Twistor Theory For Riemannian Symmetric Spaces With Applications To Harmonic Maps Of Riemann Surfaces Lecture Notes In Mathematics

This book contains refereed papers presented at the AMS-IMS-SIAM Summer Research Conference on the Penrose Transform and Analytic Cohomology in Representation Theory held in the summer of 1992 at Mount Holyoke College. The conference brought together some of the top experts in representation theory and differential geometry. One of the issues explored at the conference was the fact that various integral transforms from representation theory, complex integral geometry, and mathematical physics appear to be instances of the same general construction, which is sometimes called the Penrose transform". There is considerable scope for further research in this area, and this book would serve as an excellent introduction.

A workshop on Singularities, Bifurcation and Dynamics was held at Warwick in July 1989 as part of a year-long symposium on Singularity Theory and its applications. The proceedings fall into two halves: Volume I mainly on connections with algebraic geometry and volume II on connections with dynamical systems theory, bifurcation theory, and applications in the sciences. The papers are orginal research, stimulated by the symposium and workshops: All have been refereed, and none will appear elsewhere. The main topic, deformation theory, is represented by several papers on descriptions of the bases of versal deformations, and several more on descriptions of the generic fibres. Other topics include stratifications, and applications to differential geometry.

This volume (a sequel to LNM 1108, 1214, 1334 and 1453) continues the presentation to English speaking readers of the Voronezh University press series on Global Analysis and Its Applications. The papers are selected fromtwo Russian issues entitled "Algebraic questions of Analysis and Topology" and "Nonlinear Operators in Global Analysis". CONTENTS: YuE. Gliklikh: Stochastic analysis, groups of diffeomorphisms and Lagrangian description of viscous incompressible fluid.- A.Ya. Helemskii: From topological homology: algebras with different properties of homological triviality.- V.V. Lychagin, L.V. Zil'bergleit: Duality in stable Spencer cohomologies.- O.R. Musin: On some problems of computational geometry and topology.- V.E. Nazaikinskii, B.Yu. Sternin, V.E.Shatalov: Introduction to Maslov's operational method (non-commutative analysis and differential equations).- Yu.B. Rudyak: The problem of realization of homology classes from Poincare up to the present.- V.G. Zvyagin, N.M. Ratiner: Oriented degree of Fredholm maps of non-negativeindex and its applications to global bifurcation of solutions.- A.A. Bolibruch: Fuchsian systems with reducible monodromy and the Riemann-Hilbert problem.- I.V. Bronstein, A.Ya. Kopanskii: Finitely smooth normal forms of vector fields in the vicinity of a rest point.- B.D. Gel'man: Generalized degree of multi-valued mappings.- G.N. Khimshiashvili: On Fredholmian aspects of linear transmission problems.- A.S. Mishchenko: Stationary solutions of nonlinear stochastic equations.- B.Yu. Sternin, V.E. Shatalov: Continuation of solutions to elliptic equations and localisation of singularities.- V.G. Zvyagin, V.T. Dmitrienko: Properness of nonlinear elliptic differential operators in H|lder spaces.

The book is a fairly complete and up-to-date survey of projectivity and its generalizations in the class of Boolean algebras. Although algebra adds its own methods and questions, many of the results presented were first proved by topologists in the more general setting of (not necessarily zero-dimensional) compact spaces. An appendix demonstrates the application of advanced set-theoretic methods to the field. The intended readers are Boolean and universal algebraists. The book will also be useful for general topologists wanting to learn about kappa-metrizable spaces and related classes. The text is practically self-contained but assumes experience with the basic concepts and techniques of Boolean algebras.

Presents the proceedings of the recently held conference at the University of Plymouth. Papers describe recent work by leading researchers in twistor theory and cover a wide range of subjects, including conformal invariants, integral transforms, Einstein equations, anti-self-dual Riemannian 4-manifolds, deformation theory, 4-dimensional conformal structures, and more.;The book is intended for complex geometers and analysts, theoretical physicists, and graduate students in complex analysis, complex differential geometry, and mathematical physics.

Representation theory, and more generally Lie theory, has played a very important role in many of the recent developments of mathematics and in the interaction of mathematics with physics. In August-September 1989, a workshop (Third Workshop on Representation Theory of Lie Groups and its Applications) was held in the environs of C6rdoba, Argentina to present expositions of important recent developments in the field that would be accessible to graduate students and researchers in related fields. This volume contains articles that are edited versions of the lectures (and short courses) given at the workshop. Within representation theory, one of the main open problems is to determine the unitary dual of a real reductive group. Although this prob lem is as yet unsolved, the recent work of Barbasch, Vogan, Arthur as well as others has shed new light on the structure of the problem. The article of D. Vogan presents an exposition of some aspects of this prob lem, emphasizing an extension of the orbit method of Kostant, Kirillov. Several examples are given that explain why the orbit method should be extended and how this extension should be implemented.

The five papers originally appeared in Japanese in the journal Sugaku and would ordinarily appear in the Society's translation of that journal, but are published separately here to expedite their dissemination. They explore such aspects as representation theory, differential geometry, invariant theory, and complex analysis. No index. Member prices are $47 for institutions and $35 for individual. Annotation copyrighted by Book News, Inc., Portland, OR.

This book intends to give an introduction to harmonic maps between a surface and a symmetric manifold and constant mean curvature surfaces as completely integrable systems. The presentation is accessible to undergraduate and graduate students in mathematics but will also be useful to researchers. It is among the first textbooks about integrable systems, their interplay with harmonic maps and the use of loop groups, and it presents the theory, for the first time, from the point of view of a differential geometer. The most important results are exposed with complete proofs (except for the last two chapters, which require a minimal knowledge from the reader). Some proofs have been completely rewritten with the objective, in particular, to clarify the relation between finite mean curvature tori, Wente tori and the loop group approach - an aspect largely neglected in the literature. The book helps the reader to access the ideas of the theory and to acquire a unified perspective of the subject.

In this monograph on twistor theory and its applications to harmonic map theory, a central theme is the interplay between the complex homogeneous geometry of flag manifolds and the real homogeneous geometry of symmetric spaces. In particular, flag manifolds are shown to arise as twistor spaces of Riemannian symmetric spaces. Applications of this theory include a complete classification of stable harmonic 2-spheres in Riemannian symmetric spaces and a Bäcklund transform for harmonic 2-spheres in Lie groups which, in many cases, provides a factorisation theorem for such spheres as well as gap phenomena. The main methods used are those of homogeneous geometry and Lie theory together with some algebraic geometry of Riemann surfaces. The work addresses differential geometers, especially those with interests in minimal surfaces and homogeneous manifolds.

Twistor theory has become a diverse subject as it has spread from its origins in theoretical physics to applications in pure mathematics. This 1990 collection of review articles covers the considerable progress made in a wide range of applications such as relativity, integrable systems, differential and integral geometry and representation theory. The articles explore the wealth of geometric ideas which provide the unifying themes in twistor theory, from Penrose's quasi-local mass construction in relativity, to the study of conformally invariant differential operators, using techniques of representation theory.

This volume contains 18 papers at the Algebraic Geometry Conference, Yaroslavl', August 10-14, 1992. These conferences in algebraic geometry have a great tradition in Russia and are helt since 1979 in Yaroslavl' every second year. The present conference, the eighth one, was the first in which several foreign mathematicians participated. From the Russian side, there was a large group of specialists in algebraic geometry and related fields (invariant theory, topology of manifolds, theory of categories, mathematical physics etc.). Lectures on modern directions in algebraic geometry, such as the theory of exceptional bundles and helices on algebraic varieties, moduli of vector bundles on algebraic surfaces with applications to Donaldson's theory, geometry of Hilbert schemes of points, twistor spaces and applications to string theory, and more traditional areas, such as birational geometry of manifolds, adjunction theory, Hodge theory, problems of rationality in the invariant theory, topology of complex algebraic varieties, and others are contained in this volume.

The main general theorems on Lie Algebras are covered, roughly the content of Bourbaki's Chapter I.I have added some results on free Lie algebras, which are useful, both for Lie's theory itself (Campbell-Hausdorff formula) and for applications to pro-Jrgroups. of time prevented me from including the more precise theory of Lack semisimple Lie algebras (roots, weights, etc.); but, at least, I have given, as a last Chapter, the typical case ofal, . This part has been written with the help of F. Raggi and J. Tate. I want to thank them, and also Sue Golan, who did the typing for both parts. Jean-Pierre Serre Harvard, Fall 1964 Chapter I. Lie Algebras: Definition and Examples Let Ie be a commutativering with unit element, and let A be a k-module, then A is said to be a Ie-algebra if there is given a k-bilinear map A x A~ A (i.e., a k-homomorphism A0" A -+ A). As usual we may define left, right and two-sided ideals and therefore quo tients. Definition 1. A Lie algebra over Ie isan algebrawith the following properties: 1). The map A0i A -+ A admits a factorization A ®i A -+ A2A -+ A i.e., ifwe denote the imageof(x, y) under this map by [x, y) then the condition becomes for all x e k. [x, x)=0 2). (lx, II], z]+ny, z), x) + ([z, xl, til = 0 (Jacobi's identity) The condition 1) implies [x,1/]=-[1/, x).

From Bäcklund to Darboux: a comprehensive journey through the transformation theory of constrained Willmore surfaces, with applications to constant mean curvature surfaces.

The book describes integrable Toda type systems and their Lie algebra and differential geometry background.

In this paper, the author studies all the elliptic integrable systems, in the sense of C, that is to say, the family of all the m-th elliptic integrable systems associated to a $k^\prime$-symmetric space $N=G/G_0$. The author describes the geometry behind this family of integrable systems for which we know how to construct (at least locally) all the solutions. The introduction gives an overview of all the main results, as well as some related subjects and works, and some additional motivations.

This is a comprehensive exposition of topics covered by the American Mathematical Society’s classification “Global Analysis , dealing with modern developments in calculus expressed using abstract terminology. It will be invaluable for graduate students and researchers embarking on advanced studies in mathematics and mathematical physics. This book provides a comprehensive coverage of modern global analysis and geometrical mathematical physics, dealing with topics such as; structures on manifolds, pseudogroups, Lie groupoids, and global Finsler geometry; the topology of manifolds and differentiable mappings; differential equations (including ODEs, differential systems and distributions, and spectral theory); variational theory on manifolds, with applications to physics; function spaces on manifolds; jets, natural bundles and generalizations; and non-commutative geometry. - Comprehensive coverage of modern global analysis and geometrical mathematical physics - Written by world-experts in the field - Up-to-date contents

This book explores in detail the connections between self-duality and integrability, and also the application of twistor techniques to integrable systems.

The Second Silivri Workshop functioned as a short summer school and a working conference, producing lecture notes and research papers on recent developments of Stochastic Analysis on Wiener space. The topics of the lectures concern short time asymptotic problems and anticipative stochastic differential equations. Research papers are mostly extensions and applications of the techniques of anticipative stochastic calculus.

The purpose of this handbook is to give an overview of some recent developments in differential geometry related to supersymmetric field theories. The main themes covered are: Special geometry and supersymmetry Generalized geometry Geometries with torsion Para-geometries Holonomy theory Symmetric spaces and spaces of constant curvature Conformal geometry Wave equations on Lorentzian manifolds D-branes and K-theory The intended audience consists of advanced students and researchers working in differential geometry, string theory, and related areas. The emphasis is on geometrical structures occurring on target spaces of supersymmetric field theories. Some of these structures can be fully described in the classical framework of pseudo-Riemannian geometry. Others lead to new concepts relating various fields of research, such as special Kahler geometry or generalized geometry.

This is the first account in book form of the theory of harmonic morphisms between Riemannian manifolds. Harmonic morphisms are maps which preserve Laplace's equation. They can be characterized as harmonic maps which satisfy an additional first order condition. Examples include harmonic functions, conformal mappings in the plane, and holomorphic functions with values in a Riemann surface. There are connections with many concepts in differential geometry, for example, Killing fields, geodesics, foliations, Clifford systems, twistor spaces, Hermitian structures, iso-parametric mappings, and Einstein metrics and also the Brownain pathpreserving maps of probability theory. Giving a complete account of the fundamental aspects of the subject, this book is self-contained, assuming only a basic knowledge of differential geometry.

In three chapters on Exponential Martingales, BMO-martingales, and Exponential of BMO, this book explains in detail the beautiful properties of continuous exponential martingales that play an essential role in various questions concerning the absolute continuity of probability laws of stochastic processes. The second and principal aim is to provide a full report on the exciting results on BMO in the theory of exponential martingales. The reader is assumed to be familiar with the general theory of continuous martingales.

The fundamental problem in control engineering is to provide robust performance to uncertain plants. H -control theory began in the early eighties as an attempt to lay down rigorous foundations on the classical robust control requirements. It now turns out that H -control theory is at the crossroads of several important directions of research space or polynomial approach to control and classical interpolation theory; harmonic analysis and operator theory; minimax LQ stochastic control and integral equations. The book presents the underlying fundamental ideas, problems and advances through the pen of leading contributors to the field, for graduate students and researchers in both engineering and mathematics. From the Contents: C. Foias: Commutant Lifting Techniques for Computing Optimal H Controllers.- B.A. Francis: Lectures on H Control and Sampled-Data Systems.- J.W. Helton: Two Topics in Systems Engineering Frequency Domain Design and Nonlinear System.- H. Kwakernaak: The Polynomial Approach to H -Optimal Regulation.- J.B. Pearson: A Short Course in l - Optimal Control

Although twistor theory originated as an approach to the unification of quantum theory and general relativity, twistor correspondences and their generalizations have provided powerful mathematical tools for studying problems in differential geometry, nonlinear equations, and representation theory. At the same time, the theory continues to offer promising new insights into the nature of quantum theory and gravitation. Further Advances in Twistor Theory, Volume III: Curved Twistor Spaces is actually the fourth in a series of books compiling articles from Twistor Newsletter-a somewhat informal journal published periodically by the Oxford research group of Roger Penrose. Motivated both by questions in differential geometry and by the quest to find a twistor correspondence for general Ricci-flat space times, this volume explores deformed twistor spaces and their applications. Articles from the world's leading researchers in this field-including Roger Penrose-have been written in an informal, easy-to-read style and arranged in four chapters, each supplemented by a detailed introduction. Collectively, they trace the development of the twistor programme over the last 20 years and provide an overview of its recent advances and current status.

Publisher Description

This book introduces the reader to the geometry of surfaces and submanifolds in the conformal n-sphere.

CONTENTS: J.M. Bony: Analyse microlocale des equations aux derivees partielles non lineaires.- G.G. Grubb: Parabolic pseudo-differential boundary problems and applications.- L. H|rmander: Quadratic hyperbolic operators.- H. Komatsu: Microlocal analysis in Gevrey classes and in complex domains.- J. Sj|strand: Microlocal analysis for the periodic magnetic Schr|dinger equation and related questions.

From the reviews: "... focused mainly on complex differential geometry and holomorphic bundle theory. This is a powerful book, written by a very distinguished contributor to the field" (Contemporary Physics)"the book provides a large amount of background for current research across a spectrum of field. ... requires effort to read but it is worthwhile and rewarding" (New Zealand Math. Soc. Newsletter) " The contents are highly technical and the pace of the exposition is quite fast. Manin is an outstanding mathematician, and writer as well, perfectly at ease in the most abstract and complex situation. With such a guide the reader will be generously rewarded!" (Physicalia) This new edition includes an Appendix on developments of the last 10 years, by S. Merkulov.

About ten years ago, V.D. Goppa found a surprising connection between the theory of algebraic curves over a finite field and error-correcting codes. The aim of the meeting "Algebraic Geometry and Coding Theory" was to give a survey on the present state of research in this field and related topics. The proceedings contain research papers on several aspects of the theory, among them: Codes constructed from special curves and from higher-dimensional varieties, Decoding of algebraic geometric codes, Trace codes, Exponen- tial sums, Fast multiplication in finite fields, Asymptotic number of points on algebraic curves, Sphere packings.

The aim of the book is to give a unified approach to new developments in discrete potential theory and infinite network theory. The author confines himself to the finite energy case, but this does not result in loss of complexity. On the contrary, the functional analytic machinery may be used in analogy with potential theory on Riemann manifolds. The book is intended for researchers with interdisciplinary interests in one of the following fields: Markov chains, combinatorial graph theory, network theory, Dirichlet spaces, potential theory, abstract harmonic analysis, theory of boundaries.

The series is aimed specifically at publishing peer reviewed reviews and contributions presented at workshops and conferences. Each volume is associated with a particular conference, symposium or workshop. These events cover various topics within pure and applied mathematics and provide up-to-date coverage of new developments, methods and applications.

This volume presents an array of topics that introduce the reader to key ideas in active areas in geometry and topology. The material is presented in a way that both graduate students and researchers should find accessible and enticing. The topics covered range from Morse theory and complex geometry theory to geometric group theory, and are accompanied by exercises that are designed to deepen the reader's understanding and to guide them in exciting directions for future investigation.

Harmonic maps between Riemannian manifolds are solutions of systems of nonlinear partial differential equations which appear in different contexts of differential geometry. They include holomorphic maps, minimal surfaces, ?-models in physics. Recently, they have become powerful tools in the study of global properties of Riemannian and Kählerian manifolds. A standard reference for this subject is a pair of Reports, published in 1978 and 1988 by James Eells and Luc Lemaire. This book presents these two reports in a single volume with a brief supplement reporting on some recent developments in the theory. It is both an introduction to the subject and a unique source of references, providing an organized exposition of results spread throughout more than 800 papers. Contents:IntroductionOperations on Vector BundlesHarmonic MapsComposition PropertiesMaps into Manifolds of Nonpositive (? 0) CurvatureThe Existence Theorem for Riem N ? 0Maps into Flat ManifoldsHarmonic Maps between SpheresHolomorphic MapsHarmonic Maps of a SurfaceHarmonic Maps between SurfacesHarmonic Maps of Manifolds with Boundary Readership: Mathematicians and mathematical physicists. keywords:Harmonic Maps;Minimal Immersions;Totally Geodesic Maps;Kaehler Manifold;(1,1)-Geodesic Map;Dilatation;Nonpositive Sectional Curvature;Holomorphic Map;Teichmueller Map;Twistor Construction "… an interesting account of the progress made in the theory of harmonic maps until the year 1988 … this master-piece work will serve as an influence and good reference in the very active subject of harmonic maps both from the points of view of theory and applications." Mathematics Abstracts

This book is concerned with harmonic maps into homogeneous spaces and focuses upon maps of Riemann surfaces into flag manifolds, to bring results of 'twistor methods' for symmetric spaces into a unified framework by using the theory of compact Lie groups and complex differential geometry.

Alfred Gray's work covered a great part of differential geometry. In September 2000, a remarkable International Congress on Differential Geometry was held in his memory in Bilbao, Spain. Mathematicians from all over the world, representing 24 countries, attended the event. This volume includes major contributions by well known mathematicians (T. Banchoff, S. Donaldson, H. Ferguson, M. Gromov, N. Hitchin, A. Huckleberry, O. Kowalski, V. Miquel, E. Musso, A. Ros, S. Salamon, L. Vanhecke, P. Wellin and J.A. Wolf), the interesting discussion from the round table moderated by J.-P. Bourguignon, and a carefully selected and refereed selection of the Short Communications presented at the Congress.This book represents the state of the art in modern differential geometry, with some general expositions of some of the more active areas: special Riemannian manifolds, Lie groups and homogeneous spaces, complex structures, symplectic manifolds, geometry of geodesic spheres and tubes and related problems, geometry of surfaces, and computer graphics in differential geometry.

Quantum cohomology has its origins in symplectic geometry and algebraic geometry, but is deeply related to differential equations and integrable systems. This text explains what is behind the extraordinary success of quantum cohomology, leading to its connections with many existing areas of mathematics as well as its appearance in new areas such as mirror symmetry. Certain kinds of differential equations (or D-modules) provide the key links between quantum cohomology and traditional mathematics; these links are the main focus of the book, and quantum cohomology and other integrable PDEs such as the KdV equation and the harmonic map equation are discussed within this unified framework. Aimed at graduate students in mathematics who want to learn about quantum cohomology in a broad context, and theoretical physicists who are interested in the mathematical setting, the text assumes basic familiarity with differential equations and cohomology.

Ideas and techniques from the theory of integrable systems are playing an increasingly important role in geometry. Thanks to the development of tools from Lie theory, algebraic geometry, symplectic geometry, and topology, classical problems are investigated more systematically. New problems are also arising in mathematical physics. A major international conference was held at the University of Tokyo in July 2000. It brought together scientists in all of the areas influenced by integrable systems. This book is the second of three collections of expository and research articles. This volume focuses on topology and physics. The role of zero curvature equations outside of the traditional context of differential geometry has been recognized relatively recently, but it has been an extraordinarily productive one, and most of the articles in this volume make some reference to it.Symplectic geometry, Floer homology, twistor theory, quantum cohomology, and the structure of special equations of mathematical physics, such as the Toda field equations - all of these areas have gained from the integrable systems point of view and contributed to it. Many of the articles in this volume are written by prominent researchers and will serve as introductions to the topics. It is intended for graduate students and researchers interested in integrable systems and their relations to differential geometry, topology, algebraic geometry, and physics. The first volume from this conference, also available from the 'AMS', is ""Differential Geometry and Integrable Systems, Volume 308"" in the ""Contemporary Mathematics"" series. The forthcoming third volume will be published by the Mathematical Society of Japan and will be available outside of Japan from the 'AMS' in the ""Advanced Studies in Pure Mathematics"" series.

This monograph lays down the foundations of the theory of complex Kleinian groups, a newly born area of mathematics whose origin traces back to the work of Riemann, Poincaré, Picard and many others. Kleinian groups are, classically, discrete groups of conformal automorphisms of the Riemann sphere, and these can be regarded too as being groups of holomorphic automorphisms of the complex projective line CP1. When going into higher dimensions, there is a dichotomy: Should we look at conformal automorphisms of the n-sphere?, or should we look at holomorphic automorphisms of higher dimensional complex projective spaces? These two theories are different in higher dimensions. In the first case we are talking about groups of isometries of real hyperbolic spaces, an area of mathematics with a long-standing tradition. In the second case we are talking about an area of mathematics that still is in its childhood, and this is the focus of study in this monograph. This brings together several important areas of mathematics, as for instance classical Kleinian group actions, complex hyperbolic geometry, chrystallographic groups and the uniformization problem for complex manifolds.?