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Quantum Theory of Many-Body Systems - Alexandre Zagoskin 2012-12-06
Intended for graduates in physics and related fields, this is a self-contained treatment of the physics of many-body systems from the point of view of condensed matter. The approach, quite traditionally, covers all the important diagram techniques for normal and superconducting systems, including the zero-temperature perturbation theory, and the Matsubara, Keldysh, and Nambu-Gorov formalisms. The aim is not to be exhaustive, but to present just enough detail to enable students to follow the current research literature or to apply the techniques to new problems. Many of the examples are drawn from mesoscopic physics, which deals with systems small enough that quantum coherence is maintained throughout the volume, and which therefore provides an ideal testing ground for many-body theories. '

Nonequilibrium Many-Body Theory of Quantum Systems - Gianluca Stefanucci 2013-03-07
The Green's function method is one of the most powerful and versatile formalisms in physics, and its nonequilibrium version has proved invaluable in many research fields. This book provides a unique, self-contained introduction to nonequilibrium many-body theory. Starting with basic quantum mechanics, the authors introduce the equilibrium and nonequilibrium Green's function formalisms within a unified framework called the contour formalism. The physical content of the contour Green's functions and the diagrammatic expansions are explained with a focus on the time-dependent aspect. Every result is derived step-by-step, critically discussed and then applied to different physical systems, ranging from molecules and nanostructures to metals and insulators. With an abundance of illustrative examples, this accessible book is ideal for graduate students and researchers who are interested in excited state properties of matter and nonequilibrium physics.

Relativistic Many-Body Theory and Statistical Mechanics - Lawrence P. Horwitz 2018-05-31
In 1941, E.C.G. Stueckelberg wrote a paper, based on ideas of V. Fock, that established the foundations of a theory that could covariantly describe the classical and quantum relativistic mechanics of a single particle. Horwitz and Piron extended the applicability of this theory in 1973 (to be called the SHP theory) to the many-body problem. It is the purpose of this book to explain this development and provide examples of its applications. We first review the basic ideas of the SHP theory, both classical and quantum, and develop the appropriate form of electromagnetism on this dynamics. After studying the two body problem classically and quantum mechanically, we formulate the N-body problem. We then develop the general quantum scattering theory for the N-body problem and prove a quantum mechanical relativistically covariant form of the Gell-Mann-Low theorem. The quantum theory of relativistic spin is then developed, including spin-statistics, providing the necessary apparatus for Clebsch-Gordan additivity, and we then discuss the phenomenon of entanglement at unequal times. In the second part, we develop relativistic statistical mechanics, including a mechanism for stability of the off-shell mass, and a high temperature phase transition to the mass shell. Finally, some applications are given, such as the explanation of the Lindneret alexperiment, the proposed experiment of Palacios et al which should demonstrate relativistic entanglement (at unequal times), the space-time lattice, low energy nuclear reactions and applications to black hole physics.

Introduction to Many-Body Physics - Piers Coleman 2015-11-26
A modern, graduate-level introduction to many-body physics in condensed matter, this textbook explains the tools and concepts needed for a research-level understanding of the correlated behavior of quantum fluids. Starting with an operator-based introduction to the quantum field theory of many-body physics, this textbook presents the Feynman diagram approach, Green's functions and finite-temperature many-body physics before developing the path integral approach to interacting systems. Special chapters are devoted to the concepts of Fermi liquid theory, broken symmetry, conduction in disordered systems, superconductivity and the physics of local-moment metals. A strong emphasis on concepts and numerous exercises make this an invaluable course book for graduate students in condensed matter physics. It will also interest students in nuclear, atomic and particle physics.

Quantum Field Theory of Many-Body Systems - Xiao-Gang Wen 2004-06-03
This book is a pedagogical and systematic introduction to new concepts and quantum field theoretical methods in condensed matter physics, which may have an impact on our understanding of the origin of light, electrons and other elementary particles in the universe. Emphasis is on clear physical principles, while at the same time bringing students to the fore of today's research.

Field Theory of Non-Equilibrium Systems - Alex Kamenev 2011-09-08
The physics of non-equilibrium many-body systems is one of the most rapidly expanding areas of theoretical physics. Traditionally used in the study of laser physics and superconducting kinetics, these techniques have more recently found applications in the study of dynamics of cold atomic gases, mesoscopic and nano-mechanical systems. The book gives a self-contained presentation of the modern functional approach to non-equilibrium field-theoretical methods. They are applied to examples ranging from biophysics to the kinetics of superfluids and superconductors. Its step-by-step treatment gives particular emphasis to the pedagogical aspects, making it ideal as a reference for advanced graduate students and researchers in condensed matter physics.

Quantum Field Theory of Non-equilibrium States - Jørgen Rammer 2011-03-03
Quantum field theory is the application of quantum mechanics to systems with infinitely many degrees of freedom. This 2007 textbook presents quantum field theoretical applications to systems out of equilibrium. It introduces the real-time approach to non-equilibrium statistical mechanics and the quantum field theory of non-equilibrium states in general. It offers two ways of learning how to study non-equilibrium states of many-body systems: the mathematical canonical way and an easy intuitive way using Feynman diagrams. The latter provides an easy introduction to the powerful functional methods of field theory, and the use of

Feynman diagrams to study classical stochastic dynamics is considered in detail. The developed real-time technique is applied to study numerous phenomena in many-body systems. Complete with numerous exercises to aid self-study, this textbook is suitable for graduate students in statistical mechanics and condensed matter physics.

Quantum Many-Body Physics in Open Systems: Measurement and Strong Correlations - Yuto Ashida 2020-01-06

This book studies the fundamental aspects of many-body physics in quantum systems open to an external world. Recent remarkable developments in the observation and manipulation of quantum matter at the single-quantum level point to a new research area of open many-body systems, where interactions with an external observer and the environment play a major role. The first part of the book elucidates the influence of measurement backaction from an external observer, revealing new types of quantum critical phenomena and out-of-equilibrium dynamics beyond the conventional paradigm of closed systems. In turn, the second part develops a powerful theoretical approach to study the in- and out-of-equilibrium physics of an open quantum system strongly correlated with an external environment, where the entanglement between the system and the environment plays an essential role. The results obtained here offer essential theoretical results for understanding the many-body physics of quantum systems open to an external world, and can be applied to experimental systems in atomic, molecular and optical physics, quantum information science and condensed matter physics.

A Guide to Feynman Diagrams in the Many-Body Problem - Richard D. Mattuck 2012-08-21

Superb introduction for nonspecialists covers Feynman diagrams, quasi particles, Fermi systems at finite temperature, superconductivity, vacuum amplitude, Dyson's equation, ladder approximation, and more. "A great delight." — Physics Today. 1974 edition.

Methods of Quantum Field Theory in Statistical Physics - Alekseĭ Alekseevich Abrikosov 1963

Many-Body Problems and Quantum Field Theory - Philippe Andre Martin 2013-04-17

Emphasis is placed on analogies between the various systems rather than on advanced or specialized aspects, with the purpose of illustrating common ideas within different domains of physics. Starting from a basic knowledge of quantum mechanics and classical electromagnetism, the exposition is self-contained and explicitly details all steps of the derivations. The new edition features a substantially new treatment of nucleon pairing.

The Physics of Quantum Fields - Michael Stone 2012-12-06

A gentle introduction to the physics of quantized fields and many-body physics. Based on courses taught at the University of Illinois, it concentrates on the basic conceptual issues that many students find difficult, and emphasizes the physical and visualizable aspects of the subject. While the text is intended for students with a wide range of interests, many of the examples are drawn from condensed matter physics because of the tangible character of such systems. The first part of the book uses the Hamiltonian operator language of traditional quantum mechanics to treat simple field theories and related topics, while the Feynman path integral is introduced in the second half where it is seen as indispensable for understanding the connection between renormalization and critical as well as non-perturbative phenomena.

Condensed Matter Field Theory - Alexander Altland 2010-03-11

Modern experimental developments in condensed matter and ultracold atom physics present formidable challenges to theorists. This book provides a pedagogical introduction to quantum field theory in many-particle physics, emphasizing the applicability of the formalism to concrete problems. This second edition contains two new chapters developing path integral approaches to classical and quantum nonequilibrium phenomena. Other chapters cover a range of topics, from the introduction of many-body techniques and functional integration, to renormalization group methods, the theory of response functions, and topology. Conceptual aspects and formal methodology are emphasized, but the discussion focuses on practical experimental applications drawn largely from condensed matter physics and neighboring fields. Extended and challenging problems with fully worked solutions provide a bridge between formal manipulations and research-oriented thinking. Aimed at elevating graduate students to a level where they can engage in independent research, this book complements graduate level courses on many-particle theory.

Tensor Network Contractions - Shi-Ju Ran 2020-01-01

Tensor network is a fundamental mathematical tool with a huge range of applications in physics, such as condensed matter physics, statistic physics, high energy physics, and quantum information sciences. This open access book aims to explain the tensor network contraction approaches in a systematic way, from the basic definitions to the important applications. This book is also useful to those who apply tensor networks in areas beyond physics, such as machine learning and the big-data analysis. Tensor network originates from the numerical renormalization group approach proposed by K.G. Wilson in 1975. Through a rapid development in the last two decades, tensor network has become a powerful numerical tool that can efficiently simulate a wide range of scientific problems, with particular success in quantum many-body physics. Varieties of tensor network algorithms have been proposed for different problems. However, the connections among different algorithms are not well discussed or reviewed. To fill this gap, this book explains the fundamental concepts and basic ideas that connect and/or unify different strategies of the tensor network contraction algorithms. In addition, some of the recent progresses in dealing with tensor decomposition techniques and quantum simulations are also represented in this book to help the readers to better understand tensor network. This open access book is intended for graduated students, but can also be used as a professional book for researchers in the related fields. To understand most of the contents in the book, only basic knowledge of quantum mechanics and linear algebra is required. In order to fully understand some advanced parts, the reader will need to be familiar with notion of condensed matter physics and quantum information, that however are not necessary to understand the main parts of the book. This book is a good source for non-specialists on quantum physics to understand tensor network algorithms and the related mathematics.

Fundamentals of Many-body Physics - Wolfgang Nolting 2009-03-02

The goal of the present course on “Fundamentals of Theoretical Physics” is to be a direct accompaniment to the lower-division study of physics, and it aims at providing the ph- ical tools in the most straightforward and compact form as needed by the students in order to master theoretically more complex topics and problems in advanced studies and in research. The presentation is thus intentionally designed to be suf?ciently detailed and self-contained – sometimes, admittedly, at the cost of a certain elegance – to permit in- vidual study without reference to the secondary literature. This volume deals with the quantum theory of many-body systems. Building upon a basic knowledge of quantum mechanics and of statistical physics, modern techniques for the description of interacting many-particle systems are developed and applied to various real problems, mainly from the area of solid-state physics. A thorough revision should guarantee that the reader can access the relevant research literature without experiencing major problems in terms of the concepts and vocabulary, techniques and deductive methods found there. The world which surrounds us consists of very many particles interacting with one another, and their description requires in principle the solution of a corresponding number ofcoupledquantum-mechanicalequationsofmotion(Schrodinger¨ equations),which,h- ever, is possible only in exceptional cases in a mathematically strict sense. The concepts of elementary quantum mechanics and quantum statistics are therefore not directly applicable in the form in which we have thus far encountered them. They require an extension and restructuring, which is termed “many-body theory”.

Physics and Mathematics of Quantum Many-Body Systems - Hal Tasaki 2020-05-23

This book is a self-contained advanced textbook on the mathematical-physical aspects of quantum many-body systems, which begins with a pedagogical presentation of the necessary background information before moving on to subjects of active research, including topological phases of matter. The book explores in detail selected topics in quantum spin systems and lattice electron systems, namely, long-range order and spontaneous symmetry breaking in the antiferromagnetic Heisenberg model in two or higher dimensions (Part I), Haldane phenomena in antiferromagnetic quantum spin chains and related topics in topological phases of quantum matter (Part II), and the origin of magnetism in various versions of the Hubbard model (Part III). Each of these topics represents certain nontrivial phenomena or features that are invariably encountered in a variety of quantum many-body systems, including quantum field theory, condensed matter systems, cold atoms, and artificial quantum systems designed for future quantum computers. The book’s main focus is on universal properties of quantum many-body systems. The book

includes roughly 50 problems with detailed solutions. The reader only requires elementary linear algebra and calculus to comprehend the material and work through the problems. Given its scope and format, the book is suitable both for self-study and as a textbook for graduate or advanced undergraduate classes.

Quantum Field Theory and Condensed Matter - Ramamurti Shankar 2017-08-31

Providing a broad review of many techniques and their application to condensed matter systems, this book begins with a review of thermodynamics and statistical mechanics, before moving onto real and imaginary time path integrals and the link between Euclidean quantum mechanics and statistical mechanics. A detailed study of the Ising, gauge-Ising and XY models is included. The renormalization group is developed and applied to critical phenomena, Fermi liquid theory and the renormalization of field theories. Next, the book explores bosonization and its applications to one-dimensional fermionic systems and the correlation functions of homogeneous and random-bond Ising models. It concludes with Bohm–Pines and Chern–Simons theories applied to the quantum Hall effect. Introducing the reader to a variety of techniques, it opens up vast areas of condensed matter theory for both graduate students and researchers in theoretical, statistical and condensed matter physics.

Many-Body Problems and Quantum Field Theory - Philippe Andre Martin 2004-08-30

Many-Body Problems and Quantum Field Theory introduces the concepts and methods of the topics on a level suitable for graduate students and researchers. The formalism is developed in close conjunction with the description of a number of physical systems: cohesion and dielectric properties of the electron gas, superconductivity, superfluidity, nuclear matter and nucleon pairing, matter and radiation, interaction of fields by particle exchange and mass generation. Emphasis is placed on analogies between the various systems rather than on advanced or specialized aspects, with the purpose of illustrating common ideas within different domains of physics. Starting from a basic knowledge of quantum mechanics and classical electromagnetism, the exposition is self-contained and explicitly details all steps of the derivations. The new edition features a subtantially new treatment of nucleon pairing.

Quantum Field Theory of Many-Body Systems - Xiao-Gang Wen 2004-06-04

For most of the last century, condensed matter physics has been dominated by band theory and Landau's symmetry breaking theory. In the last twenty years, however, there has been the emergence of a new paradigm associated with fractionalisation, topological order, emergent gauge bosons and fermions, and string condensation. These new physical concepts are so fundamental that they may even influence our understanding of the origin of light and fermions in the universe. This book is a pedagogical and systematic introduction to the new concepts and quantum field theoretical methods (which have fuelled the rapid developments) in condensed matter physics. It discusses many basic notions in theoretical physics which underlie physical phenomena in nature. Topics covered are dissipative quantum systems, boson condensation, symmetry breaking and gapless excitations, phase transitions, Fermi liquids, spin density wave states, Fermi and fractional statistics, quantum Hall effects, topological and quantum order, spin liquids, and string condensation. Methods covered are the path integral, Green's functions, mean-field theory, effective theory, renormalization group, bosonization in one- and higher dimensions, non-linear sigma-model, quantum gauge theory, dualities, slave-boson theory, and exactly soluble models beyond one-dimension. This book is aimed at teaching graduate students and bringing them to the frontiers of research in condensed matter physics.

Quantum Scaling in Many-Body Systems - Mucio Continentino 2017-04-17

Focusing on experimental results, this updated edition approaches the problem of quantum phase transitions from a new and unifying perspective.

Many-body Theory Exposed! - Willem Hendrik Dickhoff 2008

This comprehensive textbook on the quantum mechanics of identical particles includes a wealth of valuable experimental data, in particular recent results from direct knockout reactions directly related to the single-particle propagator in many-body theory. The comparison with data is incorporated from the start, making the abstract concept of propagators vivid and accessible. Results of numerical calculations using propagators or Green's functions are also presented. The material has been thoroughly tested in the classroom and the introductory chapters provide a seamless connection with a one-year graduate course in quantum mechanics. While the majority of books on many-body theory deal with the subject from the viewpoint of condensed matter physics, this book emphasizes finite systems as well and should be of considerable interest to researchers in nuclear, atomic, and molecular physics. A unified treatment of many different many-body systems is presented using the approach of self-consistent Green's functions. The second edition contains an extensive presentation of finite temperature propagators and covers the technique to extract the self-energy from experimental data as developed in the dispersive optical model.The coverage proceeds systematically from elementary concepts, such as second quantization and mean-field properties, to a more advanced but self-contained presentation of the physics of atoms, molecules, nuclei, nuclear and neutron matter, electron gas, quantum liquids, atomic Bose-Einstein and fermion condensates, and pairing correlations in finite and infinite systems, including finite temperature.

Quantum Kinetic Theory - Michael Bonitz 2015-11-20

This book presents quantum kinetic theory in a comprehensive way. The focus is on density operator methods and on non-equilibrium Green functions. The theory allows to rigorously treat nonequilibrium dynamics in quantum many-body systems. Of particular interest are ultrafast processes in plasmas, condensed matter and trapped atoms that are stimulated by rapidly developing experiments with short pulse lasers and free electron lasers. To describe these experiments theoretically, the most powerful approach is given by non-Markovian quantum kinetic equations that are discussed in detail, including computational aspects.

Quantum Theory of Many-particle Systems - Alexander L. Fetter 2003-06-20

This self-contained treatment of nonrelativistic many-particle systems discusses both formalism and applications in terms of ground-state (zero-temperature) formalism, finite-temperature formalism, canonical transformations, and applications to physical systems. 149 figures. 8 tables. 1971 edition.

Physics and Mathematics of Quantum Many-Body Systems - Hal Tasaki 2020-05-07

This book is a self-contained advanced textbook on the mathematical-physical aspects of quantum many-body systems, which begins with a pedagogical presentation of the necessary background information before moving on to subjects of active research, including topological phases of matter. The book explores in detail selected topics in quantum spin systems and lattice electron systems, namely, long-range order and spontaneous symmetry breaking in the antiferromagnetic Heisenberg model in two or higher dimensions (Part I), Haldane phenomena in antiferromagnetic quantum spin chains and related topics in topological phases of quantum matter (Part II), and the origin of magnetism in various versions of the Hubbard model (Part III). Each of these topics represents certain nontrivial phenomena or features that are invariably encountered in a variety of quantum many-body systems, including quantum field theory, condensed matter systems, cold atoms, and artificial quantum systems designed for future quantum computers. The book’s main focus is on universal properties of quantum many-body systems. The book includes roughly 50 problems with detailed solutions. The reader only requires elementary linear algebra and calculus to comprehend the material and work through the problems. Given its scope and format, the book is suitable both for self-study and as a textbook for graduate or advanced undergraduate classes.

Modern Theories of Many-Particle Systems in Condensed Matter Physics - Daniel C. Cabra 2012-01-05

Condensed matter systems where interactions are strong are inherently difficult to analyze theoretically. The situation is particularly interesting in low-dimensional systems, where quantum fluctuations play a crucial role. Here, the development of non-perturbative methods and the study of integrable field theory have facilitated the understanding of the behavior of many quasi one- and two-dimensional strongly correlated systems. In view of the same rapid development that has taken place for both experimental and numerical techniques, as well as the emergence of novel testing-grounds such as cold atoms or graphene, the current understanding of strongly correlated condensed matter systems differs quite considerably from standard textbook presentations. The present volume of lecture notes aims to fill this gap in the literature by providing a collection of authoritative tutorial reviews, covering such topics as quantum phase transitions of antiferromagnets and cuprate-based high-temperature superconductors, electronic liquid crystal phases, graphene physics, dynamical mean field theory applied to strongly correlated systems, transport through quantum dots, quantum information perspectives on many-body physics, frustrated magnetism, statistical mechanics of classical and quantum computational complexity, and integrable methods in statistical field theory. As both graduate-level text and authoritative reference on this topic, this

book will benefit newcomers and more experienced researchers in this field alike.

Renormalization Group and Effective Field Theory Approaches to Many-Body Systems - Achim Schwenk 2012-06-25

There have been many recent and important developments based on effective field theory and the renormalization group in atomic, condensed matter, nuclear and high-energy physics. These powerful and versatile methods provide novel approaches to study complex and strongly interacting many-body systems in a controlled manner. The six extensive lectures gathered in this volume combine selected introductory and interdisciplinary presentations focused on recent applications of effective field theory and the renormalization group to many-body problems in such diverse fields as BEC, DFT, extreme matter, Fermi-liquid theory and gauge theories. Primarily aimed at graduate students and junior researchers, they offer an opportunity to explore fundamental physics across subfield boundaries at an early stage in their careers.

Mathematical Methods of Many-Body Quantum Field Theory - Detlef Lehmann 2019-08-30

Mathematical Methods of Many-Body Quantum Field Theory offers a comprehensive, mathematically rigorous treatment of many-body physics. It develops the mathematical tools for describing quantum many-body systems and applies them to the many-electron system. These tools include the formalism of second quantization, field theoretical perturbation theory, functional integral methods, bosonic and fermionic, and estimation and summation techniques for Feynman diagrams. Among the physical effects discussed in this context are BCS superconductivity, s-wave and higher l-wave, and the fractional quantum Hall effect. While the presentation is mathematically rigorous, the author does not focus solely on precise definitions and proofs, but also shows how to actually perform the computations. Presenting many recent advances and clarifying difficult concepts, this book provides the background, results, and detail needed to further explore the issue of when the standard approximation schemes in this field actually work and when they break down. At the same time, its clear explanations and methodical, step-by-step calculations shed welcome light on the established physics literature.

Quantum Field Theory in Condensed Matter Physics - Naoto Nagaosa 2013-11-11

This is an approachable introduction to the important topics and recent developments in the field of condensed matter physics. First, the general language of quantum field theory is developed in a way appropriate for dealing with systems having a large number of degrees of freedom. This paves the way for a description of the basic processes in such systems. Applications include various aspects of superfluidity and superconductivity, as well as a detailed description of the fractional quantum Hall liquid.

Many-Body Quantum Theory in Condensed Matter Physics - Henrik Bruus 2004-09-02

The book is an introduction to quantum field theory applied to condensed matter physics. The topics cover modern applications in electron systems and electronic properties of mesoscopic systems and nanosystems. The textbook is developed for a graduate or advanced undergraduate course with exercises which aim at giving students the ability to confront real problems.

Quantum Many-Body Physics in a Nutshell - Edward Shuryak 2018-11-27

The ideal textbook for a one-semester introductory course for graduate students or advanced undergraduates This book provides an essential introduction to the physics of quantum many-body systems, which are at the heart of atomic and nuclear physics, condensed matter, and particle physics. Unlike other textbooks on the subject, it covers topics across a broad range of physical fields—phenomena as well as theoretical tools—and does so in a simple and accessible way. Edward Shuryak begins with Feynman diagrams of the quantum and statistical mechanics of a particle; in these applications, the diagrams are easy to calculate and there are no divergencies. He discusses the renormalization group and illustrates its uses, and covers systems such as weakly and strongly coupled Bose and Fermi gases, electron gas, nuclear matter, and quark-gluon plasmas. Phenomena include Bose condensation and superfluidity. Shuryak also looks at Cooper pairing and superconductivity for electrons in metals, liquid 3He, nuclear matter, and quark-gluon plasma. A recurring topic throughout is topological matter, ranging from ensembles of quantized vortices in superfluids and superconductors to ensembles of colored (QCD) monopoles and instantons in the QCD vacuum. Proven in the classroom, Quantum Many-Body Physics in a Nutshell is the ideal textbook for a one-semester introductory course for graduate students or advanced undergraduates. Teaches students how quantum many-body systems work across many fields of physics Uses path integrals from the very beginning Features the easiest introduction to Feynman diagrams available Draws on the most recent findings, including trapped Fermi and Bose atomic gases Guides students from traditional systems, such as electron gas and nuclear matter, to more advanced ones, such as quark-gluon plasma and the QCD vacuum

Modern Quantum Field Theory - Tom Banks 2008-09-18

Presenting a variety of topics that are only briefly touched on in other texts, this book provides a thorough introduction to the techniques of field theory. Covering Feynman diagrams and path integrals, the author emphasizes the path integral approach, the Wilsonian approach to renormalization, and the physics of non-abelian gauge theory. It provides a thorough treatment of quark confinement and chiral symmetry breaking, topics not usually covered in other texts at this level. The Standard Model of particle physics is discussed in detail. Connections with condensed matter physics are explored, and there is a brief, but detailed, treatment of non-perturbative semi-classical methods. Ideal for graduate students in high energy physics and condensed matter physics, the book contains many problems,which help students practise the key techniques of quantum field theory.

Quantum Field Theory and Critical Phenomena - Jean Zinn-Justin 1993

This well-received work is now available in a new edition. It is an advanced text on quantum field theory--which is not only the accepted framework for describing all fundamental interactions except gravity, but also for understanding second-order phase transitions in statistical mechanics. The book approaches this subject in terms of path and functional integrals. A Euclidean metric has been adopted and the language of partition and correlation functions is used. Renormalization and the renormalization group are also discussed. Full mathematical details are provided. The text is intended for theoretical particle physicists and statistical physicists at the graduate level and above.

The Quantum Mechanics of Many-Body Systems - D.J. Thouless 2014-01-15

"Unabridged republication of the second edition of the work, originally published in the Pure and applied physics series by Academic Press, Inc., New York, in 1972"--Title page verso.

Relativistic Many-Body Theory - Ingvar Lindgren 2016-04-28

This revised second edition of the author’s classic text offers readers a comprehensively updated review of relativistic atomic many-body theory, covering the many developments in the field since the publication of the original title. In particular, a new final section extends the scope to cover the evaluation of QED effects for dynamical processes. The treatment of the book is based upon quantum-field theory, and demonstrates that when the procedure is carried to all orders of perturbation theory, two-particle systems are fully compatible with the relativistically covariant Bethe-Salpeter equation. This procedure can be applied to arbitrary open-shell systems, in analogy with the standard many-body theory, and it is also applicable to systems with more than two particles. Presently existing theoretical procedures for treating atomic systems are, in several cases, insufficient to explain the accurate experimental data recently obtained, particularly for highly charged ions. The main text is divided into three parts. In Part I, the standard time-independent and time-dependent perturbation procedures are reviewed. This includes a new section at the end of chapter 2 concerning the so-called ”Fock-space procedure” or ”Coulomb-only procedure” for relativistic-QED calculations . This is a procedure on an intermediate level, frequently used in recent time by chemists on molecular systems, where a full QED treatment is out of question. Part II describes three methods for QED calculations, a) the standard S-matrix formulation, b) the Two-times Green’s-function method, developed by the St Petersburg Atomic Theory group, and c) the Covariant-evolution operator (CEO) method, recently developed by the Gothenburg Atomic Theory group. In Part III, the CEO method is combined with electron correlation to arbitrary order to a unified MBPT-QED procedure. The new Part IV includes two new chapters dealing with dynamical properties and how QED effects can be evaluated for such processes. This part is much needed as there has been an increasing interest in the study of QED effects for such processes. All methods treated in the book are illustrated with numerical examples, making it a text suitable for advanced students new to the field and a useful reference for established researchers.

Quantum Theory of Many-Particle Systems - Alexander L. Fetter 2012-03-08

Self-contained treatment of nonrelativistic many-particle systems discusses both formalism and applications in terms of ground-state (zero-temperature) formalism, finite-temperature formalism, canonical

transformations, and applications to physical systems. 1971 edition.

Mathematical Methods of Many-Body Quantum Field Theory - Detlef Lehmann 2004-08-30

Mathematical Methods of Many-Body Quantum Field Theory offers a comprehensive, mathematically rigorous treatment of many-body physics. It develops the mathematical tools for describing quantum many-body systems and applies them to the many-electron system. These tools include the formalism of second quantization, field theoretical perturbation theo

The Many-Body Problem in Quantum Mechanics - Norman Henry March 1995-01-01

Single-volume account of methods used in dealing with the many-body problem and the resulting physics. Single-particle approximations, second quantization, many-body perturbation theory, Fermi fluids, superconductivity, many-boson systems, more. Each chapter contains well-chosen problems. Only prerequisite is basic understanding of elementary quantum mechanics. 1967 edition.

Quantum Physics of Light and Matter - Luca Salasnich 2014-05-27

The book gives an introduction to the field quantization (second quantization) of light and matter with applications to atomic physics. The first chapter briefly reviews the origins of special relativity and quantum mechanics and the basic notions of quantum information theory and quantum statistical mechanics. The second chapter is devoted to the second quantization of the electromagnetic field, while the third chapter shows the consequences of the light field quantization in the description of electromagnetic transitions. In the fourth chapter it is analyzed the spin of the electron, and in particular its derivation from the Dirac equation, while the fifth chapter investigates the effects of external electric and magnetic fields on the atomic spectra (Stark and Zeeman effects). The sixth chapter describes the properties of systems composed by many interacting identical particles by introducing the Hartree-Fock variational method, the density functional theory and the Born-Oppenheimer approximation. Finally, in the seventh chapter it is explained the second quantization of the non-relativistic matter field, i.e. the Schrodinger field, which gives a powerful tool for the investigation of many-body problems and also atomic quantum optics. At the end of each chapter there are several solved problems which can help the students to put into practice the things they learned.

Quantum Physics - Florian Scheck 2014-07-08

Scheck’s Quantum Physics presents a comprehensive introductory treatment, ideally suited for a two-semester course. Part One covers the basic principles and prime applications of quantum mechanics, from the uncertainty relations to many-body systems. Part Two introduces to relativistic quantum field theory and ranges from symmetries in quantum physics to electroweak interactions. Numerous worked-out examples as well as exercises, with solutions or hints, enables the book’s use as an accompanying text for courses, and also for independent study. For both parts, the necessary mathematical framework is treated in adequate form and detail. The book ends with appendices covering mathematical fundamentals and enrichment topics, plus selected biographical notes on pioneers of quantum mechanics and quantum field theory. The new edition was thoroughly revised and now includes new sections on quantization using the path integral method and on deriving generalized path integrals for bosonic and fermionic fields.

Strongly Coupled Field Theories for Condensed Matter and Quantum Information Theory - Alvaro Ferraz 2020-02-29

This book presents a selection of advanced lectures from leading researchers, providing recent theoretical results on strongly coupled quantum field theories. It also analyzes their use for describing new quantum states, which are physically realizable in condensed matter, cold-atomic systems, as well as artificial materials. It particularly focuses on the engineering of these states in quantum devices and novel materials useful for quantum information processing. The book offers graduate students and young researchers in the field of modern condensed matter theory an updated review of the most relevant theoretical methods used in strongly coupled field theory and string theory. It also provides the tools for understanding their relevance in describing the emergence of new quantum states in a variety of physical settings. Specifically, this proceedings book summarizes new and previously unrelated developments in modern condensed matter physics, in particular: the interface of condensed matter theory and quantum information theory; the interface of condensed matter physics and the mathematics emerging from the classification of the topological phases of matter, such as topological insulators and topological superconductors; and the simulation of condensed matter systems with cold atoms in optical lattices.