Many Body Quantum Theory In Condensed Matter Physi

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Many Body Quantum Theory In Condensed Matter Physi ***2023-04-12***

WERNER BRAXTON

Relativistic Many-Body Theory and Statistical Mechanics Springer

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 of Light and Matter

Cambridge University Press

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

Fundamentals of Many-body Physics Springer Science & Business Media

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.

Physics and Mathematics of Quantum Many-Body Systems CRC Press

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

Quantum Many-Body Systems in One Dimension Cambridge University Press

This textbook is for a course in advanced solid-state theory. It is aimed at graduate students in their third or fourth year of study who wish to learn the advanced techniques of solid-state theoretical physics. The method of Green's functions is introduced at the beginning and used throughout. Indeed, it could be considered a book on practical applications of Green's functions, although I prefer to call it a book on physics. The method of Green's functions has been used by many theorists to derive equations which, when solved, provide an accurate numerical description of many processes in solids and quantum fluids. In this book I attempt to summarize many of these theories in order to show how Green's functions are used to solve real problems. My goal, in writing each section, is to describe calculations which can be compared with experiments and to provide these comparisons whenever available. The student is expected to have a background in quantum mechanics at the level acquired from a graduate course using the textbook by either L. I. Schiff, A. S. Davydov, or I. Landau and E. M. Lifshiftz. Similarly, a prior course in solid-state physics is expected, since the reader is assumed to know concepts such as Brillouin zones and energy band theory. Each chapter has problems which are an important part of the lesson; the problems often provide physical insights which are not in the text. Sometimes the answers to the problems are provided, but usually not.

Particles and Quantum Fields

Morgan & Claypool Publishers

Modern electronic devices and novel materials often derive their extraordinary properties from the intriguing, complex behavior of large numbers of electrons forming what is known as an electron liquid. This book provides an in-depth introduction to the physics of the interacting electron liquid in a broad variety of systems, including metals, semiconductors, artificial nano-structures, atoms and molecules. One, two and three dimensional systems are treated separately and in parallel. Different phases of the electron liquid, from the Landau Fermi liquid to the Wigner crystal, from the Luttinger liquid to the quantum Hall liquid are extensively discussed. Both static

and time-dependent density functional theory are presented in detail. Although the emphasis is on the development of the basic physical ideas and on a critical discussion of the most useful approximations, the formal derivation of the results is highly detailed and based on the simplest, most direct methods.
Quantum Theory of the Solid State Springer Science & Business Media
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. '
Quantum Many-Body Physics in Open Systems: Measurement and Strong Correlations Springer Science & Business

Media
This book explains the fundamental concepts and theoretical techniques used to understand the properties of quantum systems having large numbers of degrees of freedom. A number of complimentary approaches are developed, including perturbation theory; nonperturbative approximations based on functional integrals; general arguments based on order parameters, symmetry, and Fermi liquid theory; and stochastic methods.
Many-Body Quantum Theory in Condensed Matter Physics
Princeton University Press
This is an introductory book on elementary particles and their interactions. It starts out with many-body Schrödinger theory and second quantization and leads, via its generalization, to relativistic fields of various spins and to gravity. The text begins with the best known quantum field theory so far, the quantum electrodynamics of photon and electrons (QED). It continues by developing the theory of strong interactions between the elementary constituents of matter (quarks). This is possible due to the property called asymptotic freedom. On the way one has to tackle the problem of removing various infinities by renormalization. The divergent sums of infinitely many diagrams are

performed with the renormalization group or by variational perturbation theory (VPT). The latter is an outcome of the Feynman-Kleinert variational approach to path integrals discussed in two earlier books of the author, one representing a comprehensive treatise on path integrals, the other dealing with critial phenomena. Unlike ordinary perturbation theory, VPT produces uniformly convergent series which are valid from weak to strong couplings, where they describe critical phenomena. The present book develops the theory of effective actions which allow to treat quantum phenomena with classical formalism. For example, it derives the observed anomalous power laws of strongly interacting theories from an extremum of the action. Their fluctuations are not based on Gaussian distributions, as in the perturbative treatment of quantum field theories, or in asymptotically-free theories, but on deviations from the average which are much larger and which obey power-like distributions. Exactly solvable models are discussed and their physical properties are compared with those derived from general methods. In the last chapter we discuss the problem of quantizing the classical theory of gravity. Contents: FundamentalsField Formulation of Many-Body Quantum PhysicsInteracting

Nonrelativistic ParticlesFree Relativistic Particles and FieldsClassical RadiationRelativistic Particles and Fields in External Electromagnetic PotentialQuantization of Relativistic Free FieldsContinuous Symmetries and Conservation Laws. Noether's TheoremScattering and Decay of ParticlesQuantum Field Theoretic Perturbation TheoryExtracting Finite Results from Perturbation Series. Regularization, RenormalizationQuantum ElectrodynamicsFormal Properties of Perturbation TheoryFunctional-Integral Representation of Quantum Field TheorySystematic Graphical Construction of Feynman DiagramsSpontaneous Symmetry BreakdownScalar Quantum ElectrodynamicsExactly Solvable O(N)-Symmetric ϕ4-Theory for Large NNonlinear σ-ModelThe Renormalization GroupCritical Properties of Nonlinear σ-ModelFunctional-Integral Calculation of Effective Action. Loop ExpansionExactly Solvable O(N)-Symmetric Four-Fermion Theory in 2+ε Dimensions Internal Symmetries of Strong InteractionsSymmetries Linking Internal and Spacetime PropertiesHadronization of Quark TheoriesWeak InteractionsNonabelian Gauge Theory of Strong InteractionsCosmology with General Curvature-Dependent LagrangianEinstein Gravity from Fluctuating Conformal GravityPurely Geometric Part of Dark Matter Readership: Students and researchers in theoretical physics.

Quantum Theory of Many-Body Systems

Springer

This book offers a compact tutorial on basic concepts and tools in quantum many-body physics, and focuses on the correlation effects produced by mutual interactions. The content is divided into three parts, the first of which introduces readers to perturbation theory. It begins with the simplest examples—hydrogen and oxygen molecules—based on their effective Hamiltonians, and looks into basic properties of electrons in solids from the perspective of localized and itinerant limits. Readers will also learn about basic theoretical methods such as the linear response theory and Green functions. The second part focuses on mean-field theory for itinerant electrons, e.g. the Fermi liquid theory and superconductivity. Coulomb repulsion among electrons is addressed in the context of high-Tc superconductivity in cuprates and iron pnictides. A recent discovery concerning hydride superconductors is also briefly reviewed. In turn, the third part highlights quantum fluctuation effects beyond the mean-field picture. Discussing the dramatic renormalization effect in the Kondo physics, it provides a clear understanding of nonperturbative interaction effects. Further it introduces readers to fractionally charged quasi-particles in one and two dimensions. The last chapter addresses the dynamical mean field theory (DMFT). The book is based on the author’s long years of experience as a lecturer and researcher. It also includes reviews of recent focus topics in condensed matter physics, enabling readers to not only grasp conventional condensed matter theories but also to catch up on the latest developments in the field.

Quantum Theory of Many-Particle Systems
Springer Science & Business Media
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.
The Strange World of Quantum Mechanics
Springer Science & Business Media
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. The Quantum Theory of Motion Cambridge University Press This text presents a self-contained treatment of the physics of many-body systems from the point of view of condensed matter. The approach, quite traditionally, uses the mathematical formalism of quasiparticles and Green's functions. In particular, it covers all the important diagram techniques for normal and superconducting systems, including the zero-temperature perturbation theory and the Matsubara, Keldysh and Nambu-Gor'kov formalism, as well as an introduction to Feynman path integrals. This new edition contains an introduction to the methods of theory of one-dimensional systems (bosonization and conformal field theory) and their applications to many-body problems. Intended for graduate students in physics and related fields, the aim is not to be exhaustive, but to present enough detail to enable the student 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 their volume and which therefore provides an ideal testing ground for many-body theories.

Quantum Theory of Many-Body Systems
Cambridge University Press

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 Theory of the Electron Liquid

CRC Press

This book is an introduction to the techniques of many-body quantum theory with a large number of applications to condensed matter physics. The basic idea of the book is to provide a self-contained formulation of the theoretical framework without losing mathematical rigor, while at the same time providing physical motivation and examples. The examples are taken from applications in electron systems and transport theory. On the formal side, the book covers an introduction to second quantization, many-body Green's function, finite temperature Feynman diagrams and bosonization. The applications include traditional transport theory in bulk as well as mesoscopic systems, where both the Landau-Büttiker formalism and recent developments in correlated transport phenomena in mesoscopic systems and nano-structures are covered. Other topics include interacting electron gases, plasmons, electron-phonon interactions, superconductivity and a final chapter on one-dimensional systems where a detailed treatment of Luttinger liquid theory and bosonization techniques is given. Having grown out of a set of lecture notes, and containing many pedagogical exercises, this book is designed as a textbook for an advanced undergraduate or graduate course, and is also well suited for self-study.

Quantum Theory at the Crossroads CRC Press The 1927 Solvay conference was perhaps the most important in the history of quantum theory. Contrary to popular belief, questions of interpretation were not settled at this conference. Instead, a range of sharply conflicting views were extensively discussed, including de Broglie's pilot-wave theory (which de Broglie presented for a many-body system), Born and Heisenberg's 'quantum mechanics' (which apparently lacked wave function collapse or fundamental time evolution), and Schrödinger's wave mechanics. Today, there is no longer a dominant interpretation of quantum theory, so it is important to re-evaluate the historical sources and keep the debate open. This book contains a complete translation of the original proceedings, with essays on the three main interpretations presented, and a detailed analysis of the lectures and discussions in the light of current research. This book will be of interest to graduate students and researchers in physics and in the history and philosophy of quantum theory.

Atomic Many-Body Theory Cambridge University Press

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 Theory
Courier Corporation
An explanation of how quantum processes may be visualised without ambiguity, in terms of a simple physical model.

Mathematical Methods of Many-Body Quantum Field Theory
Cambridge University Press
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.

Many-Body Quantum Theory in Condensed Matter Physics

Oxford University Press

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.