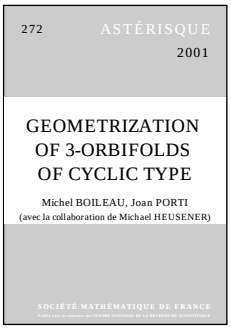
New Publications Offered by the AMS

Geometry and Topology



Geometrization of 3-Orbifolds of Cyclic Type

Michel Boileau, *CNRS, Université Paul Sabatier, Toulouse, France*, and **Joan Porti**, *Universitat Autònoma de Barcelona, Bellaterra, Spain*

A publication of the Société Mathématique de France.

In this book, the authors prove the orbifold theorem in the cyclic case: If $\mathcal{O}$ is a compact oriented irreducible atoroidal 3-orbifold whose ramification locus is a non-empty submanifold, then $\mathcal{O}$ is geometric, i.e. it has a hyperbolic, a Euclidean or a Seifert fibred structure. This theorem implies Thurston's geometrization conjecture for compact orientable irreducible three-manifolds having a non-free symmetry.

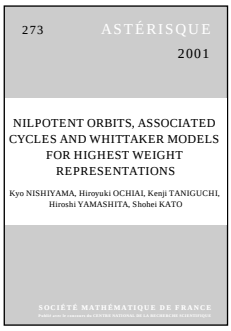
Distributed by the AMS in the United States, Canada, and Mexico. Orders from other countries should be sent to the SMF, Maison de la SMF, B.P. 67, 13274 Marseille cedex 09, France, or to Institut Henri Poincaré, 11 rue Pierre et Marie Curie, 75231 Paris cedex 05, France. Members of the SMF receive a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

Contents: Introduction; Cone manifolds; Proof of Thurston's orbifold theorem for very good 3-orbifolds; A compactness theorem for cone 3-manifolds with cone angles bounded above by π; Local soul theorem for cone 3-manifolds with cone angles less than or equal to π; Sequences of closed hyperbolic cone 3-manifolds with cone angles less than π; Very good orbifolds and sequences of hyperbolic cone 3-manifolds; Uniformization of small 3-orbifolds; Haken 3-orbifolds; Examples; Limit of hyperbolicity for spherical 3-orbifolds; Thurston's hyperbolic Dehn filling Theorem; Bibliography; Index.

Astérisque, Number 272

205 pages, ISBN 2-85629-100-7, 2000 *Mathematics Subject Classification*: 57M50, 57M60, 53C20, 53C23, **Individual member $50**, List $55, Order code AST/272N

Algebra and Algebraic Geometry



Nilpotent Orbits, Associated Cycles and Whittaker Models for Highest Weight Representations

Kyo Nishiyama, *Kyoto University, Japan*, **Hiroyuki Ochiai**, *Tokyo Institute of Technology, Japan*, **Kenji Taniguchi**, *Aoyama Gakuin University, Tokyo, Japan*, **Hiroshi Yamashita**, *Hokkaido University, Sapporo, Japan*, and **Shohei Kato**, *Nakakasai, Edogawa-ku, Tokyo, Japan*

A publication of the Société Mathématique de France.

Let G be a reductive Lie group of Hermitian type. The authors investigate irreducible (unitary) highest weight representations of G which are not necessarily in the holomorphic discrete series. The results of three articles of this volume include the determination of the associated cycles, the Bernstein degrees, and the generalized Whittaker models for such representations. They give a convenient description of K-types via branching rules for representations of classical groups. An integral formula for the degrees of small nilpotent orbits is established for arbitrary Hermitian Lie algebras. The generalized Whittaker models for each unitary highest weight module are specified by means of the principal symbol of a gradient-type differential operator, and also in relation to the multiplicity in the associated cycle. They also present expository introductions of the key notions treated in this volume, such as associated cycles, Howe correspondence for dual pairs where one member of the pair is compact, and the realization of highest weight representations on the kernels of the differential operators of gradient type.

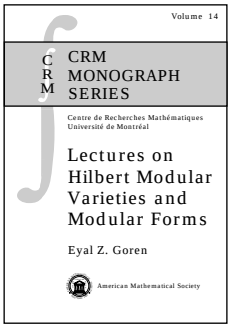
Distributed by the AMS in the United States, Canada, and Mexico. Orders from other countries should be sent to the SMF, Maison de la SMF, B.P. 67, 13274 Marseille cedex 09, France, or to Institut Henri Poin-

caré, 11 rue Pierre et Marie Curie, 75231 Paris cedex 05, France. Members of the SMF receive a 30% discount from list.

Contents: Introduction to this volume; **K. Nishiyama**, **H. Ochiai**, and **K. Taniguchi**, Bernstein degree and associated cycles of Harish-Chandra modules—Hermitian symmetric case; **H. Yamashita**, Cayley transform and generalized Whittaker models for irreducible highest weight modules; **S. Kato** and **H. Ochiai**, The degrees of orbits of the multiplicity-free actions; Concluding remarks.

Astérisque, Number 273

May 2001, ISBN 2-85629-101-5, 2000 *Mathematics Subject Classification*: 22E46, 32M15, 14L30, 58J70, **Individual member $40**, List $44, Order code AST/273N



Lectures on Hilbert Modular Varieties and Modular Forms

Eyal Z. Goren, *McGill University, Montreal, PQ, Canada*

This book is devoted to certain aspects of the theory of p-adic Hilbert modular forms and moduli spaces of abelian varieties with real multiplication.

The theory of p-adic modular forms is presented first in the elliptic case, introducing the reader to key ideas of N. M. Katz and J.-P. Serre. It is re-interpreted from a geometric point of view, which is developed to present the rudiments of a similar theory for Hilbert modular forms.

The theory of moduli spaces of abelian varieties with real multiplication is first presented very explicitly over the complex numbers. Aspects of the general theory are then exposed, in particular, local deformation theory of abelian varieties in positive characteristic.

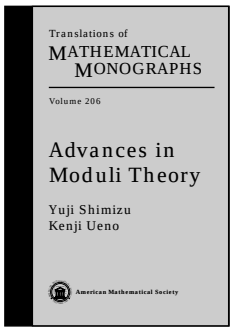
The arithmetic of p-adic Hilbert modular forms and the geometry of moduli spaces of abelian varieties are related and used to study q-expansions of Hilbert modular forms, on the one hand, and stratifications of moduli spaces on the other hand.

The book is addressed to graduate students and non-experts. It attempts to provide the necessary background to all concepts exposed in it. It may serve as a textbook for an advanced graduate course.

Contents: Introduction; Tori and abelian varieties; Complex abelian varieties with real multiplication and Hilbert modular forms; Abelian varieties with real multiplication over general fields; p-adic elliptic modular forms; p-adic Hilbert modular forms; Deformation theory of abelian varieties; Group schemes; Calculating with cusps; Bibliography; Notation index; Index.

CRM Monograph Series

November 2001, 270 pages, Hardcover, ISBN 0-8218-1995-X, 2000 *Mathematics Subject Classification*: 11G10, 11G18, 14G35, 11F33, 11F41, **Individual member $41**, List $69, Institutional member $55, Order code CRMM/14N



Supplementary Reading

Advances in Moduli Theory

Yuji Shimizu and **Kenji Ueno**, *Kyoto University, Japan*

The word "moduli" in the sense of this book first appeared in the epoch-making paper of B. Riemann, *Theorie der Abel'schen Funktionen*, published in 1857. Riemann defined a Riemann surface of an algebraic function field as a branched covering of a one-dimensional complex projective space and found out that Riemann surfaces have parameters. This work gave birth to the theory of moduli.

However, the viewpoint regarding a Riemann surface as an algebraic curve became the mainstream, and the moduli meant the parameters for the figures (graphs) defined by equations.

In 1913, H. Weyl defined a Riemann surface as a complex manifold of dimension one. Moreover, Teichmüller's theory of quasiconformal mappings and Teichmüller spaces made a start for new development of the theory of moduli, making possible a complex analytic approach toward the theory of moduli of Riemann surfaces. This theory was then investigated and made complete by Ahlfors, Bers, Rauch, and others. However, the theory of Teichmüller spaces utilized the special nature of complex dimension one, and it was difficult to generalize it to an arbitrary dimension in a direct way.

It was Kodaira-Spencer's deformation theory of complex manifolds that allowed one to study arbitrary dimensional complex manifolds. Initial motivation in Kodaira-Spencer's discussion was the need to clarify what one should mean by number of moduli. Their results, together with further work by Kuranishi, provided this notion with intrinsic meaning.

This book begins by presenting the Kodaira-Spencer theory in its original naive form in Chapter 1 and introduces readers to moduli theory from the viewpoint of complex analytic geometry. Chapter 2 briefly outlines the theory of period mapping and Jacobian variety for compact Riemann surfaces, with the Torelli theorem as a goal. The theory of period mappings for compact Riemann surfaces can be generalized to the theory of period mappings in terms of Hodge structures for compact Kähler manifolds. In Chapter 3, the authors state the theory of Hodge structures, focusing briefly on period mappings. Chapter 4 explains conformal field theory as an application of moduli theory.

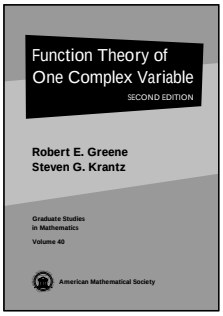
This is the English translation of a book originally published in Japanese. Other books by Kenji Ueno published in this AMS series, Translations of Mathematical Monographs, include *An Introduction to Algebraic Geometry*, Volume 166, *Algebraic Geometry 1: From Algebraic Varieties to Schemes*, Volume 185, and *Algebraic Geometry 2: Sheaves and Cohomology*, Volume 197.

Contents: Kodaira-Spencer mapping; Torelli's theorem; Period mappings and Hodge theory; Conformal field theory; Prospects and remaining problems; Solutions to problems; Bibliography; Index.

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

December 2001, approximately 320 pages, Softcover, ISBN 0-8218-2156-3, LC 2001046395, 2000 *Mathematics Subject Classification*: 54C40, 14E20; 46E25, 20C20, **All AMS members $39**, List $49, Order code MMONO-206N

Analysis



Recommended Text

Function Theory of One Complex Variable

Second Edition

Robert E. Greene, *University of California, Los Angeles*, and **Steven G. Krantz**, *Washington University, St. Louis, MO*

From a review of the First Edition:

The book is carefully and precisely written in a lively and soft style. It is extremely clear … and very detailed. Moreover, it is stimulating and very suitable for self-study … Certainly, the book reflects the authors' experience in teaching. The other features include the fruitful connection with real analysis … the authors have produced a modern, quality work that could serve as an excellent model for writing and teaching graduate texts … it will occupy a distinguished place in the extensive literature on the subject … I read this book with great pleasure and I warmly recommend it for all those who are interested in complex analysis of one variable.

—Mathematical Reviews

Complex analysis is one of the most beautiful subjects that we learn as graduate students. Part of the joy comes from being able to arrive quickly at some "real theorems". The fundamental techniques of complex variables are also used to solve real problems in neighboring subjects, such as number theory or PDEs.

This book is a text for a first-year graduate course in complex analysis. It is an engaging and modern introduction to the subject, reflecting the authors' expertise both as mathematicians and as expositors.

All the material usually treated in such a course is covered here, but following somewhat different principles. To begin with, the authors emphasize how this subject is a natural outgrowth of multivariable real analysis. Complex function theory has long been a flourishing independent field. However, an efficient path into the subject is to observe how its rudiments arise directly from familiar ideas in calculus. The authors pursue this point of view by comparing and contrasting complex analysis with its real variable counterpart.

Explanations of certain topics in complex analysis can sometimes become complicated by the intermingling of the analysis and the topology. Here, the authors have collected the primary topological issues in a separate chapter, leaving the way open for a more direct and less ambiguous approach to the analytic material.

The book concludes with several chapters on special topics, including full treatments of special functions, the prime number theorem, and the Bergman kernel. The authors also treat H^p spaces and Painlevé's theorem on smoothness to the boundary for conformal maps.

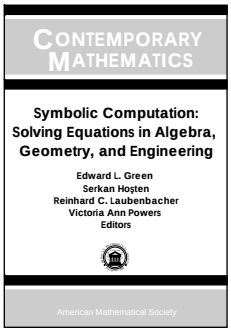
A large number of exercises are included. Some are simply drills to hone the students' skills, but many others are further developments of the ideas in the main text. The exercises are also used to explore the striking interconnectedness of the topics that constitute complex analysis.

Contents: Fundamental concepts; Complex line integrals; Applications of the Cauchy integral; Meromorphic functions and residues; The zeros of a holomorphic function; Holomorphic functions as geometric mappings; Harmonic functions; Infinite series and products; Applications of infinite sums and products; Analytic continuation; Topology; Rational approximation theory; Special classes of holomorphic functions; Hilbert spaces of holomorphic functions, the Bergman kernel, and biholomorphic mappings; Special functions; The prime number theorem; Real analysis; The statement and proof of Goursat's theorem; References; Index.

Graduate Studies in Mathematics, Volume 40

December 2001, approximately 528 pages, Hardcover, ISBN 0-8218-2905-X, LC 2001046415, 2000 *Mathematics Subject Classification*: 30-01; 30-00, 30-02, **All AMS members $55**, List $69, Order code GSM/40N

Applications



Symbolic Computation: Solving Equations in Algebra, Geometry, and Engineering

Edward L. Green, *Virginia Polytechnic Institute and State University, Blacksburg,* **Serkan Hoşten**, *San Francisco State University, CA*, **Reinhard C. Laubenbacher**, *New Mexico State University, Las Cruces,* and **Victoria Ann Powers**, *Emory University, Atlanta, GA*, Editors

This volume presents the proceedings from the research conference, "Symbolic Computation: Solving Equations in Algebra, Analysis, and Engineering," held at Mount Holyoke College (MA). It provides an overview of current research in symbolic computation as it applies to the solution of polynomial systems. The conference brought together pure and applied mathematicians, computer scientists, and engineers, who use symbolic computation to solve systems of equations or who develop the theoretical background and tools needed for this purpose. Within this general framework, the conference focused on several themes: systems of polynomials, systems of differential equations, noncommutative systems, and applications.

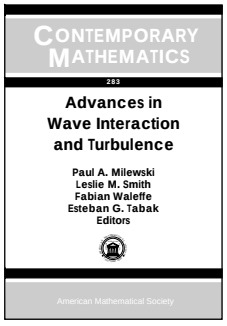
This item will also be of interest to those working in algebra and algebraic geometry.

Contents: D. A. Cox, Equations of parametric curves and surfaces via syzygies; **G. M. Díaz-Toca** and **L. González-Vega**, An explicit description for the triangular decomposition of a

zero-dimensional ideal through trace computations; **A. J. Sommese**, **J. Verschelde**, and **C. W. Wampler**, Numerical irreducible decomposition using projections from points on the components; **K. Gatermann**, Counting stable solutions of sparse polynomial systems in chemistry; **I. S. Kotsireas**, Central configurations in the Newtonian N-body problem of celestial mechanics; **D. Napoletani**, A power function approach to Kouchnirenko's conjecture; **J. M. Rojas**, Finiteness for arithmetic fewnomial systems; **D. Grigoriev**, Constructing double-exponential number of vectors of multiplicities of solutions of polynomial systems; **C. D'Andrea** and **I. Z. Emiris**, Computing sparse projection operators; **B. Sturmfels**, Gröbner bases of abelian matrix groups; **G. Boffi** and **F. Rossi**, Lexicographic Gröbner bases of 3-dimensional transportation problems; **E. Briales**, **A. Campillo**, **P. Pisón**, and **A. Vigneron**, Simplicial complexes and syzygies of lattice ideals; **U. Walther**, Algorithmic determination of the rational cohomology of complex varieties via differential forms; **M. Saito** and **W. N. Traves**, Differential algebras on semigroup algebras; **M. J. Bardzell**, Noncommutative Gröbner bases and Hochschild cohomology.

Contemporary Mathematics

December 2001, approximately 248 pages, Softcover, ISBN 0-8218-2679-4, 2000 *Mathematics Subject Classification*: 68W30, 12Y05, 14Q99, 13P10, 11C08, **Individual member $35**, List $59, Institutional member $47, Order code CONM-POWERSN



Advances in Wave Interaction and Turbulence

Paul A. Milewski, **Leslie M. Smith**, and **Fabian Waleffe**, *University of Wisconsin, Madison,* and **Esteban G. Tabak**, *New York University-Courant Institute of Mathematical Sciences, NY*, Editors

We often think of our natural environment as being composed of very many interacting particles, undergoing individual chaotic motions, of which only very coarse averages are perceptible at scales natural to us. However, we could as well think of the world as being made out of individual waves. This is so not just because the distinction between waves and particles becomes rather blurred at the atomic level, but also because even phenomena at much larger scales are better described in terms of waves rather than of particles: It is rare in both fluids and solids to observe energy being carried from one region of space to another by a given set of material particles; much more often, this transfer occurs through chains of particles, neither of them moving much, but each communicating with the next, and hence creating these immaterial objects we call waves.

Waves occur at many spatial and temporal scales. Many of these waves have small enough amplitude that they can be approximately described by linear theory. However, the joint effect of large sets of waves is governed by nonlinear interactions which are responsible for huge cascades of energy among very disparate scales. Understanding these energy transfers is crucial in order to determine the response of large systems, such as the atmosphere and the ocean, to external forcings and dissipation mechanisms which act on scales decades apart.

The field of wave turbulence attempts to understand the average behavior of large ensembles of waves, subjected to forcing and dissipation at opposite ends of their spectrum. It does so by studying individual mechanisms for energy transfer, such as resonant triads and quartets, and attempting to draw from them effects that should not survive averaging.

This book presents the proceedings of the AMS-IMS-SIAM Joint Summer Research Conference on Dispersive Wave Turbulence held at Mt. Holyoke College (MA). It drew together a group of researchers from many corners of the world, in the context of a perceived renaissance of the field, driven by heated debate about the fundamental mechanism of energy transfer among large sets of waves, as well as by novel applications—and old ones revisited—to the understanding of the natural world. These proceedings reflect the spirit that permeated the conference, that of friendly scientific disagreement and genuine wonder at the rich phenomenology of waves.

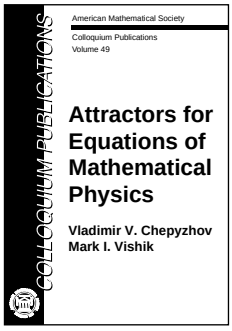
This item will also be of interest to those working in differential equations.

Contents: A. Babin, **A. Mahalov**, and **B. Nicolaenko**, Strongly stratified limit of 3D primitive equations in an infinite layer; **A. M. Balk**, Anomalous transport by wave turbulence; **R. Jordan** and **B. Turkington**, Statistical equilibrium theories for the nonlinear Schrödinger equation; **R. M. Kerr**, Is there a 2D cascade in 3D convection?; **F. Menzaque**, **R. R. Rosales**, **E. G. Tabak**, and **C. V. Turner**, The forced inviscid Burgers equation as a model for nonlinear interactions among dispersive waves; **P. Panayotaros**, Traveling surface elastic waves in the half-plane; **L. M. Smith**, Numerical study of two-dimensional stratified turbulence; **V. E. Zakharov**, **P. Guyenne**, **A. N. Pushkarev**, and **F. Dias**, Turbulence of one-dimensional weakly nonlinear dispersive waves.

Contemporary Mathematics, Volume 283

October 2001, 116 pages, Softcover, ISBN 0-8218-2714-6, LC 2001046252, 2000 *Mathematics Subject Classification*: 76B15, 35Q53, 37K10, 76B60, 74J20, 74J30, 76F55, 76F65, **Individual member $23**, List $39, Institutional member $31, Order code CONM/283N

Differential Equations



Independent Study

Attractors for Equations of Mathematical Physics

Vladimir V. Chepyzhov and **Mark I. Vishik**, *Russian Academy of Sciences, Moscow, Russia*

One of the major problems in the study of evolution equations of mathematical physics is the investigation of the behavior of the solutions to these equations when time is large or tends to infinity. The related important questions concern the stability of solutions or the character of the instability if a solution is unstable. In the last few decades, considerable progress in this area has been achieved in the study of autonomous evolution partial differ-

ential equations. For a number of basic evolution equations of mathematical physics, it was shown that the long time behavior of their solutions can be characterized by a very important notion of a global attractor of the equation.

In this book, the authors study new problems related to the theory of infinite-dimensional dynamical systems that were intensively developed during the last 20 years. They construct the attractors and study their properties for various non-autonomous equations of mathematical physics: the 2D and 3D Navier-Stokes systems, reaction-diffusion systems, dissipative wave equations, the complex Ginzburg-Landau equation, and others. Since, as it is shown, the attractors usually have infinite dimension, the research is focused on the Kolmogorov ε-entropy of attractors. Upper estimates for the ε-entropy of uniform attractors of non-autonomous equations in terms of ε-entropy of time-dependent coefficients are proved.

Also, the authors construct attractors for those equations of mathematical physics for which the solution of the corresponding Cauchy problem is not unique or the uniqueness is not proved. The theory of the trajectory attractors for these equations is developed, which is later used to construct global attractors for equations without uniqueness. The method of trajectory attractors is applied to the study of finite-dimensional approximations of attractors. The perturbation theory for trajectory and global attractors is developed and used in the study of the attractors of equations with terms rapidly oscillating with respect to spatial and time variables. It is shown that the attractors of these equations are contained in a thin neighborhood of the attractor of the averaged equation.

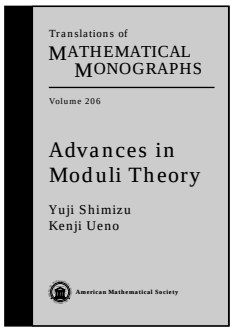
The book gives systematic treatment to the theory of attractors of autonomous and non-autonomous evolution equations of mathematical physics. It can be used both by specialists and by those who want to get acquainted with this rapidly growing and important area of mathematics.

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

Contents: Introduction; *Attractors of autonomous equations:* Attractors of autonomous ordinary differential equations; Attractors of autonomous partial differential equations; Dimension of attractors; *Attractors of non-autonomous equations:* Processes and attractors; Translation compact functions; Attractors of non-autonomous partial differential equations; Semiprocesses and attractors; Kernels of processes; Kolmogorov ε-entropy of attractors; *Trajectory attractors:* Trajectory attractors of autonomous ordinary differential equations; Attractors in Hausdorff spaces; Trajectory attractors of autonomous equations; Trajectory attractors of autonomous partial differential equations; Trajectory attractors of non-autonomous equations; Trajectory attractors of non-autonomous partial differential equations; Approximation of trajectory attractors; Perturbation of trajectory attractors; Averaging of attractors of evolution equations with rapidly oscillating terms; Proofs of Theorems II.1.4 and II.1.5; Lattices and coverings; Bibliography; Index.

Colloquium Publications, Volume 49

December 2001, 363 pages, Hardcover, ISBN 0-8218-2950-5, LC 2001046406, 2000 *Mathematics Subject Classification*: 35K90, 35B40, 37C70, 37L30; 35Q99, 35Q30, 35L70, 35K57, **All AMS members $55**, List $69, Order code COLL/49N



Bäcklund and Darboux Transformations. The Geometry of Solitons

Alan Coley, *Dalhousie University, Halifax, NS, Canada*, **Decio Levi**, *University of Rome III, Italy*, **Robert Milson**, *Dalhousie University, Halifax, NS, Canada*, **Colin Rogers**, *University of New South Wales, Sydney, NSW, Australia*, and **Pavel Winternitz**, *Université de Montréal, QC, Canada*, Editors

This book is devoted to a classical topic that has undergone rapid and fruitful development over the past 25 years, namely Bäcklund and Darboux transformations and their applications in the theory of integrable systems, also known as soliton theory.

The book consists of two parts. The first is a series of introductory pedagogical lectures presented by leading experts in the field. They are devoted respectively to Bäcklund transformations of Painlevé equations, to the dressing method and Bäcklund and Darboux transformations, and to the classical geometry of Bäcklund transformations and their applications to soliton theory. The second part contains original contributions that represent new developments in the theory and applications of these transformations.

Both the introductory lectures and the original talks were presented at an International Workshop that took place in Halifax, Nova Scotia (Canada). This volume covers virtually all recent developments in the theory and applications of Bäcklund and Darboux transformations.

Contents: *Introductory lectures:* **V. I. Gromak**, Bäcklund transformations of the higher order Painlevé equations; **D. Levi** and **O. Ragnisco**, Dressing method and Bäcklund and Darboux transformations; **C. Rogers** and **W. K. Schief**, The classical geometry of Bäcklund transformations. Introduction to applications in soliton theory; **W. K. Schief**, An introduction to integrable difference and differential geometries: Affine spheres, their natural generalization and discretization; *Original contributions:* **Yu. Aminov** and **A. Sym**, On Bianchi and Bäcklund transformations of two dimensional surfaces in four dimensional Euclidean space; **I. M. Anderson**, **M. E. Fels**, and **C. G. Torre**, Group invariant solutions without transversality and the principle of symmetric criticality; **H. Aratyn**, **E. Nissimov**, and **S. Pacheva**, Multi-component matrix KP hierarchies as symmetry-enhanced scalar KP hierarchies and their Darboux-Bäcklund solutions; **J. L. Cieśliński**, The Darboux-Bäcklund transformation and Clifford algebras; **P. A. Clarkson**, **E. L. Mansfield**, and **H. N. Webster**, On discrete Painlevé equations as Bäcklund transformations; **J. N. Clelland**, A Bäcklund transformation for timelike surfaces of constant mean curvature in $\mathbb{R}^{1,2}$; **A. V. Corro**, **W. Ferreira**, and **K. Tenenblat**, On Ribaucour transformations; **A. Doliwa**, The Ribaucour congruences of spheres within Lie sphere geometry; **N. M. Ercolani**, Bäcklund transformations for the reduced Maxwell-Bloch equations; **E. V. Ferapontov**, Transformations of quasilinear systems originating from the projective theory of congruences; **E. V. Ferapontov** and **A. M. Grundland**, Bäcklund links

between different analytic descriptions of constant mean curvature surfaces; **F. Finkel**, On the integrability of Weingarten surfaces; **F. Finkel** and **A. S. Fokas**, A new immersion formula for surfaces on Lie algebras and integrable equations; **J. D. Finley III**, Difficulties with the SDiff(2) Toda equation; **M. Havlíček**, **S. Pošta**, and **P. Winternitz**, Superposition formulas based on nonprimitive group action; **R. H. Heredero**, **D. Levi**, **M. A. Rodríguez**, and **P. Winternitz**, Symmetries of differential difference equations and Lie algebra contractions; **J. Hietarinta**, Bäcklund transformations from the bilinear viewpoint; **L. Hlavatý**, Towards the Lax formulation of SU(2) principal models with nonconstant metric; **C. A. Hoenselaers** and **S. Micciché**, Transcendental solutions of the sine-Gordon equation; **T. Ioannidou**, **B. Piette**, and **W. J. Zakrzewski**, Three dimensional skyrmions and harmonic maps; **B. G. Konopelchenko** and **G. Landolfi**, Induced surfaces and their integrable deformations; **M. Kovalyov**, Properties of a class of slowly decaying oscillatory solutions of KdV; **S. Lafortune**, **A. Ramani**, **B. Grammaticos**, **Y. Ohta**, and **K. M. Tamizhmani**, Blending two discrete integrability criteria: Singularity confinement and algebraic entropy; **W.-X. Ma** and **X. Geng**, Bäcklund transformations of soliton systems from symmetry constraints; **P. Mathieu**, Open problems for the super KdV equations; **R. Milson**, Combinatorial aspects of the Darboux transformation; **M. Musette**, **R. Conte**, and **C. Verhoeven**, Bäcklund transformation and nonlinear superposition formula of the Kaup-Kupershmidt and Tzitzéica equations; **P. J. Olver**, **J. A. Sanders**, and **J. P. Wang**, Classification of symmetry-integrable evolution equations; **E. G. Reyes**, Integrability of evolution equations and pseudo-spherical surfaces; **C. Rogers** and **W. K. Schief**, Infinitesimal Bäcklund transformations of *K*-nets. The 2 + 1-dimensional Sinh-Gordon system; **W. K. Schief**, Isothermic surfaces and the Calapso equation: The full Monty; **R. Schmid**, Bäcklund transformations induced by symmetries. Application: Discrete mKdV; **H. Steudel**, Darboux transformation for a spectral problem quadratic in the spectral parameter; **Z. Thomova** and **P. Winternitz**, Separation of variables and Darboux transformations; **P. Winternitz**, Bäcklund transformations as nonlinear ordinary differential, or difference equations with superposition formulas.

CRM Proceedings & Lecture Notes

November 2001, approximately 456 pages, Softcover, ISBN 0-8218-2803-7, 2000 *Mathematics Subject Classification*: 37K35, 35Q51, 17B80, 35Qxx, 37Kxx, **Individual member $71**, List $119, Institutional member $95, Order code CRMP-WINTERNITZN

magazine, *Kvant*, which has been enjoyed by many of the best students since its founding in 1970. The articles in *Kvant* assume only a minimal background, that of a good high school student, yet are capable of entertaining mathematicians of almost any level. Sometimes the articles require careful thought or a moment's work with a pencil and paper. However, the industrious reader will be generously rewarded by the elegance and beauty of the subjects.

This book is the third collection of articles from *Kvant* to be published by the AMS. The volume is devoted mainly to combinatorics and discrete mathematics. Several of the topics are well known: nonrepeating sequences, detecting a counterfeit coin, and linear inequalities in economics, but they are discussed here with the entertaining and engaging style typical of the magazine. The two previous collections treat aspects of algebra and analysis, including connections to number theory and other topics. They were published as Volumes 14 and 15 in the Mathematical World series.

The articles are written so as to present genuine mathematics in a conceptual, entertaining, and accessible way. The books are designed to be used by students and teachers who love mathematics and want to study its various aspects, deepening and expanding upon the school curriculum.

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

Contents: I. M. Yaglom, Two games with matchsticks; **A. B. Katok**, Economics and linear inequalities; **A. B. Katok**, Economics and linear inequalities (Continuation); **R. V. Freivald**, Switching networks; **G. M. Adel'son-Vel'skiĭ**, **I. N. Bernshteĭn**, and **M. L. Gerver**, Who will go to Rio?; **A. L. Toom**, From the life of units; **G. A. Gurevich**, Nonrepeating sequences; **A. M. Stepin** and **A. T. Tagi-Zade**, Words with restrictions; **S. Ovchinnikov**, Planar switching circuits; **P. Bleher** and **M. Kelbert**, Classification algorithms; **G. Shestopal**, How to detect a counterfeit coin; **M. Mamikon**, The generalized problem of counterfeit coins; **P. Bleher**, Truthtellers, liars, and deceivers; **V. A. Uspenskiĭ** and **A. L. Semenov**, Solvable and unsolvable algorithmic problems; **P. A. Pevzner**, Best bet for simpletons.

Mathematical World

January 2002, approximately 136 pages, Softcover, ISBN 0-8218-2171-7, 2000 *Mathematics Subject Classification*: 00–01, 00A08; 97A20, **All AMS members $23**, List $29, Order code MAWRLD/17N

General and Interdisciplinary

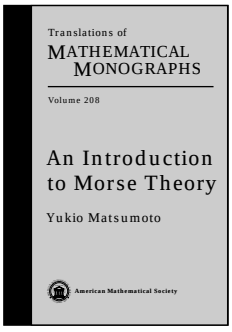
Supplementary Reading

Kvant Selecta: Combinatorics, I

Serge Tabachnikov, *University of Arkansas at Fayetteville,* Editor

There is a tradition in Russia that holds that mathematics can be both challenging and fun. One fine outgrowth of that tradition is the

Geometry and Topology



Supplementary Reading

An Introduction to Morse Theory

Yukio Matsumoto, *University of Tokyo, Japan*

In a very broad sense, "spaces" are objects of study in geometry, and "functions" are objects of study in analysis. There are, however, deep relations between functions defined on a space and the shape of the space, and the study of these relations is the main theme of Morse theory. In particular, its feature is to look at the critical points of a function, and to

derive information on the shape of the space from the information about the critical points.

Morse theory deals with both finite-dimensional and infinite-dimensional spaces. In particular, it is believed that Morse theory on infinite-dimensional space will become more and more important in the future as mathematics advances.

This book describes Morse theory for finite dimensions. Finite-dimensional Morse theory has an advantage in that it is easier to present fundamental ideas than in infinite-dimensional Morse theory, which is theoretically more involved. Therefore, finite-dimensional Morse theory is more suitable for beginners to study.

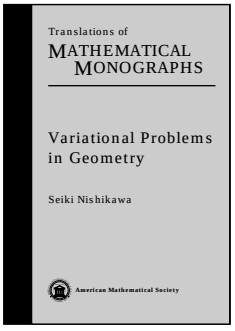
On the other hand, finite-dimensional Morse theory has its own significance, not just as a bridge to infinite dimensions. It is an indispensable tool in the topological study of manifolds. That is, one can decompose manifolds into fundamental blocks such as cells and handles by Morse theory, and thereby compute a variety of topological invariants and discuss the shapes of manifolds. These aspects of Morse theory will continue to be a treasure in geometry for years to come.

This textbook aims at introducing Morse theory to advanced undergraduates and graduate students. It is the English translation of a book originally published in Japanese.

Contents: Morse theory on surfaces; Extension to general dimensions; Handelbodies; Homology of manifolds; Low dimensional manifolds; A view from current mathematics; Answers to exercises; Bibliography; Recommended reading; Index.

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

December 2001, approximately 232 pages, Softcover, ISBN 0-8218-1022-7, 2000 *Mathematics Subject Classification*: 57–01; 57R19, 57R65, 57R70, 57M25, 57M99, **All AMS members $31**, List $39, Order code MMONO-208N



Supplementary Reading

Variational Problems in Geometry

Seiki Nishikawa, *Mathematical Institute, Tohoku University, Sendai, Japan*

A minimal length curve joining two points in a surface is called a geodesic. One may trace the origin of the problem of finding geodesics back to the birth of calculus.

Many contemporary mathematical problems, as in the case of geodesics, may be formulated as variational problems in surfaces or in a more generalized form on manifolds. One may characterize geometric variational problems as a field of mathematics that studies global aspects of variational problems relevant in the geometry and topology of manifolds. For example, the problem of finding a surface of minimal area spanning a given frame of wire originally appeared as a mathematical model for soap films. It has also been actively investigated as a geometric variational problem. With recent developments in computer graphics, totally new aspects of the study on the subject have begun to emerge.

This book is intended to be an introduction to some of the fundamental questions and results in geometric variational problems, studying the variational problems on the length of curves and the energy of maps.

The first two chapters treat variational problems of the length and energy of curves in Riemannian manifolds, with an in-depth discussion of the existence and properties of geodesics viewed as solutions to variational problems. In addition, a special emphasis is placed on the facts that concepts of connection and covariant differentiation are naturally induced from the formula for the first variation in this problem, and that the notion of curvature is obtained from the formula for the second variation.

The last two chapters treat the variational problem on the energy of maps between two Riemannian manifolds and its solution, harmonic maps. The concept of a harmonic map includes geodesics and minimal submanifolds as examples. Its existence and properties have successfully been applied to various problems in geometry and topology. The author discusses in detail the existence theorem of Eells-Sampson, which is considered to be the most fundamental among existence theorems for harmonic maps. The proof uses the inverse function theorem for Banach spaces. It is presented to be as self-contained as possible for easy reading.

Each chapter may be read independently, with minimal preparation for covariant differentiation and curvature on manifolds. The first two chapters provide readers with basic knowledge of Riemannian manifolds. Prerequisites for reading this book include elementary facts in the theory of manifolds and functional analysis, which are included in the form of appendices. Exercises are given at the end of each chapter.

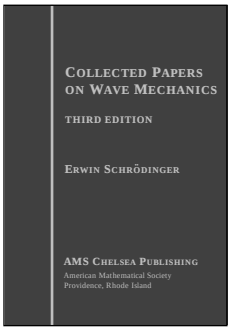
This is the English translation of a book originally published in Japanese. It is an outgrowth of lectures delivered at Tohoku University and at the Summer Graduate Program held at the Institute for Mathematics and its Applications at the University of Minnesota. It would make a suitable textbook for advanced undergraduates and graduate students. This item will also be of interest to those working in analysis.

Contents: Arc-length of curves and geodesics; First and second variation formulas; Energy of maps and harmonic maps; Existence of harmonic maps; Fundamentals of theory of manifolds and functional analysis; Prospects for contemporary mathematics; Books; Solutions to exercise problems; Bibliography; Index.

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

January 2002, approximately 240 pages, Softcover, ISBN 0-8218-1356-0, LC 2001046350, 2000 *Mathematics Subject Classification*: 53–01, 53C21, 53C43, 58E20, 58J35, **All AMS members $31**, List $39, Order code MMONO-NISHIKAWAN

Mathematical Physics



Collected Papers on Wave Mechanics

Third Edition

Erwin Schrödinger

This third, augmented edition contains the six original, famous papers in which Schrödinger created and developed the subject of Wave Mechanics as published in the original edition. As the author points out, at the time each paper was written the results of the later papers were largely unknown to him. The papers and lectures in this volume were revised by the author and translated into English, and afford the reader a striking and valuable insight into how Wave Mechanics developed.

Contents: *Papers:* Quantisation as a problem of proper values. Part I; Quantisation as a problem of proper values. Part II; The continuous transition from micro- to macro-mechanics; On the relation between the quantum mechanics of Heisenberg, Born, and Jordan, and that of Schrödinger; Quantisation as a problem of proper values. Part III; Quantisation as a problem of proper values. Part IV; The Compton effect; The energy-momentum theorem for material waves; The exchange of energy according to wave mechanics; *Lectures:* Derivation of the fundamental idea of wave mechanics from Hamilton's analogy between ordinary mechanics and geometrical optics; Ordinary mechanics only an approximation, which no longer holds for very small systems; Bohr's stationary energy-levels derived as the frequencies of proper vibrations of the waves; Rough description of the wave-systems in the hydrogen atom. Degeneracy. Perturbation; The physical meaning of the wave function. Explanation of the selection rules and of the rules for the polarization of spectral lines; Derivation of the wave equation (properly speaking) which contains the time; An atom as perturbed by an alternating electric field; Theory of secondary radiation and dispersion; Theory of resonance radiation, and of changes of the state of the atom produced by incident radiation whose frequency coincides, or nearly coincides, with a natural emission frequency; Extension of wave mechanics to systems other than a single mass-point; Examples: the oscillator, the rotator; Correction for motion of the nucleus in the hydrogen atom; Perturbation of an arbitrary system; Interaction between two arbitrary systems; The physical meaning of the generalized ψ-function.

AMS Chelsea Publishing

October 1997, 224 pages, Softcover, ISBN 0-8218-2976-9, 2000 *Mathematics Subject Classification*: 01A75, 81-03; 81-XX, **All AMS members $18**, List $20, Order code CHEL/302.SN

Previously Announced Publications

Recommended Text

Geometry of Manifolds

Richard L. Bishop, *University of Illinois, Urbana,* and **Richard J. Crittenden**

From a review for the First Edition:

This book represents an excellent treatment of a wide section of modern differential geometry … The style is elegant and at the same time considerate for the needs of a beginner … a great number of well chosen problems with pertinent references … anybody who chooses to base his course on differential geometry at the graduate level on this book could do no better.

—Mathematical Reviews

From the Preface of the First Edition: "Our purpose in writing this book is to put material which we found stimulating and interesting as graduate students into form. It is intended for individual study and for use as a text for graduate level courses such as the one from which this material stems, given by Professor W. Ambrose at MIT in 1958–1959. Previously the material had been organized in roughly the same form by him and Professor I. M. Singer, and they in turn drew upon the work of Ehresmann, Chern, and É. Cartan. Our contributions have been primarily to fill out the material with details, asides and problems, and to alter notation slightly.

"We believe that this subject matter, besides being an interesting area for specialization, lends itself especially to a synthesis of several branches of mathematics, and thus should be studied by a wide spectrum of graduate students so as to break away from narrow specialization and see how their own fields are related and applied in other fields. We feel that at least part of this subject should be of interest not only to those working in geometry, but also to those in analysis, topology, algebra, and even probability and astronomy. In order that this book be meaningful, the reader's background should include real variable theory, linear algebra, and point set topology."

This volume is a reprint with few corrections of the original work published in 1964. Starting with the notion of differential manifolds, the first six chapters lay a foundation for the study of Riemannian manifolds through specializing the theory of connections on principle bundles and affine connections. The geometry of Riemannian manifolds is emphasized, as opposed to global analysis, so that the theorems of Hopf-Rinow, Hadamard-Cartan, and Cartan's local isometry theorem are included, but no elliptic operator theory. Isometric immersions are treated elegantly and from a global viewpoint. In the final chapter are the more complicated estimates on which much of the research in Riemannian geometry is based: the Morse index theorem, Synge's theorems on closed geodesics, Rauch's comparison theorem, and the original proof of the Bishop volume-comparison theorem (with Myer's Theorem as a corollary).

The first edition of this book was the origin of a modern treatment of global Riemannian geometry, using the carefully conceived notation that has withstood the test of time. The primary source material for the book were the papers and course notes of brilliant geometers, including É. Cartan, C. Ehresmann, I. M. Singer, and W. Ambrose. It is tightly orga-

nized, uniformly very precise, and amazingly comprehensive for its length.

AMS Chelsea Publishing

October 2001, 273 pages, Hardcover, ISBN 0-8218-2923-8, 2000 *Mathematics Subject Classification*: 53-01, **All AMS members $35**, List $39, Order code CHEL/344.HRT111

Independent Study

Mathematics of Information and Coding

Te Sun Han and **Kingo Kobayashi**, *The University of Electro-Communications, Tokyo, Japan*

This book is intended to provide engineering and/or statistics students, communications engineers, and mathematicians with the firm theoretic basis of *source coding* (or *data compression*) in information theory. Although information theory consists of two main areas, source coding and channel coding, the authors choose here to focus only on source coding. The reason is that, in a sense, it is more basic than channel coding, and also because of recent achievements in source coding and compression. An important feature of the book is that whenever possible, the author describes *universal* coding methods, i.e., the methods that can be used without prior knowledge of the statistical properties of the data. The authors approach the subject of source coding from the very basics to the top frontiers in an intuitively transparent, but mathematically sound manner.

The book serves as a theoretical reference for communication professionals and statisticians specializing in information theory. It will also serve as an excellent introductory text for advanced-level and graduate students taking elementary or advanced courses in telecommunications, electrical engineering, statistics, mathematics, and computer science.

Translations of Mathematical Monographs

December 2001, approximately 296 pages, Hardcover, ISBN 0-8218-0534-7, LC 2001041262, 2000 *Mathematics Subject Classification*: 00A69, 94-02, 94A24, 94A29, 94A15, 94A45, 68P30, 62F03, 62F12, **Individual member $59**, List $99, Institutional member $79, Order code MMONO-HANRT111

Lebesgue's Theory of Integration: Its Origins and Development

Thomas Hawkins, *Boston University, MA*

From reviews for the original edition:

Thomas Hawkins has set out to place Lebesgue's early work on integration theory ... within its proper historical context ... He has succeeded brilliantly ... [He] has been able to convey the excitement of discovery and groping that must attend the birth of any fundamental theory ... [He] has written a book that is the epitome of what a mathematical history should be.

—Science

This is a book which can be recommended to every mathematician.

—Zentralblatt für Mathematik

A clear exposition ...

—Nature

Hawkins has written an excellent book, of value both to mathematicians and historians of science ... Any teacher of advanced calculus will find the material in this book invaluable in motivating the introduction of Lebesgue's theory.

—Isis

The success of the book will be ensured because it is a genuinely historical study.

—British Journal of the History of Science

An interesting book ... valuable to the worker in the field ... brings out a number of ideas and results ... It can be recommended highly to students who are getting their introduction to Lebesgue integration, particularly because it shows how an important mathematical idea develops, sometimes slowly, until it becomes an aesthetically satisfying structure.

—MAA Monthly

Lebesgue integration is one of the great success stories of modern mathematics, and Hawkins tells it very well. An introductory chapter sets the scene, describing how the first rigorous theory of integration took shape at the hands of Cauchy and Riemann. The book then plunges into fifty years of ferment, as researchers struggle to deal with "assumptionless" functions which will not fit the theory. Differentiable functions turn up with bounded derivatives which are not (Riemann) integrable; do they satisfy the fundamental theorem of calculus? Rectifiable curves are defined without assuming differentiability; must we give up the integral formula for length? To prove uniqueness for trigonometric series, we need a term-by-term integration of a series not converging uniformly; can it be justified? [One] falls into traps through not understanding the complexity of nowhere-dense sets, and through confusing them with the sets negligible in integration. The valid theorems have complicated hypotheses and even more complicated proofs. At the end of the century Hermite exclaims, "I turn away with fright and horror from this lamentable plague of functions which do not have derivatives." And then the key idea enters from a quite unexpected source.

—Bulletin of the AMS

In this book, Hawkins elegantly places Lebesgue's early work on integration theory within in proper historical context by relating it to the developments during the nineteenth century that motivated it and gave it significance and also to the contributions made in this field by Lebesgue's contemporaries.

Hawkins was awarded the 1997 MAA Chauvenet Prize and the 2001 AMS Albert Leon Whiteman Memorial Prize for notable exposition and exceptional scholarship in the history of mathematics.

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

AMS Chelsea Publishing

September 2001, 227 pages, Hardcover, ISBN 0-8218-2963-7, 2000 *Mathematics Subject Classification*: 28-03, 01A05; 01A75, **All AMS members $26**, List $29, Order code CHEL/282.HRT111

Stochastic Analysis on Manifolds

Elton P. Hsu, *Northwestern University, Evanston*

Probability theory has become a convenient language and a useful tool in many areas of modern analysis. The main purpose of this book is to explore part of this connection concerning the relations between Brownian motion on a manifold and analytical aspects of differential geometry. A dominant theme of the book is the probabilistic interpretation of the curvature of a manifold.

The book begins with a brief review of stochastic differential equations on Euclidean space. After presenting the basics of stochastic analysis on manifolds, the author introduces Brownian motion on a Riemannian manifold and studies the effect of curvature on its behavior. He then applies Brownian motion to geometric problems and vice versa, using many well-known examples, e.g., short-time behavior of the heat kernel on a manifold and probabilistic proofs of the Gauss-Bonnet-Chern theorem and the Atiyah-Singer index theorem for Dirac operators. The book concludes with an introduction to stochastic analysis on the path space over a Riemannian manifold.

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

Graduate Studies in Mathematics, Volume 38

November 2001, approximately 273 pages, Hardcover, ISBN 0-8218-0802-8, LC 2001046052, 2000 *Mathematics Subject Classification*: 58J65, 60J60, 60J65, **All AMS members $35**, List $44, Order code GSM/38RT111

The Concentration of Measure Phenomenon

Michel Ledoux, *Université Paul-Sabatier, Toulouse, France*

The observation of the concentration of measure phenomenon is inspired by isoperimetric inequalities. A familiar example is the way the uniform measure on the standard sphere S^n becomes concentrated around the equator as the dimension gets large. This property may be interpreted in terms of functions on the sphere with small oscillations, an idea going back to Lévy. The phenomenon also occurs in probability, as a version of the law of large numbers, due to Emil Borel. This book offers the basic techniques and examples of the concentration of measure phenomenon. The concentration of measure phenomenon was put forward in the early seventies by V. Milman in the asymptotic geometry of Banach spaces. It is of powerful interest in applications in various areas, such as geometry, functional analysis and infinite-dimensional integration, discrete mathematics and complexity theory, and probability theory. Particular emphasis is on geometric, functional, and probabilistic tools to reach and describe measure concentration in a number of settings.

The book presents concentration functions and inequalities, isoperimetric and functional examples, spectrum and topological applications, product measures, entropic and transportation methods, as well as aspects of M. Talagrand's deep investigation of concentration in product spaces and its application in discrete mathematics and probability theory, supremum of Gaussian and empirical processes, spin glass, random matrices, etc. Prerequisites are a basic background in measure theory, functional analysis, and probability theory.

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

Mathematical Surveys and Monographs, Volume 89

October 2001, 181 pages, Hardcover, ISBN 0-8218-2864-9, LC 2001041310, 2000 *Mathematics Subject Classification*: 28Axx, 46Bxx, 52Axx, 60–XX; 28C20, 28D20, 46G12, 58C30, 62G30, 82B44, **Individual member $35**, List $59, Institutional member $47, Order code SURV/89RT111

Independent Study

Oscillating Patterns in Image Processing and Nonlinear Evolution Equations

The Fifteenth Dean Jacqueline B. Lewis Memorial Lectures

Yves Meyer, *École Normale Supérieure de Cachan, France*

Image compression, the Navier-Stokes equations, and detection of gravitational waves are three seemingly unrelated scientific problems that, remarkably, can be studied from one perspective. The notion that unifies the three problems is that of "oscillating patterns", which are present in many natural images, help to explain nonlinear equations, and are pivotal in studying chirps and frequency-modulated signals.

The first chapter of this book considers image processing, more precisely algorithms of image compression and denoising. This research is motivated in particular by the new standard for compression of still images known as JPEG-2000. The second chapter has new results on the Navier-Stokes and other nonlinear evolution equations. Frequency-modulated signals and their use in the detection of gravitational waves are covered in the final chapter.

In the book, the author describes both what the oscillating patterns are and the mathematics necessary for their analysis. It turns out that this mathematics involves new properties of various Besov-type function spaces and leads to many deep results, including new generalizations of famous Gagliardo-Nirenberg and Poincaré inequalities.

This book is based on the "Dean Jacqueline B. Lewis Memorial Lectures" given by the author at Rutgers University. It can be used either as a textbook in studying applications of wavelets to image processing or as a supplementary resource for studying nonlinear evolution equations or frequency-modulated signals. Most of the material in the book did not appear previously in monograph literature.

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

University Lecture Series, Volume 22

September 2001, approximately 136 pages, Softcover, ISBN 0-8218-2920-3, 2000 *Mathematics Subject Classification*: 35Q30, 42C40, 65T60, 76D05, 76D06, **All AMS members $20**, List $25, Order code ULECT/22RT111