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QUANTUM MECHANICS IN PHASE SPACE

An Overview with Selected Papers



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Quantum Mechanics In Phase Space An Overview With Selected Papers

Ann Moyal



Quantum Mechanics In Phase Space An Overview With Selected Papers:

Quantum Mechanics In Phase Space: An Overview With Selected Papers Thomas L Curtright, David B Fairlie, Cosmas K Zachos, 2005-12-09 Wigner's quasi probability distribution function in phase space is a special Weyl representation of the density matrix. It has been useful in describing quantum transport in quantum optics, nuclear physics, decoherence, quantum computing, and quantum chaos. It is also important in signal processing and the mathematics of algebraic deformation. A remarkable aspect of its internal logic, pioneered by Groenewold and Moyal, has only emerged in the last quarter century; it furnishes a third alternative formulation of quantum mechanics independent of the conventional Hilbert space or path integral formulations. In this logically complete and self-standing formulation, one need not choose sides between coordinate or momentum space. It works in full phase space, accommodating the uncertainty principle, and it offers unique insights into the classical limit of quantum theory. This invaluable book is a collection of the seminal papers on the formulation, with an introductory overview which provides a trail map for those papers, an extensive bibliography, and simple illustrations suitable for applications to a broad range of physics problems. It can provide supplementary material for a beginning graduate course in quantum mechanics.

A Concise Treatise On Quantum Mechanics In Phase Space Thomas L Curtright, David B Fairlie, Cosmas K Zachos, 2013-11-11 This is a text on quantum mechanics formulated simultaneously in terms of position and momentum, i.e. in phase space. It is written at an introductory level, drawing on the remarkable history of the subject for inspiration and motivation. Wigner functions, density matrices in a special Weyl representation, and star products are the cornerstones of the formalism. The resulting framework is a rich source of physical intuition. It has been used to describe transport in quantum optics, structure and dynamics in nuclear physics, chaos, and decoherence in quantum computing. It is also of importance in signal processing and the mathematics of algebraic deformation. A remarkable aspect of its internal logic, pioneered by Groenewold and Moyal, has only emerged in the last quarter century; it furnishes a third alternative way to formulate and understand quantum mechanics independent of the conventional Hilbert space or path integral approaches to the subject. In this logically complete and self-standing formulation, one need not choose sides between coordinate or momentum space variables. It works in full phase space, accommodating the uncertainty principle, and it offers unique insights into the classical limit of quantum theory. The observables in this formulation are c -number functions in phase space instead of operators, with the same interpretation as their classical counterparts, only composed together in novel algebraic ways using star products. This treatise provides an introductory overview and supplementary material suitable for an advanced undergraduate or a beginning graduate course in quantum mechanics.

Coherent States, Wavelets, and Their Generalizations Syed Twareque Ali, Jean-Pierre Antoine, Jean-Pierre Gazeau, 2013-10-30 This second edition is fully updated, covering in particular new types of coherent states: the so-called Klauder coherent states, nonlinear coherent states, squeezed states, as used now routinely in quantum optics, and

various generalizations of wavelets wavelets on manifolds curvelets shearlets etc In addition it contains a new chapter on coherent state quantization and the related probabilistic aspects As a survey of the theory of coherent states wavelets and some of their generalizations it emphasizes mathematical principles subsuming the theories of both wavelets and coherent states into a single analytic structure The approach allows the user to take a classical like view of quantum states in physics Starting from the standard theory of coherent states over Lie groups the authors generalize the formalism by associating coherent states to group representations that are square integrable over a homogeneous space a further step allows one to dispense with the group context altogether In this context wavelets can be generated from coherent states of the affine group of the real line and higher dimensional wavelets arise from coherent states of other groups The unified background makes transparent an entire range of properties of wavelets and coherent states Many concrete examples such as coherent states from semisimple Lie groups Gazeau Klauder coherent states coherent states for the relativity groups and several kinds of wavelets are discussed in detail The book concludes with a palette of potential applications from the quantum physically oriented like the quantum classical transition or the construction of adequate states in quantum information to the most innovative techniques to be used in data processing Intended as an introduction to current research for graduate students and others entering the field the mathematical discussion is self contained With its extensive references to the research literature the first edition of the book is already a proven compendium for physicists and mathematicians active in the field and with full coverage of the latest theory and results the revised second edition is even more valuable

A Trajectory Description of Quantum Processes. I. Fundamentals Ángel S. Sanz, Salvador Miret-Artés, 2012-03-27 Trajectory based formalisms are an intuitively appealing way of describing quantum processes because they allow the use of classical concepts Beginning at an introductory level suitable for students this two volume monograph presents 1 the fundamentals and 2 the applications of the trajectory description of basic quantum processes This first volume is focussed on the classical and quantum background necessary to understand the fundamentals of Bohmian mechanics which can be considered the main topic of this work Extensions of the formalism to the fields of open quantum systems and to optics are also proposed and discussed

Symplectic Quantum Field Theory Ademir E. Santana, Faqir C. Khanna, Alesandro F. Santos, Ronni G. Gomes Amorim, Sérgio C. Ulhoa, J. David. M. Vianna, 2023-12-21 The present monograph brings to readers as researchers and students of physics and mathematics recent developments in symmetries where the representation space is a symplectic manifold This gives rise to the quantum field theory formulated in through the concept of phase space and associated with the Wigner function a quasi distribution of probability This approach provides information about non classicality of quantum systems describes quantum chaos and is the starting point of the quantum kinetic theory In this realm abelian and non abelian gauge symmetries are introduced with the concept of quasi amplitude of probability This leads for instance to Symplectic Schr dinger Klein Gordon and Dirac equations dealing with systems in condensed matter and particle physics

These achievements are depicted here following a pedagogical model of presentation

Advanced Topics in Quantum Mechanics Marcos Mariño, 2021-12-09 Quantum mechanics is one of the most successful theories in science and is relevant to nearly all modern topics of scientific research This textbook moves beyond the introductory and intermediate principles of quantum mechanics frequently covered in undergraduate and graduate courses presenting in depth coverage of many more exciting and advanced topics The author provides a clearly structured text for advanced students graduates and researchers looking to deepen their knowledge of theoretical quantum mechanics The book opens with a brief introduction covering key concepts and mathematical tools followed by a detailed description of the Wentzel Kramers Brillouin WKB method Two alternative formulations of quantum mechanics are then presented Wigner's phase space formulation and Feynman's path integral formulation The text concludes with a chapter examining metastable states and resonances Step by step derivations worked examples and physical applications are included throughout

Quantum Optics in Phase Space Wolfgang P. Schleich, 2015-12-11 Quantum Optics in Phase Space provides a concise introduction to the rapidly moving field of quantum optics from the point of view of phase space Modern in style and didactically skillful Quantum Optics in Phase Space prepares students for their own research by presenting detailed derivations many illustrations and a large set of workable problems at the end of each chapter Often the theoretical treatments are accompanied by the corresponding experiments An exhaustive list of references provides a guide to the literature Quantum Optics in Phase Space also serves advanced researchers as a comprehensive reference book Starting with an extensive review of the experiments that define quantum optics and a brief summary of the foundations of quantum mechanics the author Wolfgang P Schleich illustrates the properties of quantum states with the help of the Wigner phase space distribution function His description of waves ala WKB connects semi classical phase space with the Berry phase These semi classical techniques provide deeper insight into the timely topics of wave packet dynamics fractional revivals and the Talbot effect Whereas the first half of the book deals with mechanical oscillators such as ions in a trap or atoms in a standing wave the second half addresses problems where the quantization of the radiation field is of importance Such topics extensively discussed include optical interferometry the atom field interaction quantum state preparation and measurement entanglement decoherence the one atom maser and atom optics in quantized light fields Quantum Optics in Phase Space presents the subject of quantum optics as transparently as possible Giving wide ranging references it enables students to study and solve problems with modern scientific literature The result is a remarkably concise yet comprehensive and accessible text and reference book an inspiring source of information and insight for students teachers and researchers alike

Advances In Kinetic Theory And Computing : Selected Papers Benoit Perthame, 1994-09-30 This selection of 8 papers discusses Equations of Kinetic Physics with emphasis on analysis modelling and computing The first 3 papers are on numerical methods for Vlasov Poisson and Vlasov Maxwell Equations Comparison between Particles and Eulerian Methods G Manfredi and M R Feix Computing BGK Instability with Eulerian

Codes M R Feix Pertrand A Ghioco and Coupling Particles and Eulerian Methods S Mas Gallic and P A Raviart Followed by a survey of kinetic and macroscopic models for semiconductor devices Boltzmann Equation Drift Diffusion Models F Poupaud In addition there are 2 papers on the modelling and analysis of singular perturbation problems arising in plasma physics Derivation of the Child Lagmuyr Emission Laws P Degond and Euler Models with Small Pressure Terms F Bouchut followed by two papers on the analysis and numerical analysis of the Boltzmann equations Symmetry Properties in the Polynomials Arising in Chapman Enskog Expansion L Desvillettes and F Golse and A General Introduction to Computing the Boltzmann Equations with Random Particle Methods B Perthame

Quantum versus Classical Mechanics and Integrability

Problems Maciej Błaszczak, 2019-06-11 This accessible monograph introduces physicists to the general relation between classical and quantum mechanics based on the mathematical idea of deformation quantization and describes an original approach to the theory of quantum integrable systems developed by the author The first goal of the book is to develop of a common coordinate free formulation of classical and quantum Hamiltonian mechanics framed in common mathematical language In particular a coordinate free model of quantum Hamiltonian systems in Riemannian spaces is formulated based on the mathematical idea of deformation quantization as a complete physical theory with an appropriate mathematical accuracy The second goal is to develop of a theory which allows for a deeper understanding of classical and quantum integrability For this reason the modern separability theory on both classical and quantum level is presented In particular the book presents a modern geometric separability theory based on bi Poissonian and bi presymplectic representations of finite dimensional Liouville integrable systems and their admissible separable quantizations The book contains also a generalized theory of classical Stckel transforms and the discussion of the concept of quantum trajectories In order to make the text consistent and self contained the book starts with a compact overview of mathematical tools necessary for understanding the remaining part of the book However because the book is dedicated mainly to physicists despite its mathematical nature it refrains from highlighting definitions theorems or lemmas Nevertheless all statements presented are either proved or the reader is referred to the literature where the proof is available

Compendium of Quantum Physics Daniel

Greenberger, Klaus Hentschel, Friedel Weinert, 2009-07-25 With contributions by leading quantum physicists philosophers and historians this comprehensive A to Z of quantum physics provides a lucid understanding of key concepts of quantum theory and experiment It covers technical and interpretational aspects alike and includes both traditional and new concepts making it an indispensable resource for concise up to date information about the many facets of quantum physics

Selected Papers on Algebra and Topology by Garrett Birkhoff J.S. Oliveira, G.-C. Rota, 1987-01-01 The present volume of reprints are what I consider to be my most interesting and influential papers on algebra and topology To tie them together and to place them in context I have supplemented them by a series of brief essays sketching their historical background as I see it In addition to these I have listed some subsequent papers by others which have further developed some of my key ideas The

papers on universal algebra lattice theory and general topology collected in the present volume concern ideas which have become familiar to all working mathematicians It may be helpful to make them readily accessible in one volume I have tried in the introduction to each part to state the most significant features of each paper reprinted there and to indicate later developments The background that shaped and stimulated my early work on universal algebra lattice theory and topology may be of some interest As a Harvard undergraduate in 1928-32 I was encouraged to do independent reading and to write an original thesis My tutorial reading included de la Vallée Poussin's beautiful Cours d'Analyse Infinitésimale Hausdorff's Grundzüge der Mengenlehre and Fréchet's Espaces Abstraits In addition I discovered Carathéodory's 1912 paper Über das lineare Mass von Punktmengen and Hausdorff's 1919 paper on Dimension und Ausseres Mass and derived much inspiration from them A fragment of my thesis analyzing axiom systems for separable metrizable spaces was later published ² This background led to the work summarized in Part IV

Maverick Mathematician Ann Moyal, 2006-08-01 J E Moyal has been pronounced one of Australia's most remarkable thinkers Yet he was essentially a scientific maverick Educated in a modest high school in Tel Aviv he took himself to France to train as an engineer statistician and mathematician and escaped to England as France fell It was from outside academia that he entered into communication with the high priest of British theoretical physics P A M Dirac challenging him with the idea of a statistical basis of quantum mechanics Their correspondence forms the core of this book and opens up an important and hitherto unknown chapter for physicists mathematicians and historians of science Moyal's classic paper A statistical basis for quantum mechanics also reproduced here in full has come to underlie an explosion of research and to underpin an array of major technological developments

Publisher's description **Essence Of A Genius, The: A Tribute To Yoichiro Nambu** Lars Brink, Pierre Ramond, 2023-05-17 Yoichiro Nambu was one of the giants in the physics of the last century His profound ideas in fundamental physics are still playing an important role and are being rediscovered over and over again He preferred to share some of his deepest insights in talks rather than publications but Nambu's papers and talks were not easy to understand Like the Japanese gentleman he was he did not want to humiliate the reader with obvious statements Even if it is an interpretation it fits very well with his character of a very polite and considerate human being with a self-reliance inside him that he did not show on the outside It is no wonder that many of his breakthroughs were not immediately appreciated by his contemporaries with a late award of a well-deserved Nobel Prize He was probably the only one in the highest stratum of physicists who was respected by everybody The purpose of this book half history half physics is to trace Nambu's progress formulating some of his greatest ideas It is structured in seven chapters describing a paper or a series of papers or talks where Nambu's originality and genius emerge Each chapter begins with a historical background section that sets the physics climate of the time followed by a somewhat detailed discussion of his papers talks This tribute to Nambu hopes that he will be remembered and admired for many years to come

The Oxford Handbook of the History of Quantum Interpretations Guido

Bacciagaluppi, Olivier Darrigol, Thiago Hartz, Christian Joas, Alexei Kojevnikov, 2022 This Oxford Handbook provides a rigorous interdisciplinary review of the history of interpretations of quantum physics presenting the key controversies within the field as well as outlining its successes and its extraordinary potential across various scientific fields *Canadian Journal of*

Physics, 2016 **Graduate Programs in the Physical Sciences, Mathematics, Agricultural Sciences, the Environment, and Natural Resources 2009** Peterson's, 2007-11 The six volumes of Peterson's Annual Guides to Graduate Study the only annually updated reference work of its kind provide wide ranging information on the graduate and professional programs offered by accredited colleges and universities in the United States and U S territories and those in Canada Mexico Europe and Africa that are accredited by U S accrediting bodies Books 2 through 6 are divided into sections that contain one or more directories devoted to individual programs in a particular field Book 4 contains more than 3 800 programs of study in 56 disciplines of the physical sciences mathematics agricultural sciences the environment and natural resources *Real and Complex Singularities* Ana Claudia Nabarro, Juan J. Nuño-Ballesteros, Raúl Oset Sinha, Maria

Aparecida Soares Ruas, 2016-10-25 This volume is a collection of papers presented at the XIII International Workshop on Real and Complex Singularities held from July 27 August 8 2014 in São Carlos Brazil in honor of Maria del Carmen Romero Fuster's 60th birthday The volume contains the notes from two mini courses taught during the workshop on intersection homology by J P Brasselet and on non isolated hypersurface singularities and L cycles by D Massey The remaining contributions are research articles which cover topics from the foundations of singularity theory including classification theory and invariants to topology of singular spaces links of singularities and semi algebraic sets as well as applications to topology cobordism and Lefschetz fibrations dynamical systems Morse Bott functions and differential geometry affine geometry Gauss maps caustics frontals and non Euclidean geometries This book is published in cooperation with Real Sociedad Matemática Española RSME

Selected Papers from the 16th International Conference on Squeezed States and Uncertainty Relations (ICSSUR 2019) Margarita A. Man'ko, Luis L. Sánchez-Soto, 2020-11-09 The first quantum revolution started in the early 20th century and gave us new rules that govern physical reality Accordingly many devices that changed dramatically our lifestyle such as transistors medical scanners and lasers appeared in the market This was the origin of quantum technology which allows us to organize and control the components of a complex system governed by the laws of quantum physics This is in sharp contrast to conventional technology which can only be understood within the framework of classical mechanics We are now in the middle of a second quantum revolution Although quantum mechanics is nowadays a mature discipline quantum engineering as a technology is now emerging in its own right We are about to manipulate and sense individual particles measuring and exploiting their quantum properties This is bringing major technical advances in many different areas including computing sensors simulations cryptography and telecommunications The present collection of selected papers is a clear demonstration of the tremendous vitality of the field The issue is composed of contributions from world leading

researchers in quantum optics and quantum information and presents viewpoints both theoretical and experimental on a variety of modern problems **Some Applications of Quantum Mechanics** Mohammad Reza Pahlavani, 2012-02-22

Quantum mechanics shortly after invention obtained applications in different area of human knowledge Perhaps the most attractive feature of quantum mechanics is its applications in such diverse area as astrophysics nuclear physics atomic and molecular spectroscopy solid state physics and nanotechnology crystallography chemistry biotechnology information theory electronic engineering This book is the result of an international attempt written by invited authors from over the world to response daily growing needs in this area We do not believe that this book can cover all area of application of quantum mechanics but wish to be a good reference for graduate students and researchers *CERN Courier* ,2010

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