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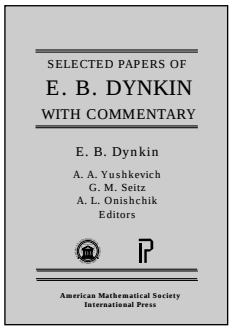
Algebra and Algebraic Geometry



Selected Papers of E. B. Dynkin with Commentary

A. A. Yushkevich, *University of North Carolina, Charlotte*, **G. M. Seitz**, *University of Oregon, Eugene*, and **A. L. Onishchik**, *Yaroslavl State University, Russia*, Editors

Eugene Dynkin is a rare example of a contemporary mathematician who has achieved outstanding results in two quite different areas of research: algebra and probability. In both areas, his ideas constitute an essential part of modern mathematical knowledge and form a basis for further development. Although his last work in algebra was published in 1955, his contributions continue to influence current research in algebra and in the physics of elementary particles. His work in probability is part of both the historical and the modern development of the topic.

This volume presents Dynkin's scientific contributions in both areas. Included are Commentary by recognized experts in the corresponding fields who describe the time, place, role, and impact of Dynkin's research and achievements. Biographical notes and the recollections of his students are also featured.

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

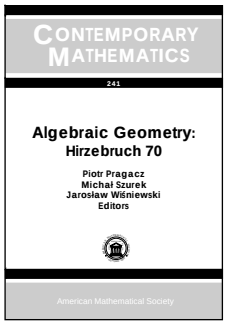
This book is jointly published by the AMS and the International Press.

Contents: *Part I: Lie groups and Lie algebras:* **G. M. Seitz**, Dynkin and Lie theory; **F. I. Karpelevich**, **A. L. Onishchik**, and **E. B. Vinberg**, On the work of E. B. Dynkin in the theory of Lie groups; **F. I. Karpelevich**, **A. L. Onishchik**, and **E. B. Vinberg**, Correction to On the work of E. B. Dynkin in the theory of Lie groups; **E. B. Dynkin**, Classification of simple Lie groups; **E. B. Dynkin**, Calculation of the coefficients in the Campbell-Hausdorff formula; **E. B. Dynkin**, The maximal subgroups of the classical groups; **A. L. Onishchik**, Comments on Maximal subgroups of the classical groups; **E. B. Dynkin**, Semisimple subalgebras of semisimple Lie algebras; **A. L. Onishchik**, Comments on the paper Semisimple subalgebras of semisimple Lie algebras; **E. B. Dynkin**, Construction of primitive cycles in compact Lie groups; **E. B. Dynkin**, Topological characteristics of homomorphisms of compact Lie groups; **A. L. Onishchik**, Comments on the paper Topological characteristics of homomorphisms of compact Lie groups; **B. Kostant**, Dynkin and modern Lie theory; **D. A. Vogan, Jr.**, Comments on the impact of Dynkin's work on current research in representation theory; **A. Gabrielov**, Coxeter-Dynkin diagrams and singularities; **K. Gottfried**, Lie groups in physics; **Y. Ne'eman**, Dynkin diagrams in the physics of particles, fields and strings; *Part II: Probability theory:* **A. A. Yushkevich**, Dynkin and probability theory; **E. B. Dynkin**, Necessary and sufficient statistics for a family of probability distributions; **E. B. Dynkin**, Some limit theorems for sums of independent random variables with infinite mathematical expectations; **E. B. Dynkin**, Markov processes and semigroups of operators; **E. B. Dynkin** and **A. A. Yushkevich**, Strong Markov processes; **E. B. Dynkin**, Infinitesimal operators of Markov processes; **E. B. Dynkin**, The natural topology and excessive functions connected with a Markov processes; **E. B. Dynkin** and **M. B. Malyutov**, Random walk on groups with a finite number of generators; **E. B. Dynkin**, The optimum choice of the instant for stopping a Markov process; **E. B. Dynkin**, Brownian motion in certain symmetric spaces and nonnegative eigenfunctions of the Laplace-Beltrami operator; **E. B. Dynkin**, Diffusion of tensors; **E. B. Dynkin**, Game variant of a problem on optimal stopping;

E. B. Dynkin and **S. E. Kuznetsov**, Determining functions of Markov processes and corresponding dual regular classes; **E. B. Dynkin**, Economic equilibrium under uncertainty; **I. V. Evstigneev**, Comments on economic equilibrium under uncertainty; **E. B. Dynkin**, Markov process es and random fields; **E. B. Dynkin**, Green's and Dirichlet spaces associated with fine Markov processes; **E. B. Dynkin**, Markov processes as a tool in field theory; **E. B. Dynkin** and **A. Mandelbaum**, Symmetric statistics, Poisson point processes, and multiple Wiener integrals; **E. B. Dynkin**, Gaussian and non-Gaussian random fields associated with Markov processes; **E. B. Dynkin**, Author's correction to Guassian and non-Gaussian random fields associated with Markov processes.; **E. B. Dynkin**, An application of flows to time shift and time reversal in stochastic processes; **E. B. Dynkin**, Author's comments on An application of flows to time shift and time reversal in stochastic processes; **E. B. Dynkin**, Representation for functionals of superprocesses by multiple stochastic integrals, with applications to self-intersection local times; **E. B. Dynkin**, A probabilistic approach to one class of nonlinear differential equations; **E. B. Dynkin**, Superdiffusions and parabolic nonlinear differential equations; **S. E. Kuznetsov**, Comments on Superdiffusions and parabolic nonlinear differential equations; **P. A. Meyer**, Dynkin and the theory of Markov processes; **A. A. Yushkevich**, To the history of strong Markov property; **M. A. Olshanetsky**, On compactifications of symmetric spaces; **J.-F. Le Gall**, Dynkin's contributions to superprocesses and partial differential equations; **I. V. Evstigneev**, Dynkin's work in mathematical economics; Acknowledgments.

Collected Works, Volume 14

October 1999, 796 pages, Hardcover, ISBN 0-8218-1065-0, LC 99-35175, 1991 *Mathematics Subject Classification*: 20–XX, 22–XX, 60–XX, **Individual member $77**, List $128, Institutional member $102, Order code CWORKS/14N



Algebraic Geometry: Hirzebruch 70

Piotr Pragacz, *Institute Mathematics PAN, Torun, Poland*, **Michal Szurek**, *Warsaw, Poland*, and **Jaroslaw Wiśniewski**, *University of Warsaw, Poland*, Editors

This book presents the proceedings from the conference on algebraic geometry in honor of Professor Friedrich Hirzebruch's 70th Birthday. The event was held at the Stefan Banach International Mathematical Center in Warsaw (Poland). Topics covered in the book include intersection theory, singularities, low-dimensional manifolds, moduli spaces, number theory, and interactions between mathematical physics and geometry. Also included are articles from notes of two special lectures. The first, by Professor Atiyah, describes the important contributions to the field of geometry by Professor Hirzebruch. The second article contains notes from the talk delivered at the conference by Professor Hirzebruch. Contributors to the volume are leading researchers in the field.

Contents: M. Atiyah, Physics and geometry: A look at the last twenty years; **F. Hirzebruch**, Complex cobordism and the elliptic genus; **G. Banaszak**, **W. Gajda**, and **P. Krasoń**, On Galois cohomology of some p-adic representations and étale K-theory of curves; **G. Barthel**, **J.-P. Brasselet**, **K.-H. Fieseler**, and **L. Kaup**, Equivariant intersection cohomology of toric varieties; **E. Bayer-Fluckiger**, Lattices and number fields; **F. Campana**, $\mathcal{G}$-connectedness of compact Kähler manifolds. I; **F. Catanese**, Singular bidouble covers and the construction of interesting algebraic surfaces; **P. B. Cohen**, Quantum statistical mechanics and number theory; **H. Esnault** and **E. Viehweg**, Semistable bundles on curves and irreducible representations of the fundamental group; **G. Faltings**, Does there exist an arithmetic Kodaira-Spencer class?; **E. Getzler**, The Virasoro conjecture for Gromov-Witten invariants; **K. Hulek**, **I. Nieto**, and **G. K. Sankaran**, Degenerations of (1,3) abelian surfaces and Kummer surfaces; **Y. Kawamata**, On the extension problem of pluricanonical forms; **S. Kleiman** and **R. Piene**, Enumerating singular curves on surfaces; **H. Kurke** and **A. Matuschke**, On the structure of moduli spaces of framed vector bundles on rational and ruled surfaces; **A. Langer**, A note on k-jet ampleness on surfaces; **A. Lascoux**, About the "y" in the χ_y-characteristic of Hirzebruch; **T. Shioda**, The splitting field of Mordell-Weil lattices; **M. Teicher**, Hirzebruch surfaces: Degenerations, related braid monodromy, Galois covers; **M.-F. Vignéras**, Intégrales orbitales modulo l pour un groupe réductif p-adique; **A. Weber**, A morphism of intersection homology and Hard Lefschetz; **S. Yokura**, On characteristic classes of complete intersections.

Contemporary Mathematics, Volume 241

September 1999, 369 pages, Softcover, ISBN 0-8218-1149-5, 1991 *Mathematics Subject Classification*: 00A79, 11–02, 11Gxx, 11Hxx, 14–02, 14Bxx, 14Cxx, 14Dxx, 14Fxx, 14Hxx, 14Jxx, 14Mxx, 22Exx, 32Cxx, 57–02, 11Rxx, **Individual member $47**, List $79, Institutional member $63, Order code CONM/241N

Algebraic Methods and q-Special Functions

Jan Felipe van Diejen, *Universidad de Chile, Santiago,* and **Luc Vinet**, *Université de Montréal, Québec, Canada*, Editors

There has been revived interest in recent years in the study of special functions. Many of the latest advances in the field were inspired by the works of R. A. Askey and colleagues on basic hypergeometric series and I. G. Macdonald on orthogonal polynomials related to root systems. Significant progress was made by the use of algebraic techniques involving quantum groups, Hecke algebras, and combinatorial methods.

The CRM organized a workshop for key researchers in the field to present an overview of current trends. This volume consists of the contributions to that workshop. Topics include basic hypergeometric functions, algebraic and representation-theoretic methods, combinatorics of symmetric functions, root systems, and the connections with integrable systems.

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

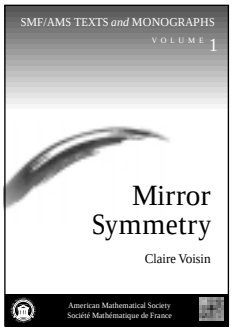
Contents: F. Bergeron and **A. M. Garsia**, Science fiction and Macdonald's polynomials; **R. Chouikha**, On the expansion of elliptic functions and applications; **D. V. Chudnovsky** and **G. V. Chudnovsky**, Generalized hypergeometric functions–Classification of identities and explicit rational approximations; **W. S. Chung**, **E. G. Kalnins**, and **W. Miller, Jr.**, Tensor products of q-superalgebras and q-series identities. I; **J. F. van Diejen** and **J. V. Stokman**, q-Racah polynomials for BC type root systems;

C. F. Dunkl, Intertwining operators of type B_N; **R. Floreanini**, **J. LeTourneux**, and **L. Vinet**, Symmetries and continuous q-orthogonal polynomials; **P. G. A. Floris**, Addition theorems for spherical polynomials on a family of quantum spheres; **F. A. Grünbaum** and **L. Haine**, On a q-analogue of the string equation and a generalization of the classical orthogonal polynomials; **M. E. H. Ismail**, **D. R. Masson**, and **S. K. Suslov**, The q-Bessel function on a q-quadratic grid; **D. Kim** and **D. Stanton**, Three statistics on lattice paths; **A. N. Kirillov**, Quantum Grothendieck polynomials; **A. N. Kirillov** and **M. Noumi**, q-difference raising operators for Macdonald polynomials and the integrality of transition coefficients; **B. A. Kupershmidt**, Great powers of q-calculus; **V. Spiridonov**, q-special functions: Differential-difference equations, roots of unity, and all that; **A. Strasburger**, On algebras of creation and annihilation operators.

CRM Proceedings & Lecture Notes, Volume 22

September 1999, 276 pages, Softcover, ISBN 0-8218-2026-5, LC 99-34734, 1991 *Mathematics Subject Classification*: 33D45; 05E05, 33C50, 33C80, 43A85, 43A90, 81R05, 81R10, **Individual member $47**, List $79, Institutional member $63, Order code CRMP/22N

Supplementary Reading



Mirror Symmetry

Claire Voisin, *Université et Marie Curie, Paris, France*

This is the English translation of Professor Voisin's book reflecting the discovery of the mirror symmetry phenomenon. The first chapter is devoted to the geometry of Calabi-Yau manifolds, and the second describes, as motivation, the ideas from quantum field theory that led to the discovery of mirror symmetry.

The other chapters deal with more specialized aspects of the subject: the work of Candelas, de la Ossa, Greene, and Parkes, based on the fact that under the mirror symmetry hypothesis, the variation of Hodge structure of a Calabi-Yau threefold determines the Gromov-Witten invariants of its mirror; Batyrev's construction, which exhibits the mirror symmetry phenomenon between hypersurfaces of toric Fano varieties, after a combinatorial classification of the latter; the mathematical construction of the Gromov-Witten potential, and the proof of its crucial property (that it satisfies the WDVV equation), which makes it possible to construct a flat connection underlying a variation of Hodge structure in the Calabi-Yau case. The book concludes with the first "naive" Givental computation, which is a mysterious mathematical justification of the computation of Candelas, et al.

SMF members are entitled to AMS member discounts.

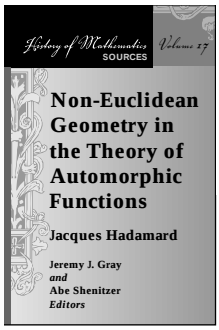
Contents: Calabi-Yau manifolds; "Physical" origin of the conjecture; The work of Candelas-de la Ossa-Green-Parkes; The work of Batyrev; Quantum cohomology; The Givental construction; Bibliography.

SMF/AMS Texts and Monographs, Volume 1

September 1999, 120 pages, Softcover, ISBN 0-8218-1947-X, LC 99-35675, 1991 *Mathematics Subject Classification*: 14D05, 14D07; 14J32, 14M25, 32G13, 32G20, 32L07, 81T30, 81T40, 53C23, 53C15, **All AMS members $22**, List $27, Order code SMFAMS/1N

Analysis

Supplementary Reading



Non-Euclidean Geometry in the Theory of Automorphic Functions

Jacques Hadamard, and **Jeremy J. Gray**, *Open University, Milton Keynes, UK*, and **Abe Shenitzer** (Editors), *York University, Toronto, ON, Canada*

This is the English translation of a volume originally published only in Russian and now out of print. The book was written by Jacques Hadamard on the work of Poincaré.

Poincaré's creation of a theory of automorphic functions in the early 1880s was one of the most significant mathematical achievements of the nineteenth century. It directly inspired the uniformization theorem, led to a class of functions adequate to solve all linear ordinary differential equations, and focused attention on a large new class of discrete groups. It was the first significant application of non-Euclidean geometry. The implications of these discoveries continue to be important to this day in numerous different areas of mathematics.

Hadamard begins with hyperbolic geometry, which he compares with plane and spherical geometry. He discusses the corresponding isometry groups, introduces the idea of discrete subgroups, and shows that the corresponding quotient spaces are manifolds. In Chapter 2 he presents the appropriate automorphic functions, in particular, Fuchsian functions. He shows how to represent Fuchsian functions as quotients, and how Fuchsian functions invariant under the same group are related, and indicates how these functions can be used to solve differential equations. Chapter 4 is devoted to the outlines of the more complicated Kleinian case. Chapter 5 discusses algebraic functions and linear algebraic differential equations, and the last chapter sketches the theory of Fuchsian groups and geodesics.

This unique exposition by Hadamard offers a fascinating and intuitive introduction to the subject of automorphic functions and illuminates its connection to differential equations, a connection not often found in other texts.

This book is the second in an informal sequence of works called "History of Mathematics, Sources", to be included within the History of Mathematics series, co-published by the AMS and the London Mathematical Society. Volumes to be published within this subset are classical mathematical works that served as cornerstones for modern mathematical thought. (For another historical translation on this topic, see *Sources of Hyperbolic Geometry*, volume 10, in the History of Mathematics series.)

Members of the LMS may order directly from the AMS at the AMS member price. The LMS is registered with the Charity Commissioners.

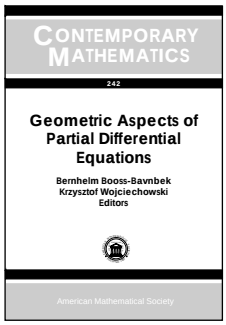
Contents: Historical introduction; A brief history of automorphic function theory, 1890–1930; The group of motions of the hyperbolic plane and its properly discontinuous subgroups;

Discontinuous groups in three geometries. Fuchsian functions; Fuchsian functions; Kleinian groups and functions; Algebraic functions and linear algebraic differential equations; Fuchsian groups and geodesics; References; Additional references.

History of Mathematics, Volume 17

October 1999, approximately 102 pages, Softcover, ISBN 0-8218-2030-3, LC 99-31709, 1991 *Mathematics Subject Classification*: 01–XX, 01A55, 01A60; 30–03, 30F35, 34A20, 51–03, **All AMS members $15**, List $19, Order code HMATH/17N

Differential Equations



Geometric Aspects of Partial Differential Equations

Bernhelm Booss-Bavnbek, *Roskilde University, Denmark*, and **Krzysztof Wojciechowski**, *Indiana University-Purdue University, Indianapolis*, Editors

This collection of papers by leading researchers gives a broad picture of current research directions in geometric aspects of partial differential equations. Based on lectures presented at a Minisymposium on Spectral Invariants - Heat Equation Approach, held in September 1998 at Roskilde University in Denmark, the book provides both a careful exposition of new perspectives in classical index theory and an introduction to currently active areas of the field.

Presented here are new index theorems as well as new calculations of the eta-invariant, of the spectral flow, of the Maslov index, of Seiberg-Witten monopoles, heat kernels, determinants, non-commutative residues, and of the Ray-Singer torsion. New types of boundary value problems for operators of Dirac type and generalizations to manifolds with cuspidal ends, to non-compact and to infinite-dimensional manifolds are also discussed. Throughout the book, the use of advanced analysis methods for gaining geometric insight emerges as a central theme. Aimed at graduate students and researchers, this book would be suitable as a text for an advanced graduate topics course on geometric aspects of partial differential equations and spectral invariants.

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

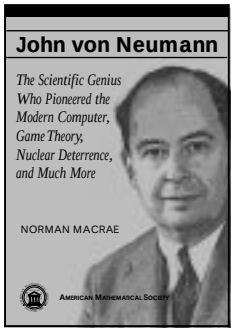
Contents: *Part I. Index and small eigenvalues:* **C. Bär** and **D. Bleecker**, The Dirac operator and the Scalar curvature of continuously deformed algebraic varieties; **B. Bojarski**, The geometry of the Riemann-Hilbert problem; **T. Kori**, Chiral anomaly and Grassmannian boundary conditions; **G. Rozenblum**, The index of cone Mellin operators; *Part II. Eta-invariants, spectral flows, and Seiberg-Witten monopoles:* **B. Booss-Bavnbek** and **K. Furutani**, Symplectic functional analysis and spectral invariants; **L. I. Nicolaescu**, Eta invariants, spectral flows and finite energy Sieberg-Witten monopoles; *Part III. Heat kernels, determinants, torsion:* **S. Dowker**, **P. Gilkey**, and **K. Kirsten**, Heat asymptotics with spectral boundary conditions; **P. Gilkey**, Heat content asymptotics; **W. Müller** and **K. Wendland**, Extremal Kähler metrics and Ray-Singer analytic torsion; **E. Schrohe**, Noncommutative residues, Dixmier's trace, and heat trace expansions on manifolds with boundary; *Part IV. Generalizations:* **A. Asada**, Spectral invariants and geometry of mapping spaces; **J. Brüning** and **M. Lesch**, Spectral theory of boundary value problems for Dirac type operators; **B.-W. Schulze** and **N. Tarkhanov**, Ellipticity and parametrices on manifolds with cuspidal edges; **M. Shubin**, Classical and quantum completeness for the Schrödinger operators on non-compact manifolds.

Contemporary Mathematics, Volume 242

September 1999, 269 pages, Softcover, ISBN 0-8218-2061-3, 1991 *Mathematics Subject Classification*: 53C21, 58G03, 58G10, 58G11, 58G20, 58G25, 81T50; 35P05, 53C55, 58D15, 58D27, 58G12, 58G26, 58G30, 81Q10, **Individual member $35**, List $59, Institutional member $47, Order code CONM/242N

General and Interdisciplinary

Biography



John von Neumann

The Scientific Genius Who Pioneered the Modern Computer, Game Theory, Nuclear Deterrence, and Much More

Norman Macrae

I always thought [von Neumann's] brain indicated that he belonged to a new species, an evolution beyond man. Macrae shows us in a lively way how this brain was nurtured and then left its great imprint on the world.

—Hans A. Bethe, Cornell University

The book makes for utterly captivating reading. Von Neumann was, of course, one of this century's geniuses, and it is surprising that we have had to wait so long … for a fully fleshed and sympathetic biography of the man. But now, happily, we have one.

Macrae nicely delineates the cultural, familial, and educational environment from which von Neumann sprang and sketches the mathematical and scientific environment in which he flourished. It's no small task to render a genius like von Neumann in ordinary language, yet, Macrae manages the trick, providing more than a glimpse of what von Neumann accomplished intellectually without expecting the reader to have a Ph.D. in mathematics. Beyond that, he captures von Neumann's qualities of temperament, mind, and personality, including his effortless wit and humor. And [Macrae] frames and accounts for von Neumann's politics in ways that even critics of them, among whom I include myself, will find provocative and illuminating.

—Daniel J. Kevles, California Institute of Technology

A lively portrait of the hugely consequential mathematician-physicist-et al., whose genius has left an enduring impress[ion] on our thought, technology, society, and culture. A double salute

to Steve White, who started this grand book designed for us avid, nonmathematical readers, and to Norman Macrae, who brought it to a triumphant conclusion.

—Robert K. Merton, Columbia University

This volume is the reprinted edition of the first full-scale biography of the man widely regarded as the greatest scientist of the century after Einstein.

Born in Budapest in 1903, John von Neumann grew up in one of the most extraordinary of scientific communities. From his arrival in America in the mid-1930s—with bases in Boston, Princeton, Washington, and Los Alamos—von Neumann pioneered and participated in the major scientific and political dramas of the next three decades, leaving his mark on more fields of scientific endeavor than any other scientist. Von Neumann's work in areas such as game theory, mathematics, physics, and meteorology formed the building blocks for the most important discoveries of the century: the modern computer, game theory, the atom bomb, radar, and artificial intelligence, to name just a few.

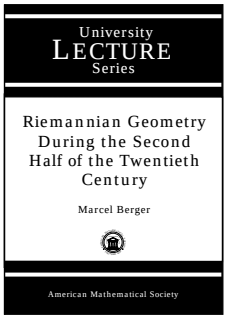
From the laboratory to the highest levels of government, this definitive biography gives us a behind-the-scenes look at the politics and personalities involved in these world-changing discoveries. Written more than 30 years after von Neumann's untimely death at age 56, it was prepared with the cooperation of his family and includes information gained from interviewing countless sources across Europe and America. Norman Macrae paints a highly readable, humanizing portrait of a man whose legacy still influences and shapes modern science and knowledge.

Contents: The cheapest way to make the world richer; A silver spoon in Budapest, 1903-14; At the Lutheran Gymnasium, 1914-21; An undergraduate with lion's claws, 1921-26; Rigor becomes more relaxed, 500 B. C.-A. D. 1931; The quantum leap, 1926-32; Sturm und Drang, marriage, emigration, 1927-31; Depression at Princeton, 1931-37; The calculating exploder, 1937-43; Los Alamos to Trinity, 1943-45; In the domain of economics; The computers at Philadelphia, 1944-46; The computers from Princeton, 1946-52; And then the H-bomb; With astonishing influence, 1950-56; Acknowledgments; Permissions acknowledgments; Notes; Bibliography; Index; Macrae on Macrae.

October 1999, 406 pages, Hardcover, ISBN 0-8218-2064-8, 1991 *Mathematics Subject Classification*: 01A70, **All AMS members $28**, List $35, Order code JVNMN

Geometry and Topology

Supplementary Reading



Riemannian Geometry During the Second Half of the Twentieth Century

Marcel Berger, *Institut des Hautes Études Scientifiques, Bures-sur-Yvette, France*

The article is masterfully written and delightful to read. In addition to the numerous digressions for newly introduced concepts, the author adds to the value of the survey by providing fertile opinions, some of them his, others those of his close colleagues and of M. Gromov in particular. The wonderful effort of the author is shown partially by the long bibliography of thirty pages, with references updated right to the very end of the century. A person who wants to learn more about Riemannian geometry will certainly do him/herself a good service by reading Berger's work.

—Mathematical Reviews

During its first hundred years, Riemannian geometry enjoyed steady, but undistinguished growth as a field of mathematics. In the last fifty years of the twentieth century, however, it has exploded with activity. Berger marks the start of this period with Rauch's pioneering paper of 1951, which contains the first real pinching theorem and an amazing leap in the depth of the connection between geometry and topology. Since then, the field has become so rich that it is almost impossible for the uninitiated to find their way through it. Textbooks on the subject invariably must choose a particular approach, thus narrowing the path. In this book, Berger provides a truly remarkable survey of the main developments in Riemannian geometry in the second half of the last fifty years.

One of the most powerful features of Riemannian manifolds is that they have invariants of (at least) three different kinds. There are the geometric invariants: topology, the metric, various notions of curvature, and relationships among these. There are analytic invariants: eigenvalues of the Laplacian, wave equations, Schrödinger equations. There are the invariants that come from Hamiltonian mechanics: geodesic flow, ergodic properties, periodic geodesics. Finally, there are important results relating different types of invariants. To keep the size of this survey manageable, Berger focuses on five areas of Riemannian geometry: Curvature and topology; the construction of and the classification of space forms; distinguished metrics, especially Einstein metrics; eigenvalues and eigenfunctions of the Laplacian; the study of periodic geodesics and the geodesic flow. Other topics are treated in less detail in a separate section.

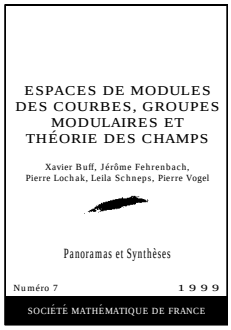
While Berger's survey is not intended for the complete beginner (one should already be familiar with notions of curvature and geodesics), he provides a detailed map to the major developments of Riemannian geometry from 1950 to 1999. Important threads are highlighted, with brief descriptions of the results that make up that thread. This supremely scholarly account is remarkable for its careful citations and voluminous bibliography. If you wish to learn about the results that have defined Riemannian geometry in the last half century, start with this book.

Reprint arranged with the approval of the publisher B.G. Teubner, Stuttgart and Leipzig.

Contents: Introduction; Riemannian geometry up to 1950; Comments on the main topics I, II, III, IV, V under consideration; Curvature and topology; The geometrical hierarchy of Riemannian manifolds: Space forms; The set of Riemannian structures on a given compact manifold: Is there a best metric?; The spectrum, the eigenfunctions; Periodic geodesics, the geodesic flow; Some other Riemannian geometric topics of interest; Bibliography; Subject and notation index; Name index.

University Lecture Series

October 1999, approximately 217 pages, Softcover, ISBN 0-8218-2052-4, LC 99-32803, 1991 *Mathematics Subject Classification*: 53Axx, 53Bxx, 53Cxx, 58Axx, 58Cxx, 58Dxx, 58Exx, 58Fxx, **All AMS members $27**, List $34, Order code ULECT-BERGERN



Espaces de Modules des Courbes, Groupes Modulaires et Théorie des Champs

Xavier Buff, **Jérôme Fehrenbach**, **Pierre Lochack**, **Leila Schneps**, and **Pierre Vogel**

A publication of Société Mathématique de France.

This volume comprises the proceedings of a three-day workshop on the following topics: moduli spaces of curves, mapping class groups, and quantum field theory. Chapter 1 presents an introduction to Teichmüller spaces, containing full proofs of many useful results not easily found in the literature. Also presented is an introduction to moduli spaces of curves, with a detailed description of the genus zero case, in particular of the part at infinity. Chapter 2 addresses the genus-zero moduli spaces and gives a complete description of their fundamental groupoids, based at tangential base points neighboring the part at infinity. The description relies on identifying these groupoids with certain canonical subgroupoids of a free braided tensor category. The section concludes with a study of the canonical Galois action on the fundamental groupids, computed using Grothendieck-Teichmüller theory. Chapter 3 studies strict ribbon categories, which are closely related to braided tensor categories. Here they are used to construct invariants of 3-manifolds which give rise to quantum field theories.

Distributed by the AMS in the United States, Canada, and Mexico. Orders from other countries should be sent to the SMF, Maison de la SMF, B.P. 67, 13274 Marseille cedex 09, France, or to Institut Henri Poincaré, 11 rue Pierre et Marie Curie, 75231 Paris cedex 05, France. Members of the SMF receive a 30% discount from list.

Contents: X. Buff, **J. Fehrenbach**, and **P. Lochak**, Éléments de géométrie des espaces de modules des courbes; **L. Schneps**, Groupoïdes fondamentaux des espaces de modules en genre 0 et catégories tensorielles tressées; **P. Vogel**, Invariants de Witten-Reshetikhin-Turaev et théories quantiques des champs.

Panoramas et Synthèses, Number 7

March 1997143 pages, Softcover, ISBN 2-85629-073-6, 1991 *Mathematics Subject Classification*: 32G15, 20F34, 57A10, 11R32, 20F36, 81Exx, **Individual member $23**, List $26, Order code PASY/7N

Logic and Foundations

Back in Print from the AMS

A Classic

Principles of Mathematical Logic

D. Hilbert and **W. Ackermann**

David Hilbert was particularly interested in the foundations of mathematics. Among many other things, he is famous for his attempt to axiomatize mathematics. This now classic text is his treatment of symbolic logic. It lays the groundwork for his later work with Bernays.

This translation is based on the second German edition, and has been modified according to the criticisms of Church and Quine. In particular, the authors' original formulation of Gödel's completeness proof for the predicate calculus has been updated.

In the first half of the twentieth century, an important debate on the foundations of mathematics took place. *Principles of Mathematical Logic* represents one of Hilbert's important contributions to that debate. Although symbolic logic has grown considerably in the subsequent decades, this book remains a classic.

Contents: The sentential calculus; The calculus of classes (monadic predicate calculus); The restricted predicate calculus; The extended predicate calculus; Editor's notes; Bibliography; Index.

AMS Chelsea Publishing

September 1999, 172 pages, Hardcover, ISBN 0-8218-2024-9, 1991 *Mathematics Subject Classification*: 03–02, **All AMS members $25**, List $28, Order code CHEL/69.HN

Number Theory

Advance Notice

Back in Print from the AMS

A Classic

Collected Papers of Srinivasa Ramanujan

G. H. Hardy, **P. V. Sheshu Aiyar**, and **B. M. Wilson**, with commentary by **Bruce Berndt**, *University of Illinois, Urbana, IL*, Editors

The influence of Ramanujan on number theory is without parallel in mathematics. His papers, problems and letters have spawned a remarkable number of later results by many different mathematicians. Here, his 37 published papers, most of his first two and last letters to Hardy, the famous 58 problems submitted to the *Journal of the Indian Mathematical Society*, and the commentary of the original editors (Hardy, Seshu Aiyar and Wilson) are reprinted again, after having been unavailable for some time.

In this, the third printing of Ramanujan's collected papers, Bruce Berndt provides an annotated guide to Ramanujan's work and to the mathematics it inspired over the last three-quarters of a century. The historical development of ideas is traced in the commentary and by citations to the copious references. The editor has done the mathematical world a tremendous service that few others would be qualified to do.

Contents: Some properties of Bernoulli's numbers; On Question 330 of Prof. Sanjana; Note on a set of simultaneous equations; Irregular numbers; Squaring the circle; Modular equations and approximations to π; On the integral $\int_0^x \frac{\tan^{-1} t}{t} dt$; On the number of divisors of a number; On the sum of the square roots of the first n natural numbers; On the product $\prod_{n=0}^{n=\infty} [1 + (\frac{x}{a+nd})^3]$; Some definite integrals; Some definite integrals connected with Gauss's sums; Summation of a certain series; New expressions for Riemann's functions $\xi(s)$ and $\Xi(t)$; Highly composite numbers; On certain infinite series; Some formulæ in the analytic theory of numbers; On certain arithmetical functions; A series for Euler's constant γ; On the expression of a number in the form $ax^2 + by^2 + cz^2 + du^2$; On certain trigonometrical sums and their applications in the theory of numbers; Some definite integrals; Some definite inte-

grals; A proof of Bertrand's postulate; Some properties of $p(n)$, the number of partitions of n; Proof of certain identities in combinatory analysis; A class of definite integrals; Congruence properties of partitions; Algebraic relations between certain infinite products; Congruence properties of partitions; Une formule asymptotique pour le nombre des partitions de n; Proof that almost all numbers n are composed of about $\log\log n$ prime factors; Asymptotic formulæ in combinatory analysis; Asymptotic formulæ for the distribution of integers of various types; The normal number of prime factors of a number n; Asymptotic formulæ in combinatory analysis; On the coefficients in the expansions of certain modular functions; Questions and solutions; Appendix I: Notes on the papers; Appendix II: Further extracts from Ramanujan's letters to G. H. Hardy.

AMS Chelsea Publishing

February 2000, 355 pages, Hardcover, ISBN 0-8218-2076-1, LC 62-8326, 1991 *Mathematics Subject Classification*: 11–06, **All AMS members $28**, List $31, Order code CHEL/159.HN

Back in Print from the AMS

A Classic

Ramanujan

Twelve Lectures on Subjects Suggested by His Life and Work

G. H. Hardy

From the fact that practically all topics of analytic number theory are mentioned, briefly or extensively, in this book in connection with one or the other of Ramanujan's ideas, theorems, conjectures, we realize the far-reaching influence which his work has had on present-day mathematics … the book is not only an homage to Ramanujan's genius; it is a survey of many branches of modern arithmetic and analysis and, altogether, a book which makes fascinating reading.

—Hans Rademacher, Mathematical Reviews

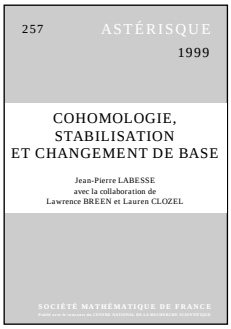
Ramanujan occupies a unique place in analytic number theory. His formulas, identities and calculations are still amazing three-quarters of a century after his death. Many of his discoveries seem to have appeared as if from the ether. His mentor and primary collaborator was the famous G. H. Hardy. Here, Hardy collects twelve of his own lectures on topics stemming from Ramanujan's life and work. The topics include: partitions, hypergeometric series, Ramanujan's τ-function and round numbers.

Hardy was the first to recognize the brilliance of Ramanujan's ideas. As one of the great mathematicians of the time, it is fascinating to read Hardy's accounts of their importance and influence.

Contents: The Indian mathematician Ramanujan; Ramanujan and the theory of prime numbers; Round numbers; Some more problems of the analytic theory of numbers; A lattice-point problem; Ramanujan's work on partitions; Hypergeometric series; Asymptotic theory of partitions; The representation of numbers as sums of squares; Ramanujan's function $\tau(n)$; Definite integrals; Elliptic and modular functions; Bibliography.

AMS Chelsea Publishing

November 1999, 236 pages, Hardcover, ISBN 0-8218-2023-0, 1991 *Mathematics Subject Classification*: 11; 01, **All AMS members $25**, List $28, Order code CHEL/136.HN



Cohomologie, Stabilisation et Changement de Base

Jean-Pierre Labesse, *Université Paris 7, France*

A publication of Société Mathématique de France.

In this volume, the concept of a "crossed set" (a generalization of crossed modules) is introduced; the author studies Galois cohomology of these objects. This is the key to the stabilization of all elliptic terms for the twisted trace formula. Labesse then proves the existence of the stable transfer for cyclic base change, and from a conditional stabilization of the twisted trace formula, the existence of weak base change in some cases is deduced, in particular for automorphic representations on simply connected semi-simple groups which are Steinberg at two places. In an appendix, Labesse and Clozel study certain unitary groups. In a second appendix, L. Breen rephrases crossed sets in the framework of simplicial algebra. Text is in French.

Distributed by the AMS in the United States, Canada, and Mexico. Orders from other countries should be sent to the SMF, Maison de la SMF, B.P. 67, 13274 Marseille cedex 09, France, or to Institut Henri Poincaré, 11 rue Pierre et Marie Curie, 75231 Paris cedex 05, France. Members of the SMF receive a 30% discount from list.

Contents: Cohomologie, stabilisation et changement de base; Introduction; Préliminaires cohomologiques; Conjugaison stable, intégrales orbitales et norme; Transfert local; Stabilisation de la formule des traces et applications; Bibliographie; Appendices; Bibliographie.

Astérisque, Number 257

May 1999, 161 pages, Softcover, 1991 *Mathematics Subject Classification*: 11F70, 11F72, 11E72, 11F75, 11R34, 11R39, 18G30, 22E55, **Individual member $40**, List $44, Order code AST/257N

Previously Announced Publications

Recommended Text

Pioneers of Representation Theory: Frobenius, Burnside, Schur, and Brauer

Charles W. Curtis, *University of Oregon, Eugene*

The year 1897 was marked by two important mathematical events: the publication of the first paper on representations of finite groups by Ferdinand Georg Frobenius (1849–1917) and the appearance of the first treatise in English on the theory of finite groups by William Burnside (1852–1927). Burnside soon developed his own approach to representations of finite groups. In the next few years, working independently, Frobenius and Burnside explored the new subject and its applications to finite group theory.

They were soon joined in this enterprise by Issai Schur (1875–1941) and some years later, by Richard Brauer (1901–1977). These mathematicians' pioneering research is the subject of this book. It presents an account of the early history of representation theory through an analysis of the published

work of the principals and others with whom the principals' work was interwoven. Also included are biographical sketches and enough mathematics to enable readers to follow the development of the subject. An introductory chapter contains some of the results involving characters of finite abelian groups by Lagrange, Gauss, and Dirichlet, which were part of the mathematical tradition from which Frobenius drew his inspiration.

This book presents the early history of an active branch of mathematics. It includes enough detail to enable readers to learn the mathematics along with the history. The volume would be a suitable text for a course on representations of finite groups, particularly one emphasizing an historical point of view.

Co-published with the London Mathematical Society. Members of the LMS may order directly from the AMS at the AMS member price. The LMS is registered with the Charity Commissioners.

History of Mathematics, Volume 15

October 1999, 292 pages, Hardcover, ISBN 0-8218-9002-6, LC 99-14983, 1991 *Mathematics Subject Classification*: 01A55, 01A60, 20C15, 20C20; 01A70, 16G10, 20G05, **All AMS members $39**, List $49, Order code HMATH/15RT99

Recommended Text

An Introduction to the Mathematical Theory of Waves

Roger Knobel, *University of Texas-Pan American, Edinburg*

This book is based on an undergraduate course taught at the IAS/Park City Mathematics Institute, on linear and nonlinear waves. The first part of the text overviews the concept of a wave, describes one-dimensional waves using functions of two variables, provides an introduction to partial differential equations, and discusses computer-aided visualization techniques.

The second part of the book discusses traveling waves, leading to a description of solitary waves and soliton solutions of the Klein-Gordon and Korteweg-deVries equations. The wave equation is derived to model the small vibrations of a taut string, and solutions are constructed via d'Alembert's formula and Fourier series.

The last part of the book discusses waves arising from conservation laws. After deriving and discussing the scalar conservation law, its solution is described using the method of characteristics, leading to the formation of shock and rarefaction waves. Applications of these concepts are then given for models of traffic flow.

The intent of this book is to create a text suitable for independent study by undergraduate students in mathematics, engineering, and science. The content of the book is meant to be self-contained, requiring no special reference material. Access to computer software such as Mathematica®, MATLAB®, or Maple® is recommended, but not necessary. Scripts for MATLAB applications will be available via a Web site. Exercises are given within the text to allow further practice with selected topics.

® Wolfram Research, Inc., Champaign IL.
® The Math Works, Inc., Natick, MA.
® Waterloo Maple, Inc., Ontario, Canada.

Student Mathematical Library, Volume 3

November 1999, 196 pages, Softcover, ISBN 0-8218-2039-7, 1991 *Mathematics Subject Classification*: 35–01; 00–01, 73–01, **All AMS members $18**, List $23, Order code STML/3RT99

Recommended Text

Lectures on Contemporary Probability

Gregory F. Lawler, *Duke University, Durham, NC*, and **Lester N. Coyle**, *Loyola College, Baltimore, MD*

This volume is based on classes in probability for advanced undergraduates held at the IAS/Park City Mathematics Institute. It is derived from both lectures (Chapters 1–10) and computer simulations (Chapters 11–13) that were held during the program. The material is coordinated so that some of the major computer simulations relate to topics covered in the first ten chapters. The goal is to present topics that are accessible to advanced undergraduates, yet are areas of current research in probability. The combination of the lucid yet informal style of the lectures and the hands-on nature of the simulations allows readers to become familiar with some interesting and active areas of probability.

The first four chapters discuss random walks and the continuous limit of random walks: Brownian motion. Chapters 5 and 6 consider the fascinating mathematics of card shuffles, including the notions of random walks on a symmetric group and the general idea of random permutations.

Chapters 7 and 8 discuss Markov chains, beginning with a standard introduction to the theory. Chapter 8 addresses the recent important application of Markov chains to simulations of random systems on large finite sets: Markov Chain Monte Carlo.

Random walks and electrical networks are covered in Chapter 9. Uniform spanning trees, as connected to probability and random walks, are treated in Chapter 10.

The final three chapters of the book present simulations. Chapter 11 discusses simulations for random walks. Chapter 12 covers simulation topics such as sampling from continuous distributions, random permutations, and estimating the number of matrices with certain conditions using Markov Chain Monte Carlo. Chapter 13 presents simulations of stochastic differential equations for applications in finance. (The simulations do not require one particular piece of software. They can be done in symbolic computation packages or via programming languages such as C.)

The volume concludes with a number of problems ranging from routine to very difficult. Of particular note are problems that are typical of simulation problems given to students by the authors when teaching undergraduate probability.

Student Mathematical Library, Volume 2

September 1999, 99 pages, Softcover, ISBN 0-8218-2029-X, LC 99-23838, 1991 *Mathematics Subject Classification*: 60–02; 60J10, 60J15, 65C05, **All AMS members $14**, List $17, Order code STML/2RT99

Foundations of p-adic Teichmüller Theory

Shinichi Mochizuki, *Research Institute for the Mathematical Sciences, Kyoto, Japan*

This book lays the foundation for a theory of *uniformization of p-adic hyperbolic curves and their moduli*. On one hand, this theory generalizes the Fuchsian and Bers uniformizations of complex hyperbolic curves and their moduli to nonarchimedian places. That is why in this book, the theory is referred to as *p-adic Teichmüller theory*, for short. On the other hand, the theory may be regarded as a fairly precise hyperbolic analog of the Serre-Tate theory of ordinary abelian varieties and their moduli.

The theory of uniformization of p-adic hyperbolic curves and their moduli was initiated in a previous work by Mochizuki. And in some sense, this book is a continuation and generalization of that work. This book aims to bridge the gap between the approach presented and the classical uniformization of a hyperbolic Riemann surface that is studied in undergraduate complex analysis.

Features:

- Presents a systematic treatment of the moduli space of curves from the point of view of p-adic Galois representations.
- Treats the analog of Serre-Tate theory for hyperbolic curves.
- Develops a p-adic analog of Fuchsian and Bers uniformization theories.
- Gives a systematic treatment of a "nonabelian example" of p-adic Hodge theory.

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

AMS/IP Studies in Advanced Mathematics, Volume 11

July 1999, 529 pages, Hardcover, ISBN 0-8218-1190-8, LC 99-26586, 1991 *Mathematics Subject Classification*: 14F30, 14H10, **All AMS members $47**, List $59, Order code AMSIP/11RT99

Supplementary Reading

Miles of Tiles

Charles Radin, *University of Texas, Austin*

In this book, we try to display the value (and joy!) of starting from a mathematically amorphous problem and combining ideas from diverse sources to produce new and significant mathematics—mathematics unforeseen from the motivating problem …

—***from the* Preface**

The common thread throughout this book is aperiodic tilings; the best-known example is the "kite and dart" tiling. This tiling has been widely discussed, particularly since 1984 when it was adopted to model quasicrystals. The presentation uses many different areas of mathematics and physics to analyze the new features of such tilings. Although many people are aware of the existence of aperiodic tilings, and maybe even their origin in a question in logic, not everyone is familiar with their subtleties and the underlying rich mathematical theory. For the interested reader, this book fills that gap.

Understanding this new type of tiling requires an unusual variety of specialties, including ergodic theory, functional analysis, group theory and ring theory from mathematics, and statistical mechanics and wave diffraction from physics. This interdisciplinary approach also leads to new mathematics seemingly unrelated to the tilings. Included are many worked examples and a large number of figures. The book's multidisciplinary approach and extensive use of illustrations make it useful for a broad mathematical audience.

Student Mathematical Library, Volume 1

August 1999, 120 pages, Softcover, ISBN 0-8218-1933-X, LC 99-20662, 1991 *Mathematics Subject Classification*: 52C22; 58F11, 47A35, 82D25, 20H15, **All AMS members $13**, List $16, Order code STML/1RT99

Advance Notice

Independent Study

Prime Numbers and Their Distribution

Gérald Tenenbaum, *Université Henri Poincaré, Nancy I, France*, and **Michel Mendès Franc**, *Université Bordeaux I, France*

From reviews for the French edition …

This is a short introductory book on analytic number theory. The prerequisites are quite modest, but it still contains an impressive amount of information. A multitude of results is included, some of which were proved just recently … this book is very well written. It is fun to read and at the same time presents most of the fundamental concepts and ideas in analytic number theory.

—***Mathematical Reviews***

The reviewer recommends it to all interested readers.

—***Zentralblatt für Mathematik***

We have been curious about numbers—and prime numbers—since antiquity. One notable new direction this century in the study of primes has been the influx of ideas from probability. The goal of this book is to provide insights into the prime numbers and to describe how a sequence so tautly determined can incorporate such a striking amount of randomness.

There are two ways in which the book is exceptional. First, some familiar topics are covered with refreshing insight and/or from new points of view. Second, interesting recent developments and ideas are presented that shed new light on the prime numbers and their distribution among the rest of the integers.

The book begins with a chapter covering some classic topics, such as quadratic residues and the Sieve of Eratosthenes. Also discussed are other sieves, primes in cryptography, twin primes, and more.

Two separate chapters address the asymptotic distribution of prime numbers. In the first of these, the familiar link between $\zeta(s)$ and the distribution of primes is covered with remarkable efficiency and intuition. The later chapter presents a walk through an elementary proof of the Prime Number Theorem. To help the novice understand the "'why" of the proof, connections are made along the way with more familiar results such as Stirling's formula.

A most distinctive chapter covers the stochastic properties of prime numbers. The authors present a wonderfully clever interpretation of primes in arithmetic progressions as a phenomenon in probability. They also describe Cramér's model, which provides a probabilistic intuition for formulating conjectures that have a habit of being true. In this context, they address interesting questions about equipartition modulo 1 for sequences involving prime numbers. The final section of the chapter compares geometric visualizations of random sequences with the visualizations for similar sequences derived from the primes. The resulting pictures are striking and illuminating. The book concludes with a chapter on the outstanding big conjectures about prime numbers.

This book is suitable for anyone who has had a little number theory and some advanced calculus involving estimates. Its engaging style and invigorating point of view will make refreshing reading for advanced undergraduates through research mathematicians. This book is the English translation of the French edition.

Student Mathematical Library

January 2000, approximately 120 pages, Softcover, ISBN 0-8218-1647-0, **All AMS members $14**, List $17, Order code STML-TENENBAURT99