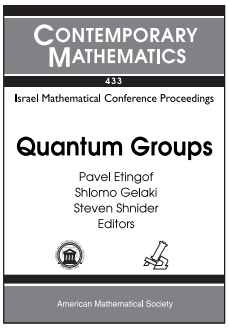
New Publications Offered by the AMS

Algebra and Algebraic Geometry



Quantum Groups

Pavel Etingof, *Massachusetts Institute of Technology, Cambridge, MA*, **Shlomo Gelaki**, *Technion-Israel Institute of Technology, Haifa, Israel*, and **Steven Shnider**, *Bar-Ilan University, Ramat-Gan, Israel*, Editors

The papers in this volume are based on the talks given at the conference on quantum groups dedicated to the memory of Joseph Donin, which was held at the Technion Institute, Haifa, Israel in July 2004. A survey of Donin's distinguished mathematical career is included. Several articles, which were directly influenced by the research of Donin and his colleagues, deal with invariant quantization, dynamical R-matrices, Poisson homogeneous spaces, and reflection equation algebras. The topics of other articles include Hecke symmetries, orbifolds, set-theoretic solutions to the pentagon equations, representations of quantum current algebras, unipotent crystals, the Springer resolution, the Fourier transform on Hopf algebras, and, as a change of pace, the combinatorics of smoothly knotted surfaces.

The articles all contain important new contributions to their respective areas and will be of great interest to graduate students and research mathematicians interested in Hopf algebras, quantum groups, and applications.

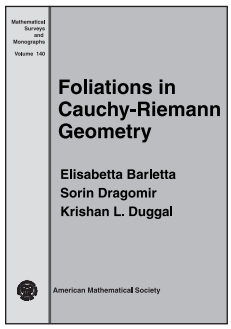
This book is copublished with Bar-Ilan University (Ramat-Gan, Israel).

Contents: **A. Mudrov** and **S. Shnider**, Joseph Donin's mathematical research, 1966–2003; **A. Berenstein** and **D. Kazhdan**, Geometric and unipotent crystals II: From unipotent bicrystals to crystal bases; **R. Bezrukavnikov** and **A. Lachowska**, The small quantum group and the Springer resolution; **A. Braverman**, **D. Gaitsgory**, and **M. Vybornov**, Relation between two geometrically defined bases in representations of GL_n; **M. Cohen** and **S. Westreich**, Fourier transforms for Hopf algebras; **B. Enriquez**, **P. Etingof**, and **I. Marshall**, Quantization of some Poisson-Lie dynamical r-matrices and Poisson homogeneous spaces; **B. Enriquez**, **S. Pakuliak**, and **V. Rubtsov**, Basic representations of quantum current algebras in higher genus; **G. Felder**, **R. Rimányi**, and **A. Varchenko**, Poincaré-Birkhoff-Witt expansions of the canonical elliptic differential form; **D. Gurevich** and **P. Saponov**, Geometry of non-commutative orbits related to Hecke symmetries; **V. Hinich**, Drinfeld double for orbifolds; **R. M. Kashaev** and **N. Reshetikhin**, Symmetrically factorizable groups and set-theoretical solutions of the pentagon equation; **P. P. Kulish** and **A. I. Mudrov**, Dynamical reflection equation; **G. Lancaster**, **R. Larson**, and **J. Towber**, On the combinatorics of Carter-Rieger-Saito movies in the theory of smoothly knotted surfaces in $\mathbb{R}^4$.

Contemporary Mathematics, Volume 433

August 2007, 336 pages, Softcover, ISBN: 978-0-8218-3713-9, LC 2007060761, 2000 *Mathematics Subject Classification:* 16W30, 81R50, 18D10, 17B37, **AMS members US$79**, List US$99, Order code CONM/433

Analysis



Foliations in Cauchy–Riemann Geometry

Elisabetta Barletta and **Sorin Dragomir**, *Università degli Studi della Basilicata, Potenza, Italy*, and **Krishan L. Duggal**, *University of Windsor, Ontario, Canada*

The authors study the relationship between foliation theory and differential geometry and analysis on Cauchy–Riemann (CR) manifolds. The main objects of study are transversally and tangentially CR foliations, Levi foliations of CR manifolds, solutions of the Yang–Mills equations, tangentially Monge–Ampére foliations, the transverse Beltrami equations, and CR orbifolds. The novelty of the authors' approach consists in the overall use of the methods of foliation theory and choice of specific applications. Examples of such applications are Rea's holomorphic extension of Levi foliations, Stanton's holomorphic degeneracy, Boas and

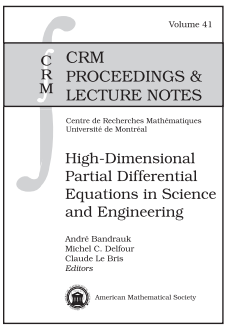
Straube's approximately commuting vector fields method for the study of global regularity of Neumann operators and Bergman projections in multi-dimensional complex analysis in several complex variables, as well as various applications to differential geometry. Many open problems proposed in the monograph may attract the mathematical community and lead to further applications of foliation theory in complex analysis and geometry of Cauchy–Riemann manifolds.

Contents: Review of foliation theory; Foliated CR manifolds; Levi foliations; Levi foliations of CR submanifolds in $\mathbb{C}P^N$; Tangentially CR foliations; Transversally CR foliations; $\mathcal{G}$-Lie foliations; Transverse Beltrami equations; Review of orbifold theory; Pseudo-differential operators on orbifolds; Cauchy-Riemann orbifolds; Holomorphic bisectional curvature; Partition of unity on orbifolds; Pseudo-differential operators on $\mathbb{R}^n$; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 140

July 2007, 256 pages, Hardcover, ISBN: 978-0-8218-4304-8, LC 2007060684, 2000 *Mathematics Subject Classification:* 53C12, 53C50, 53D10, 32T15, 32T27, 32V05, 32V15, 32V20, 32V30, 32V35, **AMS members US$60**, List US$75, Order code SURV/140

Differential Equations



High-Dimensional Partial Differential Equations in Science and Engineering

André Bandrauk, *Université de Sherbrooke, QC, Canada*, **Michel C. Delfour**, *Université de Montréal, QC, Canada*, and **Claude Le Bris**, *École Nationale des Ponts et Chaussés, Marne La Vallée, France, and INRIA Rocquencourt, Le Chesnay, France*, Editors

High-dimensional spatio-temporal partial differential equations are a major challenge to scientific computing of the future. Up to now deemed prohibitive, they have recently become manageable by combining recent developments in numerical techniques, appropriate computer implementations, and the use of computers with parallel and even massively parallel architectures. This opens new perspectives in many fields of applications. Kinetic plasma physics equations, the many body Schrödinger equation, Dirac and Maxwell equations for molecular electronic structures and nuclear dynamic computations, options pricing equations in mathematical finance, as well as Fokker–Planck and fluid dynamics equations for complex fluids, are examples of equations that can now be handled.

The objective of this volume is to bring together contributions by experts of international stature in that broad spectrum of areas to confront their approaches and possibly bring out common problem formulations and research directions in the numerical solutions of high-dimensional partial differential equations in various fields of science and engineering with special emphasis on chemistry and physics.

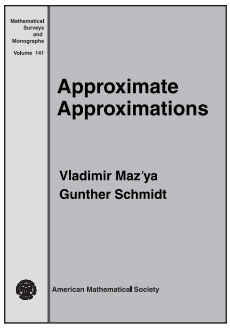
This item will also be of interest to those working in mathematical physics and applications.

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

Contents: **A. D. Bandrauk** and **H. Lu**, Singularity-free methods for the time-dependent Schrödinger equation for nonlinear molecules in intense laser fields—A non-perturbative approach; **E. Cancès**, **C. Le Bris**, **Y. Maday**, **N. C. Nguyen**, **A. T. Patera**, and **G. S. H. Pau**, Feasibility and competitiveness of a reduced basis approach for rapid electronic structure calculations in quantum chemistry; **G. Chen**, **Z. Ding**, **A. Perronnet**, **M. O. Scully**, **R. Xie**, and **Z. Zhang**, Some fundamental mathematical properties in atomic and molecular quantum mechanics; **P. Delaunay**, **A. Lozinski**, and **R. G. Owens**, Sparse tensor-product Fokker–Planck-based methods for nonlinear bead-spring chain models of dilute polymer solutions; **M. Escobar** and **L. Seco**, A partial differential equation for credit derivatives pricing; **M. J. Esteban**, A short review on computational issues arising in relativistic atomic and molecular physics; **P. Gori-Giorgi**, **J. Toulouse**, and **A. Savin**, Model Hamiltonians in density functional theory; **H. Kim** and **R. Kapral**, Simulation of quantum-classical dynamics by surface-hopping trajectories; **D. M. Koch**, **Q. K. Timerghazin**, and **G. H. Peslherbe**, Simulating realistic and nonadiabatic chemical dynamics: Application to photochemistry and electron transfer reactions; **E. Lorin**, **S. Chelkowski**, and **A. Bandrauk**, A Maxwell-Schrödinger model for non-perturbative laser-molecule interaction and some methods of numerical computation; **Y. Maday**, Parareal in time algorithm for kinetic systems based on model reduction.

CRM Proceedings & Lecture Notes, Volume 41

July 2007, 194 pages, Softcover, ISBN: 978-0-8218-3853-2, LC 2007060763, 2000 *Mathematics Subject Classification:* 65Mxx, 35Gxx; 76-XX, **AMS members US$63**, List US$79, Order code CRMP/41



Approximate Approximations

Vladimir Maz′ya, *University of Linköping, Sweden, and University of Liverpool, United Kingdom*, and **Gunther Schmidt**, *Weierstrass Institute for Applied Analysis and Stochastics, Berlin, Germany*

In this book, a new approach to approximation procedures is developed. This new approach is characterized by the common feature that the procedures are accurate without being convergent as the mesh size tends to zero. This lack of convergence is compensated for by the flexibility in the choice of approximating functions, the simplicity of multi-dimensional generalizations, and the possibility of obtaining explicit formulas for the values of various integral and pseudodifferential operators applied to approximating functions.

The developed techniques allow the authors to design new classes of high-order quadrature formulas for integral and pseudodifferential operators, to introduce the concept of approximate wavelets, and to develop new efficient numerical and semi-numerical methods for solving boundary value problems of mathematical physics.

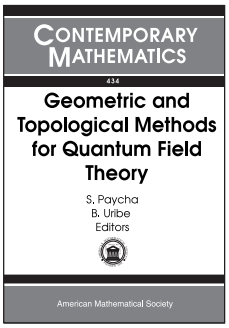
The book is intended for researchers interested in approximation theory and numerical methods for partial differential and integral equations.

Contents: Quasi-interpolation; Error estimates for quasi-interpolation; Various basis functions—examples and constructions; Approximation of integral operators; Cubature of diffraction, elastic, and hydrodynamic potentials; Some other cubature problems; Approximation by Gaussians; Approximate wavelets; Cubature over bounded domains; More general grids; Scattered data approximate approximations; Numerical algorithms based upon approximate approximations—linear problems; Numerical algorithms based upon approximate approximations—non-linear problems; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 141

August 2007, approximately 356 pages, Hardcover, ISBN: 978-0-8218-4203-4, LC 2007060769, 2000 *Mathematics Subject Classification:* 41A30, **AMS members US$71**, List US$89, Order code SURV/141

Mathematical Physics



Geometric and Topological Methods for Quantum Field Theory

S. Paycha, *Université Blaise Pascal, Aubière, Cedex, France*, and **B. Uribe**, *Universidad de Los Andes, Bogatá, Columbia*, Editors

This volume, based on lectures and short communications at a summer school in Villa de Leyva, Colombia (July 2005), offers an introduction to some recent developments in several active topics at the interface between geometry, topology and quantum field theory. It is aimed at graduate students in physics or mathematics who might want insight in the following topics (covered in five survey lectures):

- Anomalies and noncommutative geometry,
- Deformation quantisation and Poisson algebras,
- Topological quantum field theory and orbifolds.

These lectures are followed by nine articles on various topics at the borderline of mathematics and physics ranging from quasicrystals to invariant instantons through black holes, and involving a number of mathematical tools borrowed from geometry, algebra and analysis.

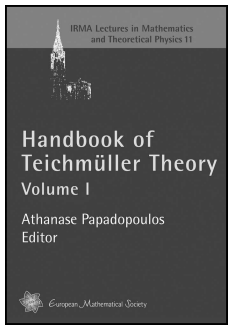
Contents: *Invited lecturers:* **M. Bordemann**, Deformation quantizaton: A mini-lecture; **G. Landi**, Examples of noncommutative instantons; **E. Lupercio** and **B. Uribe**, Topological quantum field theories, strings and orbifolds; **H. Omori**, **Y. Maeda**, **N. Miyazaki**, and **A. Yoshioka**, Non-formal deformation quantization of Fréchet-Poisson algebras: The Heisenberg Lie algebra case; **D. Perrot**, Anomalies and noncommutative index theory; *Contributed talks:* **M. Ángel** and **R. Díaz**, N-flat connections; **A. Cáceres**, Dirac equation in a black hole background; **E. Castillo** and **R. Díaz**, Homological matrices; **A. Giniatoulline** and **O. Zapata**, On some qualitative properties of stratified flows; **M. P. Gomez-Aparicio**, Property (T) and tensor products by irreducible finite dimensional representations for $SL_n(\mathbb{R})n \geq 3$; **R. M. Manasliski**, Painlevé VI equation from invariant instantons; **J. Plazas**, Quantum statistical mechanics and class field theory; **P. Polesello**, Uniqueness of Kashiwara's quantization of complex contact manifolds; **F. Ypma**, K-theoretic gap labeling for quasicrystals.

Contemporary Mathematics, Volume 434

August 2007, 255 pages, Softcover, ISBN: 978-0-8218-4062-7, LC 2007060762, 2000 *Mathematics Subject Classification:* 53-06, 55-06, 58-06, 81-06, **AMS members US$63**, List US$79, Order code CONM/434

New AMS-Distributed Publications

Analysis



Handbook of Teichmüller Theory

Volume I

Athanase Papadopoulos, *Institut de Recherche Mathématique Avancée, Strasbourg, France*, Editor

The Teichmüller space of a surface was introduced by O. Teichmüller in the 1930s. It is a basic tool in the study of Riemann's moduli spaces and the mapping class groups. These objects are fundamental in several fields of mathematics, including algebraic geometry, number theory, topology, geometry, and dynamics.

The original setting of Teichmüller theory is complex analysis. The work of Thurston in the 1970s brought techniques of hyperbolic geometry to the study of Teichmüller space and its asymptotic geometry. Teichmüller spaces are also studied from the point of view of the representation theory of the fundamental group of the surface in a Lie group G, most notably $G = \mathrm{PSL}(2, \mathbb{R})$ and $G = \mathrm{PSL}(2, \mathbb{C})$. In the 1980s, there evolved an essentially combinatorial treatment of the Teichmüller and moduli spaces involving techniques and ideas from high-energy physics, namely from string theory. The current research interests include the quantization of Teichmüller space, the Weil-Petersson symplectic and Poisson geometry of this space as well as gauge-theoretic extensions of these structures. The quantization theories can lead to new invariants of hyperbolic 3-manifolds.

The purpose of this handbook is to give a panorama of some of the most important aspects of Teichmüller theory. The handbook should be useful to specialists in the field, to graduate students, and more generally to mathematicians who want to learn about the

subject. All the chapters are self-contained and have a pedagogical character. They are written by leading experts in the subject.

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

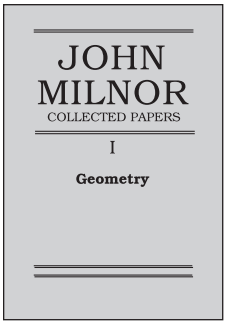
A publication of the European Mathematical Society. Distributed within the Americas by the American Mathematical Society.

Contents: A. Papadopoulos, Introduction to Teichmüller theory, old and new; *Part A. The metric and the analytic theory, 1:* **G. D. Daskalopoulos** and **R. A. Wentworth**, Harmonic maps and Teichmüller theory; **A. Papadopoulos** and **G. Théret**, On Teichmüller's metric and Thurston's asymmetric metric on Teichmüller space; **R. C. Penner**, Surfaces, circles, and solenoids; **J.-P. Otal**, About the embedding of Teichmüller space in the space of geodesic Hölder distributions; **W. J. Harvey**, Teichmüller spaces, triangle groups and Grothendieck dessins; **F. Herrlich** and **G. Schmithüsen**, On the boundary of Teichmüller disks in Teichmüller and in Schottky space; *Part B. The group theory, 1:* **S. Morita**, Introduction to mapping class groups of surfaces and related groups; **L. Mosher**, Geometric survey of subgroups of mapping class groups; **A. Marden**, Deformations of Kleinian groups; **U. Hamenstädt**, Geometry of the complex of curves and of Teichmüller space; *Part C. Surfaces with singularities and discrete Riemann surfaces:* **C. Charitos** and **I. Papadoperakis**, Parameters for generalized Teichmüller spaces; **M. Troyanov**, On the moduli space of singular euclidean surfaces; **C. Mercat**, Discrete Riemann surfaces; *Part D. The quantum theory, 1:* **L. O. Chekhov** and **R. C. Penner**, On quantizing Teichmüller and Thurston theories; **V. V. Fock** and **A. B. Goncharov**, Dual Teichmüller and lamination spaces; **J. Teschner**, An analog of a modular functor from quantized Teichmüller theory; **R. M. Kashaev**, On quantum moduli space of flat $PSL_2(\mathbb{R})$-connections; List of contributors; Index.

IRMA Lectures in Mathematics and Theoretical Physics, Volume 11

May 2007, 802 pages, Hardcover, ISBN: 978-3-03719-029-6, 2000 *Mathematics Subject Classification:* 30-00, 32G15, 30F60; 30C62, 57N16, 53A35, 20F65, 30F20, 30F25, 30F10, 30F30, 30F40, 30F45, 14H15, 20H10, 30F15, 53B35, 57M60, 14H60, 14D20, 57M20, 20F38, 57M07, **AMS members US$102**, List US$128, Order code EMSILMTP/11

Geometry and Topology



John Milnor Collected Papers

Volume I: Geometry

John Milnor, *SUNY at Stony Brook, NY*

This volume contains papers on geometry of one of the best modern geometers and topologists, John Milnor. This book covers a wide variety of topics and includes several previously unpublished works. It is delightful reading for any mathematician with an interest in geometry and topology and for any person with an interest in mathematics. (A number of papers in the collection, intended for a general mathematical audience, have been published in the *American Mathematical Monthly*.) Each paper is accompanied by the author's comments on further development of the subject.

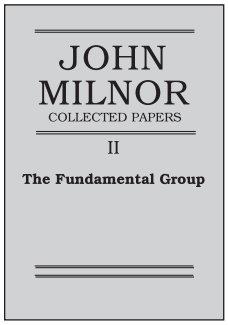
This volume contains twenty-one papers and is partitioned into three parts: differential geometry and curvature, algebraic geometry and topology, and Euclidean and non-Euclidean geometry. Although some of the papers were written quite a while ago, they appear more modern than many of today's publications. Milnor's excellent, clear, and laconic style makes the book a real treat.

This volume is highly recommended to a broad mathematical audience, and, in particular, to young mathematicians who will certainly benefit from their acquaintance with Milnor's mode of thinking and writing.

A publication of Publish or Perish, Inc.

Contents: Differential geometry and curvature; Algebraic geometry and topology; Euclidean and non-euclidean geometry.

October 1994, 295 pages, Hardcover, ISBN: 978-0-914098-30-0, 2000 *Mathematics Subject Classification:* 01A75; 53-03, 55-03, 57-03, **AMS members US$47**, List US$59, Order code MILNOR/1



John Milnor Collected Papers

Volume II: The Fundamental Group

John Milnor, *SUNY at Stony Brook, NY*

This volume contains papers of one of the best modern geometers and topologists, John Milnor, on various topics related to the notion of the fundamental group. It is excellent reading for any mathematician with an interest in geometry and topology and for any person with an interest in mathematics.

This volume contains sixteen papers and is partitioned into four parts: Knot theory, free action on spheres, torsion, and three-dimensional manifolds. Each part is preceded by an introduction containing the author's comments on further development of the subject. Although some of the papers were written quite a while ago, they appear more modern than many of today's publications. Milnor's excellent, clear, and laconic style makes the book a real treat.

This volume is highly recommended to a broad mathematical audience, and, in particular, to young mathematicians who will certainly benefit from their acquaintance with Milnor's mode of thinking and writing.

A publication of Publish or Perish, Inc.

Contents: Part 1: Knot theory; Part 2: Free actions on spheres; Part 3: Torsion; Part 4: Three-dimensional manifolds.

December 1995, 302 pages, Hardcover, ISBN: 978-0-914098-31-7, 2000 *Mathematics Subject Classification:* 54-XX, 55-XX, **AMS members US$47**, List US$59, Order code MILNOR/2