Symplectic techniques in physics

Symplectic Techniques In Physics

Victor Guillemin,Shlomo Sternberg

Symplectic Techniques In Physics:

Symplectic Techniques in Physics Victor Guillemin,Shlomo Sternberg,1990-05-25 Symplectic geometry is very useful for clearly and concisely formulating problems in classical physics and also for understanding the link between classical problems and their quantum counterparts It is thus a subject of interest to both mathematicians and physicists though they have approached the subject from different view points This is the first book that attempts to reconcile these approaches The authors use the uncluttered coordinate free approach to symplectic geometry and classical mechanics that has been developed by mathematicians over the course of the last thirty years but at the same time apply the apparatus to a great number of concrete problems In the first chapter the authors provide an elementary introduction to symplectic geometry and explain the key concepts and results in a way accessible to physicists and mathematicians The remainder of the book is devoted to the detailed analysis and study of the ideas discussed in Chapter 1 Some of the themes emphasized in the book include the pivotal role of completely integrable systems the importance of symmetries analogies between classical dynamics and optics the importance of symplectic tools in classical variational theory symplectic features of classical field theories and the principle of general covariance This work can be used as a textbook for graduate courses but the depth of coverage and the wealth of information and application means that it will be of continuing interest to and of lasting significance for mathematicians and mathematically minded physicists *Symplectic techniques in physics* Victor Guillemin,1984

Symplectic Techniques in Physics Victor Guillemin,Shlomo Sternberg,1983 *Symplectic Fibrations and Multiplicity Diagrams* Victor Guillemin,Eugene Lerman,Shlomo Sternberg,1996-09-28 Applications of the techniques of symplectic geometry to describe symmetry breaking in quantum physics *Symplectic Methods in Harmonic Analysis and in Mathematical Physics* Maurice A. de Gosson,2011-07-30 The aim of this book is to give a rigorous and complete treatment of various topics from harmonic analysis with a strong emphasis on symplectic invariance properties which are often ignored or underestimated in the time frequency literature The topics that are addressed include but are not limited to the theory of the Wigner transform the uncertainty principle from the point of view of symplectic topology Weyl calculus and its symplectic covariance Shubin s global theory of pseudo differential operators and Feichtinger s theory of modulation spaces Several applications to time frequency analysis and quantum mechanics are given many of them concurrent with ongoing research For instance a non standard pseudo differential calculus on phase space where the main role is played by Bopp operators also called Landau operators in the literature is introduced and studied This calculus is closely related to both the Landau problem and to the deformation quantization theory of Flato and Sternheimer of which it gives a simple pseudo differential formulation where Feichtinger s modulation spaces are key actors This book is primarily directed towards students or researchers in harmonic analysis in the broad sense and towards mathematical physicists working in quantum mechanics It can also be read with profit by researchers in time frequency analysis providing a valuable complement to the existing

literature on the topic A certain familiarity with Fourier analysis in the broad sense and introductory functional analysis e g the elementary theory of distributions is assumed Otherwise the book is largely self contained and includes an extensive list ofreferences Topological Methods in Hydrodynamics Vladimir I. Arnold,Boris A. Khesin,2008-01-08 The first monograph to treat topological group theoretic and geometric problems of ideal hydrodynamics and magnetohydrodynamics from a unified point of view It describes the necessary preliminary notions both in hydrodynamics and pure mathematics with numerous examples and figures The book is accessible to graduates as well as pure and applied mathematicians working in hydrodynamics Lie groups dynamical systems and differential geometry **Symplectic Geometry and Quantization** Yoshiaki Maeda,Hideki Omori,Alan Weinstein,1994 This volume contains a state of the art discussion of recent progress in a range of related topics in symplectic geometry and mathematical physics including symplectic groupoids geometric quantization noncommutative differential geometry equivariant cohomology deformation quantization topological quantum field theory and knot invariants **Lectures on Symplectic Geometry** Ana Cannas da Silva,2004-10-27 The goal of these notes is to provide a fast introduction to symplectic geometry for graduate students with some knowledge of differential geometry de Rham theory and classical Lie groups This text addresses symplectomorphisms local forms contact manifolds compatible almost complex structures Kaehler manifolds hamiltonian mechanics moment maps symplectic reduction and symplectic toric manifolds It contains guided problems called homework designed to complement the exposition or extend the reader s understanding There are by now excellent references on symplectic geometry a subset of which is in the bibliography of this book However the most efficient introduction to a subject is often a short elementary treatment and these notes attempt to serve that purpose This text provides a taste of areas of current research and will prepare the reader to explore recent papers and extensive books on symplectic geometry where the pace is much faster For this reprint numerous corrections and clarifications have been made and the layout has been improved **Algebra without Borders – Classical and Constructive Nonassociative Algebraic Structures** Mahouton Norbert Hounkonnou,Melanija Mitrović,Mujahid Abbas,Madad Khan,2023-12-01 This book gathers invited peer reviewed works presented at the 2021 edition of the Classical and Constructive Nonassociative Algebraic Structures Foundations and Applications CaCNAS FA 2021 virtually held from June 30 to July 2 2021 in dedication to the memory of Professor Neboj a Stevanovi 1962 2009 The papers cover new trends in the field focusing on the growing development of applications in other disciplines These aspects interplay in the same cadence promoting interactions between theory and applications and between nonassociative algebraic structures and various fields in pure and applied mathematics In this volume the reader will find novel studies on topics such as left almost algebras logical algebras groupoids and their generalizations algebraic geometry and its relations with quiver algebras enumerative combinatorics representation theory fuzzy logic and foundation theory fuzzy algebraic structures group amalgams computer aided development and transformation of the theory of nonassociative algebraic structures and

applications within natural sciences and engineering Researchers and graduate students in algebraic structures and their applications can hugely benefit from this book which can also interest any researcher exploring multi disciplinarity and complexity in the scientific realm *Principles Of Newtonian And Quantum Mechanics, The: The Need For Planck's Constant, H (Second Edition)* Maurice A De Gosson,2016-11-10 The second edition of this book deals as the first with the foundations of classical physics from the symplectic point of view and of quantum mechanics from the metaplectic point of view We have revised and augmented the topics studied in the first edition in the light of new results and added several new sections The Bohmian interpretation of quantum mechanics is discussed in detail Phase space quantization is achieved using the principle of the symplectic camel which is a deep topological property of Hamiltonian flows We introduce the notion of quantum blob which can be viewed as the fundamental phase space unit The mathematical tools developed in this book are the theory of the symplectic and metaplectic group the Maslov index in a rigorous form and the Leray index of a pair of Lagrangian planes The concept of the metatron is introduced in connection with the Bohmian theory of motion The short time behavior of the propagator is studied and applied to the quantum Zeno effect *Quantum Nonlocality and Reality* Mary Bell,Shan Gao,2016-09-19 Combining twenty six original essays written by an impressive line up of distinguished physicists and philosophers of physics this anthology reflects some of the latest thoughts by leading experts on the influence of Bell s theorem on quantum physics Essays progress from John Bell s character and background through studies of his main work and on to more speculative ideas addressing the controversies surrounding the theorem and investigating the theorem s meaning and its deep implications for the nature of physical reality Combined they present a powerful comment on the undeniable significance of Bell s theorem for the development of ideas in quantum physics over the past 50 years Questions surrounding the assumptions and significance of Bell s work still inspire discussion in the field of quantum physics Adding to this with a theoretical and philosophical perspective this balanced anthology is an indispensable volume for students and researchers interested in the philosophy of physics and the foundations of quantum mechanics *Variations on a Theme by Kepler* Victor Guillemin,Shlomo Sternberg,1990 This book is based on the Colloquium Lectures presented by Shlomo Sternberg in 1990 The authors delve into the mysterious role that groups especially Lie groups play in revealing the laws of nature by focusing on the familiar example of Kepler motion the motion of a planet under the attraction of the sun according to Kepler s laws Newton realized that Kepler s second law that equal areas are swept out in equal times has to do with the fact that the force is directed radially to the sun Kepler s second law is really the assertion of the conservation of angular momentum reflecting the rotational symmetry of the system about the origin of the force In today s language we would say that the group O 3 the orthogonal group in three dimensions is responsible for Kepler s second law By the end of the nineteenth century the inverse square law of attraction was seen to have O 4 symmetry where O 4 acts on a portion of the six dimensional phase space of the planet Even larger groups have since been found to be involved in Kepler motion In quantum

mechanics the example of Kepler motion manifests itself as the hydrogen atom Exploring this circle of ideas the first part of the book was written with the general mathematical reader in mind The remainder of the book is aimed at specialists It begins with a demonstration that the Kepler problem and the hydrogen atom exhibit O 4 symmetry and that the form of this symmetry determines the inverse square law in classical mechanics and the spectrum of the hydrogen atom in quantum mechanics The space of regularized elliptical motions of the Kepler problem also known as the Kepler manifold plays a central role in this book The last portion of the book studies the various cosmological models in this same conformal class and having varying isometry groups from the viewpoint of projective geometry The computation of the hydrogen spectrum provides an illustration of the principle that enlarging the phase space can simplify the equations of motion in the classical setting and aid in the quantization problem in the quantum setting The authors provide a short summary of the homological quantization of constraints and a list of recent applications to many interesting finite dimensional settings The book closes with an outline of Kostant s theory in which a unitary representation is associated to the minimal nilpotent orbit of SO 4 4 and in which electromagnetism and gravitation are unified in a Kaluza Klein type theory in six dimensions *Lagrangian and Hamiltonian Dynamics* Peter Mann,2018 The book introduces classical mechanics It does so in an informal style with numerous fresh modern and inter disciplinary applications assuming no prior knowledge of the necessary mathematics The book provides a comprehensive and self contained treatment of the subject matter up to the forefront of research in multiple areas **Reduction, Symmetry, and Phases in Mechanics** Jerrold E. Marsden,Richard Montgomery,Tudor S. Raţiu,1990 Various holonomy phenomena are shown to be instances of the reconstruction procedure for mechanical systems with symmetry We systematically exploit this point of view for fixed systems and for slowly moving systems in adiabatic context For the latter we obtain the phases as the holonomy for a connection which synthesizes the Cartan connection for moving mechanical systems with the Hannay Berry connection for integrable systems **Lie Algebraic Methods in Integrable Systems** Amit K. Roy-Chowdhury,1999-09-28 Over the last thirty years the subject of nonlinear integrable systems has grown into a full fledged research topic In the last decade Lie algebraic methods have grown in importance to various fields of theoretical research and worked to establish close relations between apparently unrelated systems The various ideas associated with Lie algebra and Lie groups can be used to form a particularly elegant approach to the properties of nonlinear systems In this volume the author exposes the basic techniques of using Lie algebraic concepts to explore the domain of nonlinear integrable systems His emphasis is not on developing a rigorous mathematical basis but on using Lie algebraic methods as an effective tool The book begins by establishing a practical basis in Lie algebra including discussions of structure Lie loop and Virasor groups quantum tori and Kac Moody algebras and gradation It then offers a detailed discussion of prolongation structure and its representation theory the orbit approach for both finite and infinite dimension Lie algebra The author also presents the modern approach to symmetries of integrable systems including important new

ideas in symmetry analysis such as gauge transformations and the soldering approach He then moves to Hamiltonian structure where he presents the Drinfeld Sokolov approach the Lie algebraic approach Kupershmidt s approach Hamiltonian reductions and the Gelfand Dikii formula He concludes his treatment of Lie algebraic methods with a discussion of the classical r matrix its use and its relations to double Lie algebra and the KP equation **Lasers, Molecules, and Methods, Volume 73** Joseph O. Hirschfelder,Robert E. Wyatt,Rob D. Coalson,2009-09-08 Based on a symposium on lasers molecules and methods held at the Los Alamos Center for Nonlinear Studies held in July 1986 Contributors present recent advances in theoretical and experimental research on a diversity of dynamical and optical phenomena resulting from the interactions of laser beams with molecules They describe the predictive results of sophisticated mathematical models the equipment involved in experiments and reveal new insights into molecular structure and behavior **Geometric Mechanics and Symmetry** James Montaldi,Tudor Ratiu,2005-05-05 The lectures in this 2005 book are intended to bring young researchers to the current frontier of knowledge in geometrical mechanics and dynamical systems **Oxford Users' Guide to Mathematics** Eberhard Zeidler,W. Hackbusch,Hans Rudolf Schwarz,2004-08-19 The Oxford Users Guide to Mathematics is one of the leading handbooks on mathematics available It presents a comprehensive modern picture of mathematics and emphasises the relations between the different branches of mathematics and the applications of mathematics in engineering and the natural sciences The Oxford User s Guide covers a broad spectrum of mathematics starting with the basic material and progressing on to more advanced topics that have come to the fore in the last few decades The book is organised into mathematical sub disciplines including analysis algebra geometry foundations of mathematics calculus of variations and optimisation theory of probability and mathematical statistics numerical mathematics and scientific computing and history of mathematics The book is supplemented by numerous tables on infinite series special functions integrals integral transformations mathematical statistics and fundamental constants in physics It also includes a comprehensive bibliography of key contemporary literature as well as an extensive glossary and index The wealth of material reaching across all levels and numerous sub disciplines makes The Oxford User s Guide to Mathematics an invaluable reference source for students of engineering mathematics computer science and the natural sciences as well as teachers practitioners and researchers in industry and academia **New Lagrangian and Hamiltonian Methods in Field Theory** G. Giachetta,L. Mangiarotti,Gennadi? Aleksandrovich Sardanashvili,1997 This book incorporates 3 modern aspects of mathematical physics the jet methods in differential geometry Lagrangian formalism on jet manifolds and the multimomentum approach to Hamiltonian formalism Several contemporary field models are investigated in detail This is not a book on differential geometry However modern concepts of differential geometry such as jet manifolds and connections are used throughout the book Quadratic Lagrangians and Hamiltonians are studied at the general level including a treatment of Hamiltonian formalism on composite fiber manifolds The book presents new geometric methods and results in 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

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