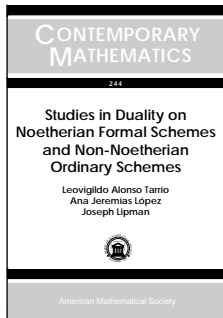# New Publications Offered by the AMS

Algebra and Algebraic Geometry

Studies in Duality on Noetherian Formal Schemes and Non-Noetherian Ordinary Schemes

Leovigildo Alonso and **Ana Jeremías**, *Universidade de Santiago de Compostela, Spain*, and **Joseph Lipman**, *Purdue University, West Lafayette, IN*

This volume contains three papers on the foundations of Grothendieck duality on Noetherian formal schemes and on not-necessarily-Noetherian ordinary schemes.
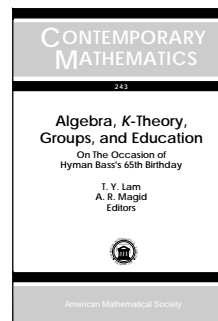
The first paper presents a self-contained treatment for formal schemes which synthesizes several duality-related topics, such as local duality, formal duality, residue theorems, dualizing complexes, etc. Included is an exposition of properties of torsion sheaves and of limits of coherent sheaves. A second paper extends Greenlees-May duality to complexes on formal schemes. This theorem has important applications to Grothendieck duality. The third paper outlines methods for eliminating the Noetherian hypotheses. A basic role is played by Kiehl's theorem affirming conservation of pseudo-coherence of complexes under proper pseudo-coherent maps.

This work gives a detailed introduction to the subject of Grothendieck Duality. The approach is unique in its presentation of a complex series of special cases that build up to the main results.

Contents: *Duality and Flat Base Change on Formal Schemes:* Duality and flat base change on formal schemes; *Greenlees-May Duality on Formal Schemes:* Greenlees-May duality on formal schemes; *Non-Noetherian Grothendieck Duality:* Non-noetherian Grothendieck duality; Index.

Contemporary Mathematics, Volume 244

November 1999, 126 pages, Softcover, ISBN 0-8218-1942-9, LC 99-42685, 1991 *Mathematics Subject Classification*: 14F99; 13D99, 14B15, 32C37, **Individual member $20**, List $33, Institutional member $26, Order code CONM/244N

Algebra, *K*-Theory, Groups, and Education

On the Occasion of Hyman Bass's 65th Birthday

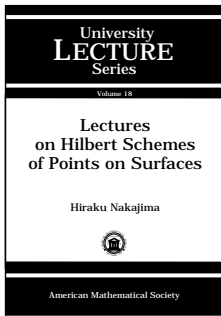**T. Y. Lam**, *University of California, Berkeley*, and **A. R. Magid**, *University of Oklahoma, Norman, OK*, Editors

This volume includes expositions of key developments over the past four decades in commutative and noncommutative algebra, algebraic *K*-theory, infinite group theory, and applications of algebra to topology. Many of the articles are based on lectures given at a conference at Columbia University honoring the 65th birthday of Hyman Bass. Important topics related to Bass's mathematical interests are surveyed by leading experts in the field. Of particular note is a professional autobiography of Professor Bass, and an article by Deborah Ball on mathematical education. The range of subjects covered in the book offers a convenient single source for topics in the field.

Contents: J. Ewing, On the occasion of the 65th birthday of Hyman Bass; **H. Bass**, A professional autobiography; **D. L. Ball**, Crossing boundaries: Probing the interplay of mathematics and pedagogy in elementary teaching; **E. Formanek**, Bass's work on the Jacobian conjecture; **R. M. Guralnick** and **C. J. Pappacena**, Torsion in genus class groups; **C. Huneke**, Hyman Bass and ubiquity: Gorenstein rings; **I. Kaplansky**, A salute to Euler and Dickson on the occasion of Hy's 65th birthday; **T. Y. Lam**, Bass's work in ring theory and projective modules; **A. Lubotzky**, One for almost all: Generation of $SL(n, p)$ by subsets of $SL(n, \mathbb{Z})$; **A. R. Magid**, Deformations of representations; **S. Mozes**, Trees, lattices and commensurators; **M. P. Murthy**, A survey of obstruction theory for projective modules of top rank; **A. S. Rapinchuk**, The congruence subgroup problem; **P. B. Shalen**, Three-manifold topology and the tree for PSL_2: The Smith conjecture and beyond; **C. A. Weibel**, The development of algebraic *K*-theory before 1980.

Contemporary Mathematics, Volume 243

November 1999, approximately 237 pages, Softcover, ISBN 0-8218-1087-1, LC 99-044937, 1991 *Mathematics Subject Classification*: 16–XX, 19–XX, 20–XX, 00–XX, **Individual member $29**, List $49, Institutional member $39, Order code CONM/234N

Lectures on Hilbert Schemes of Points on Surfaces

Hiraku Nakajima, *Kyoto University, Japan*

The Hilbert scheme $X^{[n]}$ of a surface X describes collections of n (not necessarily distinct) points on X. More precisely, it is the moduli space for 0-dimensional subschemes of X of length n. Recently it was realized that Hilbert schemes originally studied in algebraic geometry are closely related to several branches of mathematics, such as singularities, symplectic geometry, representation theory–even theoretical physics. The discussion in the book reflects this feature of Hilbert schemes.

For example, a construction of the representation of the infinite dimensional Heisenberg algebra (i.e., Fock space) is presented. This representation has been studied extensively in the literature in connection with affine Lie algebras, the conformal field theory, etc. However, the construction presented in this volume is completely unique and provides the unexplored link between geometry and representation theory.
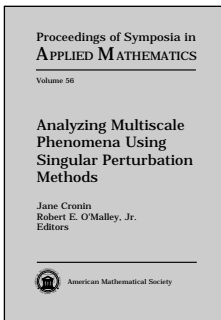
The book offers a nice survey of current developments in this rapidly growing subject. It is suitable as a text at the advanced graduate level.

Contents: Introduction; Hilbert scheme of points; Framed moduli space of torsion free sheaves on $\mathbb{P}^2$; Hyper-Kähler metric on $(\mathbb{C}^2)^{[n]}$; Resolution of simple singularities; Poincaré polynomials of the Hilbert schemes (1); Poincaré polynomials of Hilbert schemes (2); Hilbert scheme on the cotangent bundle of a Riemann surface; Homology group of the Hilbert schemes and the Heisenberg algebra; Symmetric products of an embedded curve, symmetric functions and vertex operators; Bibliography; Index.

University Lecture Series, Volume 18

Analysis

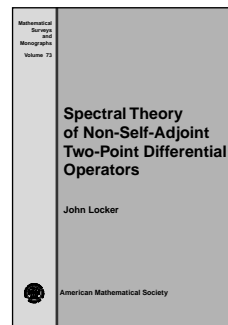# Analyzing Multiscale Phenomena Using Singular Perturbation Methods

Jane Cronin, *Rutgers University, New Brunswick, NJ*, and **Robert E. O'Malley, Jr.**, *University of Washington, Seattle*, Editors

To understand multiscale phenomena, it is essential to employ asymptotic methods to construct approximate solutions and to design effective computational algorithms. This volume consists of articles based on the AMS Short Course in Singular Perturbations held at the annual Joint Mathematics Meetings in Baltimore (MD). Leading experts discussed the following topics which they expand upon in the book: boundary layer theory, matched expansions, multiple scales, geometric theory, computational techniques, and applications in physiology and dynamic metastability. Readers will find that this text offers an up-to-date survey of this important field with numerous references to the current literature, both pure and applied.

Contents: R. E. O'Malley, Jr., Figuring out singular perturbations after a first course in ODEs; **M. H. Holmes**, The method of multiple scales; **S. Adjerid, M. Aiffa**, and **J. E. Flaherty**, Computational methods for singularly perturbed systems; **T. J. Kaper**, An introduction to geometric methods and dynamical systems theory for singular perturbation problems; **J. Cronin**, Analysis of cellular oscillations; **M. J. Ward**, Exponential asymptotics and convection-diffusion-reaction models; Index.

Proceedings of Symposia in Applied Mathematics, Volume 56

Spectral Theory of Non-Self-Adjoint Two-Point Differential Operators

John Locker, *Colorado State University, Fort Collins*

This monograph develops the spectral theory of an nth order non-self-adjoint two-point differential operator L in the Hilbert space $L^2[0, 1]$. The mathematical foundation is laid in the first part, where the spectral theory is developed for closed linear operators and Fredholm operators. An important completeness theorem is established for the Hilbert-Schmidt discrete operators. The operational calculus plays a major role in this general theory.

In the second part, the spectral theory of the differential operator L is developed by expressing L in the form $L = T + S$, where T is the principal part determined by the nth order derivative and S is the part determined by the lower-order derivatives. The spectral theory of T is developed first using operator theory, and then the spectral theory of L is developed by treating L as a perturbation of T. Regular and irregular boundary values are allowed for T, and regular boundary values are considered for L. Special features of the spectral theory for L and T include the following: calculation of the eigenvalues, algebraic multiplicities and ascents; calculation of the associated family of projections which project onto the generalized eigenspaces; completeness of the generalized eigenfunctions; uniform bounds on the family of all finite sums of the associated projections; and expansions of functions in series of generalized eigenfunctions of L and T.

Contents: Unbounded linear operators; Fredholm operators; Introduction to the spectral theory of differential operators; Principal part of a differential operator; Projections and gener-
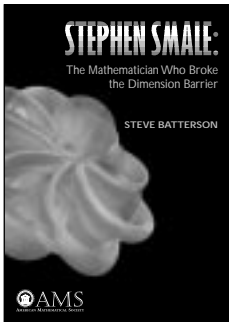
alized eigenfunction expansions; Spectral theory for general differential operators; Bibliography; Index.

Mathematical Surveys and Monographs, Volume 73

General and Interdisciplinary

Stephen Smale: The mathematician who broke the dimension barrier

Steve Batterson, *Emory University, Atlanta, GA*

In 1957 Stephen Smale startled the mathematical world by showing that it is possible to turn a sphere inside out without cutting, tearing, or crimping. A few years later, from the beaches of Rio, he introduced the horseshoe map, demonstrating that simple functions could have chaotic dynamics. His next stunning mathematical accomplishment was to solve the higher-dimensional Poincaré conjecture, thus demonstrating that six or more dimensions are simpler than the more familiar three. In 1966 in Moscow, he was awarded the Fields Medal, the most prestigious prize in mathematics.

Smale's vision and influence extended beyond mathematics into two vastly different realms. In 1965 in Berkeley, he initiated a program with Jerry Rubin of civil disobedience directed at ending the Vietnam war. And as a mineral collector, he accumulated a museum-quality collection that ranks among the finest in the world. Despite these diverse accomplishments, Smale's name is virtually unknown outside mathematics and mineralogy. One of the objectives of this book is to bring his life and work to the attention of a larger community.

There are few good biographies of mathematicians. This makes sense when considering that to place their lives in perspective requires some appreciation of their theorems. Biographical writers are not usually trained in mathematics, and mathematicians do not usually write biographies. Though the author, Steve Batterson, is primarily a mathematician, he has long been intrigued by the notion of working on a biography of Smale. In this book, Batterson records and makes known the life and accomplishments of this great mathematician and significant figure in intellectual history.

"Transparent Peach Eversion" cover art used with permission from the "Outside In" video project, generated at the Geometry Center (University of MN); distributed by A. K. Peters (Natick, MA).

Contents: One room schoolhouse; Marxism and mathematics at Ann Arbor; Early mathematical audacity; On the beaches of Rio; Berkeley to Columbia and back to Berkeley; The Lone Ranger of the antiwar movement; The summer of 1966; Smale versus the National Science Foundation; The aesthetic side: Minerals and photography; Adventure and physical risks; Other people; Smale the mathematician; Mathematical appendix A:
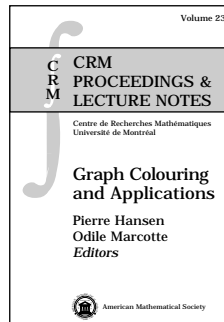
Smale's thesis; Mathematical appendix B: Everting the sphere; Mathematical appendix C: Chaos and the horseshoe; Mathematical appendix D: The higher dimensional Poincaré conjecture; Notes; Index.

Discrete Mathematics and Combinatorics

Graph Colouring and Applications

Pierre Hansen, *École des Hautes Études Commerciales, Montréal, PQ, Canada*, and **Odile Marcotte**, *Université du Québec à Montréal, Canada*, Editors

This volume presents the proceedings of the CRM workshop on graph coloring and applications. The articles span a wide spectrum of topics related to graph coloring, including: list-colorings, total colorings, colorings and embeddings of graphs, chromatic polynomials, characteristic polynomials, chromatic scheduling, and graph coloring problems related to frequency assignment. Outstanding researchers in combinatorial optimization and graph theory contributed their work. A list of open problems is included.

Contents: **D. K. Arrowsmith** and **J. W. Essam**, Chromatic polynomials and mod λ flows on directed graphs and their applications; **K. L. Collins** and **J. P. Hutchinson**, Four-coloring six-regular graphs on the torus; **M. Dror**, **G. Finke**, **S. Gravier**, and **W. Kubiak**, On the complexity of a restricted list-coloring problem; **G. M. Hamilton**, **A. J. W. Hilton**, and **H. R. F. Hind**, Totally critical graphs and the conformability conjecture; **F. Harary** and **M. Plantholt**, Graphs whose radio coloring number equals the number of nodes; **O. Marcotte** and **P. Hansen**, The height and length of colour switching; **H. Sachs**, Characteristic polynomials in the theory of polyhedra; **T. R. Walsh**, The number of edge 3-colourings of the n-prism; **T. R. Walsh**, The cost of radio-colouring paths and cycles; **D. de Werra**, Restricted graph coloring: Some mathematical programming models; Open problems.
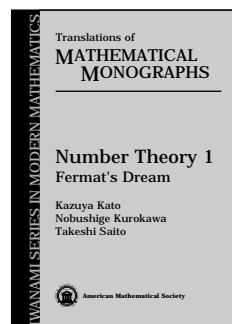
CRM Proceedings & Lecture Notes, Volume 23

Number Theory

Number Theory 1
Fermat's Dream

Kazuya Kato, *University of Tokyo, Japan*, **Nobushige Kurokawa**, *Tokyo Institute of Technology, Japan*, and **Takeshi Saito**, *University of Tokyo, Japan*

This is the English translation of the original Japanese book. In this volume, "Fermat's Dream", core theories in modern number theory are introduced. Developments are given in elliptic curves, p-adic numbers, the ζ-function, and the number fields. This work presents an elegant perspective on the wonder of numbers. *Number Theory 2* on class field theory, and *Number Theory 3* on Iwasawa theory and the theory of modular forms, are forthcoming in the series.

Contents: Introduction; Rational points on elliptic curves; Conics and p-adic numbers; ζ; Algebraic number theory; Rudiments on Dedekind domains; Answers to questions; Answers to exercises; Index.

Translations of Mathematical Monographs (*Iwanami Series in Modern Mathematics*)

December 1999, approximately 165 pages, Softcover, ISBN 0-8218-0863-X, LC 99-33556, 1991 *Mathematics Subject Classification*: 11–XX, 14–XX, **All AMS members $20**, List $25, Order code MMONO-KATON

Previously Announced Publications

Riemannian Geometry During the Second Half of the Twentieth Century

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

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.

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-BERGERRT911

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.

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 17

November 1999, 95 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/17RT911

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.

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.HRT911

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.

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.HRT911

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 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.

October 1999, 406 pages, Hardcover, ISBN 0-8218-2064-8, LC 99-37303, 1991 *Mathematics Subject Classification*: 01A70, **All AMS members $28**, List $35, Order code JVNMRT911

which is a mysterious mathematical justification of the computation of Candelas, et al.

SMF members are entitled to AMS member discounts.

SMF/AMS Texts and Monographs, Volume 1

August 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/1RT911

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,