Geometric Quantization

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Abstract

Geometric quantization is an attempt at using the differential-geometric ingredients of classical phase spaces regarded as symplectic manifolds in order to define a corresponding quantum theory. Generally, the process of geometric quantization is applicable to other symplectic manifolds, not only cotangent spaces. The resulting formalism provides a way of looking at quantum theory that is distinct from conventional approaches to the subject, e.g., the Dirac bra-ket formalism. In particular, such familiar features as the quantization of spin, the canonical quantization of position and momentum, and the Schrödinger equation all emerge from geometric quantization. This paper serves as a review of the subject written in an informal style, often taking an example-based approach to exposition, and attempts to present the material without assuming the reader is an expert in differential geometry.

Contents

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Geometric Quantization

Paul Lee Robinson,John Howard Rawnsley

Geometric Quantization:

Geometric Quantization Nicholas Michael John Woodhouse,1992 This book presents a survey of the geometric quantization theory of Kostant and Souriau and was first published in 1980 It has been extensively rewritten and brought up to date with the addition of many new examples **Geometric Quantization and Quantum Mechanics** Jedrzej Sniatycki,2012-12-06 This book contains a revised and expanded version of the lecture notes of two seminar series given during the academic year 1976 77 at the Department of Mathematics and Statistics of the University of Calgary and in the summer of 1978 at the Institute of Theoretical Physics of the Technical University Clausthal The aim of the seminars was to present geometric quantization from the point of view of its applica tions to quantum mechanics and to introduce the quantum dynamics of various physical systems as the result of the geometric quantization of the classical dynamics of these systems The group representation aspects of geometric quantiza tion as well as proofs of the existence and the uniqueness of the introduced structures can be found in the expository papers of Blattner Kostant Sternberg and Wolf and also in the references quoted in these papers The books of Souriau 1970 and Simms and Woodhouse 1976 present the theory of geometric quantization and its relationship to quantum mech anics The purpose of the present book is to complement the preceding ones by including new developments of the theory and emphasizing the computations leading to results in quantum mechanics *Geometric Quantization in Action* N.E. Hurt,2012-12-06 Approach your problems from the right It isn t that they can t see the solution It end and begin with the answers Then is that they can t see the problem one day perhaps you will fmd the final question G K Chesterton The Scandal of Father Brown The Point of a Pin The Hermit Clad in Crane Feathers in R Van Gulik s The Chinese Maze Murders Growing specialization and diversification have brought a host of monographs and textbooks on increasingly specialized topics However the tree of knowledge of mathematics and related fields does not grow only by putting forth new branches It also happens quite often in fact that branches which were thought to be completely disparate are suddenly seen to be related Further the kind and level of sophistication of mathematics applied in various sciences has changed drastically in recent years measure theory is used non trivially in regional and theoretical economics algebraic geo metry interacts with physics the Minkowsky lemma coding theory and the structure of water meet one another in packing and covering theory quantum fields crystal defects and mathematical progmmming profit from homotopy theory Lie algebras are relevant to fIltering and prediction and electrical engineering can use Stein spaces

Lectures on the Geometry of Quantization Sean Bates,Alan Weinstein,1997 These notes are based on a course entitled Symplectic Geometry and Geometric Quantization taught by Alan Weinstein at the University of California Berkeley fall 1992 and at the Centre Emile Borel spring 1994 The only prerequisite for the course needed is a knowledge of the basic notions from the theory of differentiable manifolds differential forms vector fields transversality etc The aim is to give students an introduction to the ideas of microlocal analysis and the related symplectic geometry with an emphasis on the role these ideas

play in formalizing the transition between the mathematics of classical dynamics hamiltonian flows on symplectic manifolds and quantum mechanics unitary flows on Hilbert spaces These notes are meant to function as a guide to the literature The authors refer to other sources for many details that are omitted and can be bypassed on a first reading *Geometry, Topology and Quantization* P. Bandyopadhyay,1996-10-31 This is a monograph on geometrical and topological features which arise in various quantization procedures Quantization schemes consider the feasibility of arriving at a quantum system from a classical one and these involve three major procedures viz i geometric quantization ii Klauder quantization and iii stochastic quanti zation In geometric quantization we have to incorporate a hermitian line bundle to effectively generate the quantum Hamiltonian operator from a classical Hamil tonian Klauder quantization also takes into account the role of the connection one form along with coordinate independence In stochastic quantization as pro posed by Nelson Schrodinger equation is derived from Brownian motion processes however we have difficulty in its relativistic generalization It has been pointed out by several authors that this may be circumvented by formulating a new geometry where Brownian motion proceses are considered in external as well as in internal space and when the complexified space time is considered the usual path integral formulation is achieved When this internal space variable is considered as a direc tion vector introducing an anisotropy in the internal space we have the quantization of a Fermi field This helps us to formulate a stochastic phase space formalism when the internal extension can be treated as a gauge theoretic extension This suggests that massive fermions may be considered as Skyrme solitons The nonrelativistic quantum mechanics is achieved in the sharp point limit

Quantization And Coherent States Methods - Proceedings Of Xi Workshop On Geometric Methods In Physics S Twareque Ali,Anatol Odzijewicz,I M Mladenov,1993-10-29 The aim of the conference was to find common elements between quantization and coherent states and quantization on Poisson manifolds Topics included are coherent states geometric quantization phase space quantization deformation and products and Berry s phase **Geometry, Topology and Quantization** P. Bandyopadhyay,2013-03-07 This is a monograph on geometrical and topological features which arise in various quantization procedures Quantization schemes consider the feasibility of arriving at a quantum system from a classical one and these involve three major procedures viz i geometric quantization ii Klauder quantization and iii stochastic quanti zation In geometric quantization we have to incorporate a hermitian line bundle to effectively generate the quantum Hamiltonian operator from a classical Hamil tonian Klauder quantization also takes into account the role of the connection one form along with coordinate independence In stochastic quantization as pro posed by Nelson Schrodinger equation is derived from Brownian motion processes however we have difficulty in its relativistic generalization It has been pointed out by several authors that this may be circumvented by formulating a new geometry where Brownian motion proceses are considered in external as well as in internal space and when the complexified space time is considered the usual path integral formulation is achieved When this internal space variable is considered as a direc tion vector introducing an

anisotropy in the internal space we have the quantization of a Fermi field This helps us to formulate a stochastic phase space formalism when the internal extension can be treated as a gauge theoretic extension This suggests that massive fermions may be considered as Skyrme solitons The nonrelativistic quantum mechanics is achieved in the sharp point limit

Geometric Quantization in Action N.E. Hurt,1982-12-31 Approach your problems from the right It isn t that they can t see the solution It end and begin with the answers Then is that they can t see the problem one day perhaps you will fmd the final question G K Chesterton The Scandal of Father Brown The Point of a Pin The Hermit Clad in Crane Feathers in R Van Gulik s The Chinese Maze Murders Growing specialization and diversification have brought a host of monographs and textbooks on increasingly specialized topics However the tree of knowledge of mathematics and related fields does not grow only by putting forth new branches It also happens quite often in fact that branches which were thought to be completely disparate are suddenly seen to be related Further the kind and level of sophistication of mathematics applied in various sciences has changed drastically in recent years measure theory is used non trivially in regional and theoretical economics algebraic geo metry interacts with physics the Minkowsky lemma coding theory and the structure of water meet one another in packing and covering theory quantum fields crystal defects and mathematical progmmming profit from homotopy theory Lie algebras are relevant to fIltering and prediction and electrical engineering can use Stein spaces *Loop Spaces, Characteristic Classes and Geometric Quantization* Jean-Luc Brylinski,2009-12-30 This book examines the differential geometry of manifolds loop spaces line bundles and groupoids and the relations of this geometry to mathematical physics Applications presented in the book involve anomaly line bundles on loop spaces and anomaly functionals central extensions of loop groups K hler geometry of the space of knots and Cheeger Chern Simons secondary characteristics classes It also covers the Dirac monopole and Dirac s quantization of the electrical charge *Lectures on Geometric Quantization* David John Simms,Nicholas Michael John Woodhouse,1976 **The Metaplectic Representation, Mp^c Structures and Geometric Quantization** Paul Lee Robinson,John Howard Rawnsley,1989 We present an account of the metaplectic representation in terms of the Bargmann Segal model rather than the standard Schr dinger model this allows us to describe explicitly the structure and pairing of vacuum states for positive polarizations We develop a scheme for geometric spinors and following Hess using Mp superscript italic c structures in place of metaplectic structures **The Physics of Phase Space** Young S. Kim,Woodford W. Zachary,2005-09-13 The concept of phase space plays a decisive role in the study of the transition from classical to quantum physics This is particularly the case in areas such as nonlinear dynamics and chaos geometric quantization and the study of the various semi classical theories which are the setting of the present volume Much of the content is devoted to the study of the Wigner distribution This volume gives the first complete survey of the progress made by both mathematicians and physicists It will serve as an excellent reference for further research Hamiltonian Mechanical Systems and Geometric Quantization Mircea Puta,2012-12-06 This volume presents various aspects of the

geometry of symplectic and Poisson manifolds and applications in Hamiltonian mechanics and geometric quantization are indicated Chapter 1 presents some general facts about symplectic vector space symplectic manifolds and symplectic reduction Chapter 2 deals with the study of Hamiltonian mechanics Chapter 3 considers some standard facts concerning Lie groups and algebras which lead to the theory of momentum mappings and the Marsden Weinstein reduction Chapters 4 and 5 consider the theory and the stability of equilibrium solutions of Hamilton Poisson mechanical systems Chapters 6 and 7 are devoted to the theory of geometric quantization This leads in Chapter 8 to topics such as foliated cohomology the theory of the Dolbeault Kostant complex and their applications A discussion of the relation between geometric quantization and the Marsden Weinstein reduction is presented in Chapter 9 The final chapter considers extending the theory of geometric quantization to Poisson manifolds via the theory of symplectic groupoids Each chapter concludes with problems and solutions many of which present significant applications and in some cases major theorems For graduate students and researchers whose interests and work involve symplectic geometry and Hamiltonian mechanics **Symplectic Connections in Geometric Quantization and Factor Orderings** Harald Hess,1981 **A Mathematical Introduction to Conformal Field Theory** Martin Schottenloher,2008-09-26 The first part of this book gives a self contained and mathematically rigorous exposition of classical conformal symmetry in n dimensions and its quantization in two dimensions The second part surveys some more advanced topics of conformal field theory Geometric Quantization and Applications to Fields and Fluids V. Parameswaran Nair,2024-11-23 This open access book explains geometric quantization from a physicist s perspective After presenting the general formalism it delves into several examples reflecting current research interests in high energy physics and condensed matter physics Applications explore Chern Simons theory theta vacuum the Hall effect fluid dynamics and elements of noncommutative geometry The content is tailored to appeal to researchers graduate students and advanced undergraduates in high energy physics particle physics and mathematical physics A background in differential geometry and group theory is beneficial for a comprehensive understanding of the discussions *Geometry, Integrability and Quantization* Ivailo M. Mladenov,Gregory L. Naber,2000 *Differential Geometrical Methods in Mathematical Physics II* K. Bleuler,H. R. Petry,A. Reetz,2006-11-15 **Symplectic Geometry and Mathematical Physics** P. Donato,1991-12 This volume contains the proceedings of the conference Colloque de Goometrie Symplectique et Physique Mathematique which was held in Aix en Provence France June 11 15 1990 in honor of Jean Marie Souriau The conference was one in the series of international meetings of the Seminaire Sud Rhodanien de Goometrie an organization of geometers and mathematical physicists at the Universities of Avignon Lyon Mar seille and Montpellier The scientific interests of Souriau one of the founders of geometric quantization range from classical mechanics symplectic geometry and quantization problems to general relativity and astrophysics The themes of this conference cover only the first two of these four areas The subjects treated in this volume could be classified in the follow ing way symplectic and Poisson geometry Arms Wilbour Bloch Ratiu Brylinski Kostant

Cushman Sjamaar Dufour Lichnerowicz Medina Ouzilou classical mechanics Benenti Holm Marsden Marle particles and fields in physics Garcia Perez Munoz Masque Gotay Montgomery Ne eman Sternberg Sniatycki and quantization Blattner Huebschmann Karasev Rawnsley Roger Rosso Weinstein However these subjects are so interrelated that a classification by headings such as pure differential geometry applications of Lie groups constrained systems in physics etc would have produced a completely different clustering The list of authors is not quite identical to the list of speakers at the conference M Karasev was invited but unable to attend C Itzykson and M Vergne spoke on work which is represented here only by the title of Itzykson s talk Surfaces triangulees et integration matricielle and a summary of Vergne s talk **Differential Geometric Methods in Theoretical Physics** Ling-Lie Chau,Werner Nahm,2013-06-29 After several decades of reduced contact the interaction between physicists and mathematicians in the front line research of both fields recently became deep and fruit ful again Many of the leading specialists of both fields became involved in this devel opment This process even led to the discovery of previously unsuspected connections between various subfields of physics and mathematics In mathematics this concerns in particular knots von Neumann algebras Kac Moody algebras integrable non linear partial differential equations and differential geometry in low dimensions most im portantly in three and four dimensional spaces In physics it concerns gravity string theory integrable classical and quantum field theories solitons and the statistical me chanics of surfaces New discoveries in these fields are made at a rapid pace This conference brought together active researchers in these areas reporting their results and discussing with other participants to further develop thoughts in future new directions The conference was attended by SO participants from 15 nations These proceedings document the program and the talks at the conference This conference was preceded by a two week summer school Ten lecturers gave extended lectures on related topics The proceedings of the school will also be published in the NATO AS volume by Plenum The Editors vii ACKNOWLEDGMENTS We would like to thank the many people who have made the conference a success Furthermore we appreciate the excellent talks The active participation of everyone present made the conference lively and stimulating All of this made our efforts worth while

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Table of Contents Geometric Quantization

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