Anyons Quantum Mechanics Of Particles With Fractional Statistics

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REINA CARTER

Quantum Particle Illusion, The - Conceptual Quantum Mechanics CRC Press
Symmetries in Quantum Mechanics: From Angular Momentum to Supersymmetry (PBK) provides a thorough, didactic exposition of the role of symmetry, particularly rotational symmetry, in quantum mechanics. The bulk of the book covers the description of rotations (geometrically and group-theoretically) and their representations, and the quantum theory of angular momentum. Later chapters introduce more advanced topics such as relativistic theory, supersymmetry, anyons, fractional spin, and statistics. With clear, in-depth explanations, the book is ideal for use as a course text for postgraduate and advanced undergraduate students in physics and those specializing in theoretical physics. It is also useful for researchers looking for an accessible introduction to this important area of quantum theory.
New Research in Quantum Physics Springer Science & Business Media
This is the third, significantly expanded edition of the comprehensive textbook published in 1990 on the theory and applications of path integrals. It is the first book to explicitly solve path integrals of a wide variety of nontrivial quantum-mechanical systems, in particular the hydrogen atom. The solutions have become possible by two major advances. The first is a new euclidean path integral formula which increases the restricted range of applicability of Feynman's famous formula to include singular attractive 1/r and 1/r2 potentials. The second is a simple quantum equivalence principle governing the transformation of euclidean path integrals to spaces with curvature and torsion, which leads to time-sliced path integrals that are manifestly invariant under coordinate transformations. In addition to the time-sliced definition, the author gives a perturbative definition of path integrals which makes them invariant under coordinate transformations. A consistent implementation of this property leads to an extension of the theory of generalized functions by defining uniquely integrals over products of distributions. The powerful Feynman–Kleinert variational approach is explained and developed systematically into a variational perturbation theory which, in contrast to ordinary perturbation theory, produces convergent expansions. The convergence is uniform from weak to strong couplings, opening a way to precise approximate evaluations of analytically unsolvable path integrals. Tunneling processes are treated in detail. The results are used to determine the lifetime of supercurrents, the stability of metastable thermodynamic phases, and the large-order behavior of perturbation expansions. A new variational treatment extends the range of validity of previous tunneling theories from large to small barriers. A corresponding extension of large-order perturbation theory also applies now to small orders. Special attention is devoted to path integrals with topological restrictions. These are

relevant to the understanding of the statistical properties of elementary particles and the entanglement phenomena in polymer physics and biophysics. The Chern–Simons theory of particles with fractional statistics (anyons) is introduced and applied to explain the fractional quantum Hall effect. The relevance of path integrals to financial markets is discussed, and improvements of the famous Black–Scholes formula for option prices are given which account for the fact that large market fluctuations occur much more frequently than in the commonly used Gaussian distributions. The author's other book on 'Critical Properties of Φ4 Theories' gives a thorough introduction to the field of critical phenomena and develops new powerful resummation techniques for the extraction of physical results from the divergent perturbation expansions. Request Inspection Copy

Quantum Mechanics of Particles and Wave Fields World Scientific

The principal intent of this monograph is to present in a systematic and self-con tained fashion the basic tenets, ideas and results of a framework for the consistent unification of relativity and quantum theory based on a quantum concept of spacetime, and incorporating the basic principles of the theory of stochastic spaces in combination with those of Born's reciprocity theory. In this context, by the physicial consistency of the present framework we mean that the advocated approach to relativistic quantum theory relies on a consistent probabilistic interpretation, which is proven to be a direct extrapolation of the conventional interpretation of nonrelativistic quantum mechanics. The central issue here is that we can derive conserved and relativistically convariant probability currents, which are shown to merge into their nonrelativistic counterparts in the nonrelativistic limit, and which at the same time explain the physical and mathe matical reasons behind the basic fact that no probability currents that consistently describe pointlike particle localizability exist in conventional relativistic quantum mechanics. Thus, it is not that we dispense with the concept oflocality, but rather the advanced central thesis is that the classical concept of locality based on point like localizability is inconsistent in the realm of relativistic quantum theory, and should be replaced by a concept of quantum locality based on stochastically formulated systems of covariance and related to the aforementioned currents.

Introduction to Topological Quantum Matter & Quantum Computation Springer Science & Business Media

At the intersection of physics, mathematics, and computer science, an exciting new field of study has formed, known as “Topological Quantum.” This research field examines the deep connections between the theory of knots, special types of subatomic particles known as anyons, certain phases of matter, and quantum computation. This book elucidates this nexus, drawing in topics ranging from quantum gravity to topology to experimental condensed matter physics. Topological quantum has increasingly been a focus point in the fields of condensed matter physics and quantum information over the last few decades, and the forefront of research now builds on the basic ideas presented in this book. The material is presented in a down-to-earth and entertaining way that is far less abstract than most of what is in the literature. While introducing the crucial concepts and placing them in

context, the subject is presented without resort to the highly mathematical category theory that underlies the field. Requiring only an elementary background in quantum mechanics, this book is appropriate for all readers, from advanced undergraduates to the professional practitioner. This book will be of interest to mathematicians and computer scientists as well as physicists working on a wide range of topics. Those interested in working in these field will find this book to be an invaluable introduction as well as a crucial reference.

Anyons World Scientific

In The Age of Entanglement, Louisa Gilder brings to life one of the pivotal debates in twentieth century physics. In 1935, Albert Einstein famously showed that, according to the quantum theory, separated particles could act as if intimately connected–a phenomenon which he derisively described as “spooky action at a distance.” In that same year, Erwin Schrödinger christened this correlation “entanglement.” Yet its existence was mostly ignored until 1964, when the Irish physicist John Bell demonstrated just how strange this entanglement really was. Drawing on the papers, letters, and memoirs of the twentieth century’s greatest physicists, Gilder both humanizes and dramatizes the story by employing the scientists’ own words in imagined face-to-face dialogues. The result is a richly illuminating exploration of one of the most exciting concepts of quantum physics.

Quantum Theory of Tunneling University of Chicago Press

"Niels Bohr was a central figure in quantum physics, well-known for his work on atomic structure and his contributions to the Copenhagen interpretation of quantum mechanics. In this book, philosopher Slobodan Perović explores the way Bohr practiced and understood physics, and the implications of this for our understanding of modern science, especially contemporary quantum experimental physics. Perović's method of studying Bohr is philosophical-historical, and his aim is to make sense of both Bohr's understanding of physics and his method of inquiry. He argues that in several important respects, Bohr's vision of physics was driven by his desire to develop a comprehensive perspective on key features of experimental observation as well as emerging experimental work. Perović uncovers how Bohr's distinctive breakthrough contributions are characterized by a multi-layered, phased approach of building on basic experimental insights inductively to develop intermediary and overarching hypotheses. The strengths and limitations of this approach, in contrast to the mathematically or metaphysically driven approaches of other physicists at the time, made him a thoroughly distinctive kind of theorist and scientific leader. Once we see that Bohr played the typical role of a laboratory mediator, and excelled in the inductive process this required, we can fully understand the way his work was generated, the role it played in developing novel quantum concepts, and its true limitations, as well as current adherence to and use of Bohr's complementarity approach among contemporary experimentalists"--

Quantum Hall Effects World Scientific

This outstanding new volume brings together state of the art developments in quantum physics. The forefront of contemporary advances in physics lies in the submicroscopic regime, whether it be in atomic, nuclear, condensed-matter,

plasma, or particle physics, or in quantum optics, or even in the study of stellar structure. All are based upon quantum theory (i.e., quantum mechanics and quantum field theory) and relativity, which together form the theoretical foundations of modern physics. a range of possible values are in quantum theory constrained to have discontinuous, or discrete, values. The intrinsically deterministic character of classical physics is replaced in quantum theory by intrinsic uncertainty. According to quantum theory, electromagnetic radiation does not always consist of continuous waves; instead it must be viewed under some circumstances as a collection of particle-like photons, the energy and momentum of each being directly proportional to its frequency (or inversely proportional to its wavelength, the photons still possessing some wavelike characteristics). Classical Concepts (Millard Baublitz, JR, Boston University); Irreversible Time Flow and Hilbert Space Structure (Pavel Kundrat, Milos V. Lokajicek, Institute of Physics, AVCR, Czech Republic); Time as a Dynamical Variable (Z. Y. Wang, University of Electronic Science and Technology of China and B. Chen, University of Central Florida); Gamow Vectors and Time Asymmetric Quantum Mechanics (M. Gadella, Universidad de Valladolid, Spain, and S. Wickramasekara, St. Olaf College); Nonperturbative Methods in Quantum Mechanics: The Gaussian Functional Approach (J. Casahorran, Universidad de Zaragoza, Spain); Wave Packet Dynamics and Tunneling in External Time Dependent Fields: A Semiclassical Real-Time Approach (Markus Saltzer and Joachim Ankerhold, Albert-Ludwigs-Universitaet Freiburg, Germany); Finite Size Scaling in Quantum Mechanics (Sabre Kais, Purdue University and Pablo Serra, Universidad Nacional de Cordoba, Argentina); Nonlocality in Time of Interaction in Theories with Disparate Energy Scales (Renat Kh. Gainutdinov and Aigul A. Mutygullina, Kazan State University, Russia); Classical and Quantum Mechanics of A

Stochastic Quantum Mechanics and Quantum Spacetime World Scientific Publishing Company

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Introduction to Topological Quantum Computation Anshan Pub

Quantum Physics of Matter explores the way in which quantum physics determines the properties of materials. The quantum physics of solids, for example, dictates whether they are good insulators, conductors, semiconductors, or even superconductors. At a deeper level, it explores how the quantum physics of nuclei and elementary particles determines the stability of matter and hence the range of substances that came into existence through the big bang and the evolution of stars.

Fractional Statistics and Quantum Theory Springer

In solid-state physics especially topological techniques have turned out to be extremely useful for modelling and explaining physical properties of matter. This book illustrates various applications of algebraic topology in classical field theory (non-linear sigma-models) and in quantizationsin multiply connected spaces (anyons). It treats Chern-Simon Lagrangians, Berry's phase, the polarization of light and the fractional quantum Hall effect.

Physics And Mathematics Of Anyons -

Proceedings Of The Tcsuh Workshop John Wiley & Sons
This book presents the basic elements of theoretical physics in a highly accessible, captivating way for university students in the third year of a degree in physics. It covers analytical mechanics, thermodynamics and statistical physics, special and general relativity and non-relativistic quantum theory, fully developing the necessary mathematical methods beyond standard calculus. The central theme is scientific curiosity and the main focus is on the experimental meaning of all quantities and equations. Several recent verifications of General Relativity are presented, with emphasis on the physical effects – why they were predicted to exist and what signals they were seen to produce. Similarly, the basic reasons why superconductors have zero resistance and are perfect diamagnets are pinpointed. Quantum Eraser Experiments and Delayed Choice Experiments are described. Many statements of Quantum Theory are a challenge to common sense and some crucial predictions have often been considered hard to believe and have been tested experimentally. The book examines the EPR paradox, Bell states and teleportation. To show the beauty and richness of the subject, various topics from different areas of Physics are covered. These include: discrete quantum models and lattices (periodic and not), Casimir effect, Anyons, Fano Resonances, the Hanbury Brown and Twiss effect, the Aharonov-Bohm effect, the Meitner-Auger effect, Squeezed Light, the Rabi model, neutrino oscillations, aspects of Quantum Transport, Quantum Pumping, and Berry phases, black holes and cosmological problems.
Quantum Mechanics and the Particles of Nature Springer
Self-duality greatly reduces the mathematical difficulties of a theory but it is also a notion of considerable physical significance. The new class of self-dual Chern-Simons theories discussed in detail in this book arise in the context of anyonic quantum field theory and have applications to models such as the quantum Hall effect, anyonic superconductivity, and Aharonov-Bohm scattering. There are also interesting connections with the theory of integrable models. The author presents the abelian and non-abelian models for relativistic and non-relativistic realizations of the self-dual Chern-Simons theories and finishes with some applications in quantum physics. The book is written for advanced students and researchers in mathematical, particle, and condensed matter physics.
Elements of Classical and Quantum Physics Oxford University Press
The Poincaré Seminar is held twice a year at the Institut Henri Poincaré in Paris. The goal of this seminar is to provide up-to-date information about general topics of great interest in physics. Both the theoretical and experimental results are covered, with some historical background. Particular care is devoted to the pedagogical nature of the presentation. This volume is devoted to the quantum Hall effect. After a historical and general presentation by Nobel prize winner Klaus von Klitzing, discoverer of this effect, the volume proceeds with reviews on the mathematics and physics of both the integer and fractional case. It includes up to date presentations of the tunneling and metrology experiments related to the quantum Hall effect. It will serve the community of physicists and mathematicians at professional or

graduate student level.

Q Is for Quantum World Scientific

This is the fifth, expanded edition of the comprehensive textbook published in 1990 on the theory and applications of path integrals. It is the first book to explicitly solve path integrals of a wide variety of nontrivial quantum-mechanical systems, in particular the hydrogen atom. The solutions have been made possible by two major advances. The first is a new euclidean path integral formula which increases the restricted range of applicability of Feynman's time-sliced formula to include singular attractive 1/r- and 1/r2-potentials. The second is a new nonholonomic mapping principle carrying physical laws in flat spacetime to spacetimes with curvature and torsion, which leads to time-sliced path integrals that are manifestly invariant under coordinate transformations.In addition to the time-sliced definition, the author gives a perturbative, coordinate-independent definition of path integrals, which makes them invariant under coordinate transformations. A consistent implementation of this property leads to an extension of the theory of generalized functions by defining uniquely products of distributions.The powerful Feynman-Kleinert variational approach is explained and developed systematically into a variational perturbation theory which, in contrast to ordinary perturbation theory, produces convergent results. The convergence is uniform from weak to strong couplings, opening a way to precise evaluations of analytically unsolvable path integrals in the strong-coupling regime where they describe critical phenomena.Tunneling processes are treated in detail, with applications to the lifetimes of supercurrents, the stability of metastable thermodynamic phases, and the large-order behavior of perturbation expansions. A variational treatment extends the range of validity to small barriers. A corresponding extension of the large-order perturbation theory now also applies to small orders.Special attention is devoted to path integrals with topological restrictions needed to understand the statistical properties of elementary particles and the entanglement phenomena in polymer physics and biophysics. The Chern-Simons theory of particles with fractional statistics (anyons) is introduced and applied to explain the fractional quantum Hall effect.The relevance of path integrals to financial markets is discussed, and improvements of the famous Black-Scholes formula for option prices are developed which account for the fact, recently experienced in the world markets, that large fluctuations occur much more frequently than in Gaussian distributions.

Quantum Theory of Many-particle Systems Academic Press

This book explains the subtleties of quantum statistical mechanics in lower dimensions and their possible ramifications in quantum theory. The discussion is at a pedagogical level and is addressed to both graduate students and advanced researchers with a reasonable background in quantum and statistical mechanics. Topics in the first part of the book include the flux tube model of anyons, the braid group and a detailed discussion about the various aspects of quantum and statistical mechanics of a noninteracting anyon gas. The second part of the book includes a detailed discussion about fractional statistics from the point of view of ChernOCoSimons theories. Topics covered here include

ChernOCoSimons field theories, charged vortices, anyon superconductivity and the fractional quantum Hall effect. Since the publication of the first edition of the book, an exciting possibility has emerged, that of quantum computing using anyons. A section has therefore been included on this topic in the second edition. In addition, new sections have been added about scattering of anyons with hard disk repulsion as well as fractional exclusion statistics and negative probabilities."

Path Integrals In Quantum Mechanics, Statistics, Polymer Physics, And Financial Markets (5th Edition) CRC Press

In this volume, the fractional quantum Hall effect is reviewed and reexamined with emphasis on the fractional statistics. Possible relevance of the anyon idea to high temperature superconductivity is addressed both theoretically and experimentally.

Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles Springer Science & Business Media

Enthusiasm for research on the quantum Hall effect (QHE) is unbounded. The QHE is one of the most fascinating and beautiful phenomena in all branches of physics. Tremendous theoretical and experimental developments are still being made in this sphere. Composite bosons, composite fermions and anyons were among distinguishing ideas in the original edition. In the 2nd edition, fantastic phenomena associated with the interlayer phase coherence in the bilayer system were extensively described. The microscopic theory of the QHE was formulated based on the noncommutative geometry. Furthermore, the unconventional QHE in graphene was reviewed, where the electron dynamics can be treated as relativistic Dirac fermions and even the supersymmetric quantum mechanics plays a key role. In this 3rd edition, all chapters are carefully reexamined and updated. A highlight is the new chapter on topological insulators. Indeed, the concept of topological insulator stems from the QHE. Other new topics are recent prominent experimental discoveries in the QHE, provided by the experimentalists themselves in Part V. This new edition presents an instructive and comprehensive overview of the QHE. It is also suitable for an introduction to quantum field theory with vividly described applications. Only knowledge of quantum mechanics is assumed. This book is ideal for students and researchers in condensed matter physics, particle physics, theoretical physics and mathematical physics.

Symmetries in Quantum Mechanics American Mathematical Soc.

Problems with the conceptual foundations of quantum mechanics date back to attempts by Max Born, Niels Bohr, Werner Heisenberg, as well as many others in the 1920s to continue to employ the classical concept of a particle in the context of the quantum world. The experimental observations at the time and the assumption that the classical concept of a particle was to be preserved have led to an enormous literature on the foundations of quantum mechanics and a great deal of confusion then and now among non-physicists and students in any field that involves quantum theory. It is the historical approach to the teaching of quantum mechanics that is at the root of the problem.Spacetime is the arena within which quantum mechanical phenomena take place. For this reason, several Appendices are devoted to the nature of spacetime as well as to topics that can help us understand it such as vacuum

fluctuations, the Unruh effect and Hawking radiation.Because of the success of quantum mechanical calculations, those who wish to understand the foundations of the theory are often given the apocryphal advice, 'just ignore the issue and calculate'. It is hoped that this book will help dispel some of the dismay, frustration, and confusion among those who refuse to take to heart this admonition.

The Age of Entanglement John Wiley & Sons

Originally published in 1965, the aim of this book was to challenge the dualistic view of physics, that is, the assumption that beams of electrons consist of discrete particles and of waves. Lande argues that this dualistic view is unnecessary, not only on methodological grounds but also from the standpoint of physics. Lande sets out to point out that there are faults in the purely physical arguments, which have led to the dualistic doctrine and shows that by making use of the quantum rule for the exchange of linear momentum, established by W. Duane in 1923, wave-like phenomena can be fully explained on a unitary particle theory of matter. Chapters cover a variety of subjects and range from 'Dualism versus quantum mechanics' to the 'Origin of the quantum rules'. Appendices are included for reference. This book will be of value to students and scholars of the history of physics.

Topology and Condensed Matter Physics Springer Science & Business Media

A comprehensive encyclopedia of quantum physics.Here in one volume, the award-winning science writer and physicist John Gribbin has provided everything you need to know about the quantum world -the place where most of the greatest scientific advances of the last hundred years have been made.This exceptional A to Z reference begins with a thorough introduction setting out the current state of knowledge in particle physics. Throughout, Gribbin includes articles on the structure of particles and their interactions, accounts of the theoretical breakthroughs in quantum mechanics and their practical applications, and entertaining biographies of the scientists who have blazed the trail of discovery. In a special section, "Timelines," key dates in our quest to understand the quantum world are mapped out alongside landmarks in world history and the history of science.An encyclopedia of the fundamental science of the future, Q is for Quantum is an essential companion for anyone interested in particle physics."Gribbin presents an overview of a hundred years of particle physics through a handy, accessible A-Z dictionary of definitions and identifications."-Natural History