
operator; K. Lee and L. Li, On natural maps from strata of quiver Grassmannians to ordinary Grassmannians; D. Nacin, Properties of a minimal non-Koszul A(Γ); A. Odesskii, V. Rubtsov, and V. Sokolov, Double Poisson brackets on free associative algebras; M. Vancliff and P. P. Veerapen, Generalizing the notion of rank to noncommutative quadratic forms.

Contemporary Mathematics, Volume 592

An Introduction to Central Simple Algebras and Their Applications to Wireless Communication
Grégory Berhuy, Université Joseph Fourier, Grenoble, France, and Frédérique Oggier, Nanyang Technological University, Singapore, Singapore

Central simple algebras arise naturally in many areas of mathematics. They are closely connected with ring theory, but are also important in representation theory, algebraic geometry and number theory. Recently, surprising applications of the theory of central simple algebras have arisen in the context of coding for wireless communication. The exposition in the book takes advantage of this serendipity, presenting an introduction to the theory of central simple algebras intertwined with its applications to coding theory. Many results or constructions from the standard theory are presented in classical form, but with a focus on explicit techniques and examples, often from coding theory.

Topics covered include quaternion algebras, splitting fields, the Skolem-Noether Theorem, the Brauer group, crossed products, cyclic algebras and algebras with a unitary involution. Code constructions give the opportunity for many examples and explicit computations. This book provides an introduction to the theory of central algebras accessible to graduate students, while also presenting topics in coding theory for wireless communication for a mathematical audience. It is also suitable for coding theorists interested in learning how division algebras may be useful for coding in wireless communication.

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

Contents: Introduction; Central simple algebras; Quaternion algebras; Fundamental results on central simple algebras; Splitting fields of central simple algebras; The Brauer group of a field; Crossed products; Cyclic algebras; Central simple algebras of degree 4; Central simple algebras with unitary involutions; Tensor products; A glimpse of number theory; Complex ideal lattices; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 189
Analysis

Complex Analysis and Dynamical Systems V

Mark L. Agranovsky, Bar-Ilan University, Ramat-Gan, Israel, Matania Ben-Artzi, Hebrew University of Jerusalem, Israel, Greg Galloway, University of Miami, Coral Gables, FL, Lavi Karp, ORT Braude College, Karmiel, Israel, Vladimir Maz’ya, Linköping University, Sweden, Simeon Reich, Technion-Israel Institute of Technology, Haifa, Israel, David Shoikhet, ORT Braude College, Karmiel, Israel, Gilbert Weinstein, University of Alabama at Birmingham, AL, and Lawrence Zalcman, Bar-Ilan University, Ramat-Gan, Israel, Editors

This volume contains the proceedings of the Fifth International Conference on Complex Analysis and Dynamical Systems, held from May 22–27, 2011, in Akko (Acre), Israel.

The papers cover a wide variety of topics in complex analysis and partial differential equations, including meromorphic functions, one-parameter semigroups, subordination chains, quasilinear hyperbolic systems, and the Euler-Poisson-Darboux equation. In addition, there are several articles dealing with various aspects of fixed point theory, hyperbolic geometry, and optimal control.

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

This book is co-published with Bar-Ilan University (Ramat-Gan, Israel).


Contemporary Mathematics, Volume 591


Differential Equations

Introduction to Smooth Ergodic Theory

Luis Barreira, Instituto Superior Técnico, Lisbon, Portugal, and Yakov Pesin, Pennsylvania State University, State College, PA

This book is the first comprehensive introduction to smooth ergodic theory. It consists of two parts: the first introduces the core of the theory and the second discusses more advanced topics. In particular, the book describes the general theory of Lyapunov exponents and its applications to the stability theory of differential equations, the concept of nonuniform hyperbolicity, stable manifold theory (with emphasis on the absolute continuity of invariant foliations), and the ergodic theory of dynamical systems with nonzero Lyapunov exponents. The authors also present a detailed description of all basic examples of conservative systems with nonzero Lyapunov exponents, including the geodesic flows on compact surfaces of nonpositive curvature.

This book is a revised and considerably expanded version of the previous book by the same authors: Lyapunov Exponents and Smooth Ergodic Theory (University Lecture Series, Vol. 23, AMS, 2002). It is aimed at graduate students specializing in dynamical systems and ergodic theory as well as anyone who wants to acquire a working knowledge of smooth ergodic theory and to learn how to use its tools. With more than 80 exercises, the book can be used as a primary textbook for an advanced course in smooth ergodic theory. The book is self-contained and only a basic knowledge of real analysis, measure theory, differential equations, and topology is required and, even so, the authors provide the reader with the necessary background definitions and results.

Contents: The core of the theory: Examples of hyperbolic dynamical systems; General theory of Lyapunov exponents; Lyapunov stability theory of nonautonomous equations; Elements of the nonuniform hyperbolicity theory; Cocycles over dynamical systems; The multiplicative ergodic theorem; Local manifold theory; Absolute continuity of local manifolds; Ergodic properties of smooth hyperbolic measures; Geodesic flows on surfaces of nonpositive curvature; Selected advanced topics: Cone techniques; Partially hyperbolic diffeomorphisms with nonzero exponents; More examples
of dynamical systems with nonzero Lyapunov exponents; Anosov rigidity; $C^1$ pathological behavior: Pugh’s example; Bibliography; Index.

Graduate Studies in Mathematics, Volume 148

Algebraic and Geometric Aspects of Integrable Systems and Random Matrices
Anton Dzhamay, University of Northern Colorado, Greeley, CO, and Kenichi Maruno and Virgil U. Pierce, University of Texas-Pan American, Edinburg, TX, Editors

This volume contains the proceedings of the AMS Special Session on Algebraic and Geometric Aspects of Integrable Systems and Random Matrices, held from January 6–7, 2012, in Boston, MA.

The very wide range of topics represented in this volume illustrates the importance of methods and ideas originating in the theory of integrable systems to such diverse areas of mathematics as algebraic geometry, combinatorics, and probability theory. The volume offers a balanced combination of survey articles and research papers with important new results.

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


Contemporary Mathematics, Volume 593

Evolution Equations
David Ellwood, Harvard University, Cambridge, MA, Igor Rodnianski and Gigliola Staffilani, Massachusetts Institute of Technology, Cambridge, MA, and Jared Wunsch, Northwestern University, Evanston, IL, Editors

This volume is a collection of notes from lectures given at the 2008 Clay Mathematics Institute Summer School, held in Zürich, Switzerland. The lectures were designed for graduate students and mathematicians within five years of the Ph.D., and the main focus of the program was on recent progress in the theory of evolution equations. Such equations lie at the heart of many areas of mathematical physics and arise not only in situations with a manifest time evolution (such as linear and nonlinear wave and Schrödinger equations) but also in the high energy or semi-classical limits of elliptic problems.

The three main courses focused mainly on microlocal analysis and spectral and scattering theory, the theory of nonlinear Schrödinger and wave equations, and evolution problems in general relativity. These major topics were supplemented by several mini-courses reporting on the derivation of effective evolution equations from microscopic quantum dynamics; on wave maps with and without symmetries; on quantum N-body scattering, diffraction of waves, and symmetric spaces; and on nonlinear Schrödinger equations at critical regularity.

Although highly detailed treatments of some of these topics are now available in the published literature, in this collection the reader can learn the fundamental ideas and tools with a minimum of technical machinery. Moreover, the treatment in this volume emphasizes common themes and techniques in the field, including exact and approximate conservation laws, energy methods, and positive commutator arguments.

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

Contents: J. Wunsch, Microlocal analysis and evolution equations: Lecture notes from the 2008 CMI/ETH Summer School; D. Baskin and R. Mazzeo, Some global aspects of linear wave equations; M. Dafermos and I. Rodnianski, Lectures on black holes and linear waves; G. Staffilani, The theory of nonlinear Schrödinger equations; P. Raphael, On the singularity formation for the nonlinear Schrödinger equation; R. Killip and M. Višan, Nonlinear Schrödinger equations at critical regularity; A. Vasy, Geometry and analysis in many-body scattering; M. Struwe, Wave maps with and without symmetries; B. Schlein, Derivation of effective evolution equations from microscopic quantum dynamics.

Clay Mathematics Proceedings, Volume 17
Recent Trends in Nonlinear Partial Differential Equations I
Evolution Problems
James B. Serrin, Enzo L. Mitidieri, University of Trieste, Italy, and Vincenţiu D. Rădulescu, University of Craiova, Romania, Editors

This book is the first of two volumes which contain the proceedings of the Workshop on Nonlinear Partial Differential Equations, held from May 28–June 1, 2012, at the University of Perugia in honor of Patrizia Pucci’s 60th birthday.

The workshop brought together leading experts and researchers in nonlinear partial differential equations to promote research and to stimulate interactions among the participants. The workshop program testified to the wide ranging influence of Professor Pucci on the field of nonlinear analysis and partial differential equations.

In her own work, Patrizia Pucci has been a seminal influence in many important areas: the maximum principle, qualitative analysis of solutions to many classes of nonlinear PDEs (Kirchhoff problems, polyharmonic systems), mountain pass theorem in the critical case, critical exponents, variational identities, as well as various degenerate or singular phenomena in mathematical physics. This same breadth is reflected in the mathematical papers included in this volume.

The companion volume (Contemporary Mathematics, Volume 595) is devoted to stationary problems in nonlinear partial differential equations.


Contemporary Mathematics, Volume 594
F. Robert, Uniform estimates for polyharmionic Green functions in domains with small holes; G. Molica Bisci, Variational problems on the sphere; N. S. Papageorgiou and V. Rădulescu, Semilinear Neumann problems with indefinite and unbounded potential and crossing nonlinearity; R. Servadei, Infinitely many solutions for fractional Laplace equations with subcritical nonlinearity.

Contemporary Mathematics, Volume 595

Discrete Mathematics and Combinatorics

Difference Sets
Connecting Algebra, Combinatorics, and Geometry

Emily H. Moore, Grinnell College, IA, and Harriet S. Pollatsek, Mount Holyoke College, South Hadley, MA

Difference sets belong both to group theory and to combinatorics. Studying them requires tools from geometry, number theory, and representation theory. This book lays a foundation for these topics, including a primer on representations and characters of finite groups. It makes the research literature on difference sets accessible to students who have studied linear algebra and abstract algebra, and it prepares them to do their own research.

This text is suitable for an undergraduate capstone course, since it illuminates the many links among topics that the students have already studied. To this end, almost every chapter ends with a coda highlighting the main ideas and emphasizing mathematical connections. This book can also be used for self-study by anyone interested in these connections and concrete examples.

An abundance of exercises, varying from straightforward to challenging, invites the reader to solve puzzles, construct proofs, and investigate problems—by hand or on a computer. Hints and solutions are provided for selected exercises, and there is an extensive bibliography. The last chapter introduces a number of applications to real-world problems and offers suggestions for further reading.

Both authors are experienced teachers who have successfully supervised undergraduate research on difference sets.

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

Contents: Introduction; Designs; Automorphisms of designs; Introducing difference sets; Bruck-Ryser-Chowla theorem; Multipliers; Necessary group conditions; Difference sets from geometry; Families from Hadamard matrices; Representation theory; Group characters; Using algebraic number theory; Applications; Background; Notation; Hints and solutions to selected exercises; Bibliography; Index; Index of parameters.

Student Mathematical Library, Volume 67
This volume contains the proceedings of the summer school Galoisian and Arithmetic Theory of Differential Equations, held at the CIRM in Luminy from September 21 to September 25, 2009. This school brought together mathematicians from various areas of research, united by their interest in ordinary differential equations, particularly those that arise in arithmetic.

This volume consists of five surveys, corresponding to the five lecture courses given during the school, plus six original papers, corresponding to research talks also given on this occasion. The volume also contains a reworking, by B. Chiarellotto, G. Gerotto, and F. J. Sullivan, of notes of the lectures on exponential modules given by B. M. Dwork at the University of Padova in 1994.

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

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: D. Bertrand, Galois descent in Galois theories; F. Beukers, Notes on A-hypergeometric functions; V. Bosser and F. Pellarin, Drinfeld A-quasi-modular forms; G. Casale, An introduction to Malgrange pseudogroup; B. Chiarellotto, An invitation to p-adic differential equations (Edited with the aid of G. Gerotto and F. Sullivan); L. Di Vizio and J. Sauloy, Outils pour la classification locale des équations aux q-différences linéaires complexes; C. Hardouin, Unipotent radicals of Tannakian Galois groups in positive characteristic; G. Krattenthaler and T. Rivoal, Multivariate p-adic formal congruences and integrality of Taylor coefficients of mirror maps; A. Pulita, A basic introduction to deformation and confluence of ultrametric differential and q-difference equations; J. Roques, On the Galois groups of families of regular singular difference systems; V. P. Spiridonov, Elliptic hypergeometric terms; B. Chiarellotto, G. Gerotto, and F. J. Sullivan, Dwork’s 1994 Padova lectures on exponential modules.

Séminaires et Congrès, Number 23

General Interest

Connected at Infinity II
A Selection of Mathematics by Indians

Rajendra Bhatia, Indian Statistical Institute, Delhi, India, C. S. Rajan, Tata Institute of Fundamental Research, Mumbai, India, and Ajit Iqbal Singh, Indian Statistical Institute, Delhi, India, Editors

Like the first volume, this is a special collection of articles describing the work of some of the best-known mathematicians from India. It contains eight articles written by experts, each of whom has chosen one major research contribution by an Indian mathematician and explained its context, significance, and impact. This is done in a way that makes the main ideas accessible to someone whose own research interests might be in a different area. Included here are commentaries on important works by:

- R. C. Bose, S. S. Shrikhande and E. T. Parker
- H. Cramer and C. R. Rao
- V. B. Mehta and A. Ramanathan
- R. Parthasarathy
- K. R. Parthasarathy, R. Ranga Rao, and V. S. Varadarajan
- R. Narasimha
- H. H. Andersen
- N. Wiener and P. R. Masani

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Hindustan Book Agency

Probability and Statistics

Voter Model Perturbations and Reaction Diffusion Equations

J. Theodore Cox, Syracuse University, NY, Richard Durrett, Duke University, Durham, NC, and Edwin A. Perkins, University of British Columbia, Vancouver, Canada

The authors consider particle systems that are perturbations of the voter model and show that when space and time are rescaled the system converges to a solution of a reaction diffusion equation in dimensions $d \geq 3$. Combining this result with properties of the P.D.E., some methods arising from a low density super-Brownian limit theorem, and a block construction, the authors give general, and often asymptotically sharp, conditions for the existence of non-trivial stationary distributions, and for extinction of one type.

As applications, the authors describe the phase diagrams of four systems when the parameters are close to the voter model: (i) a stochastic spatial Lotka-Volterra model of Neuhauser and Pacala, (ii) a model of the evolution of cooperation of Ohtsuki, Hauert, Lieberman, and Nowak, (iii) a continuous time version of the non-linear voter model of Molofsky, Durrett, Dushoff, Griffiths, and Levin, and (iv) a voter model in which opinion changes are followed by an exponentially distributed latent period during which voters will not change again.

The first application confirms a conjecture of Cox and Perkins, and the second confirms a conjecture of Ohtsuki et al. in the context of certain infinite graphs. An important feature of the authors’ general results is that they do not require the process to be attractive.

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

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 and statement of results; Construction, duality and coupling; Proofs of Theorems 1.2 and 1.3; Achieving low density; Percolation results; Existence of stationary distributions; Extinction of the process; Bibliography.

Astérisque, Number 349