

Graduate Texts in Physics

Alexandre Zagoskin

# Quantum Theory of Many-Body Systems

Techniques and Applications

*Second Edition*



Springer

# Quantum Mechanics Of Many Body Systems

**J. Maruani, Roland Lefebvre, Erkki J.  
Brändas**



## **Quantum Mechanics Of Many Body Systems:**

**Quantum Theory of Many-Body Systems** Alexandre Zagoskin, 2012-12-06 Intended for graduate students in physics and related fields this text is 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 formalisms The aim is not to be exhaustive but to present just 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 The book begins by introducing the Green s function for one particle systems using Feynman path integrals general perturbation theory and second quantization It then turns to the usual zero temperature formalism discussing the properties and physical meaning of the Green s function for many body systems and then developing the diagram techniques of perturbation theory The theory is extended to finite temperatures including a discussion of the Matsubara formalism as well as the Keldysh technique for essentially nonequilibrium systems The final chapter is devoted to applications of the techniques to superconductivity including discussions of the superconducting phase transition elementary excitations transport Andreev reflections and Josephson junctions Problems at the end of each chapter help to guide learning an to

**The Quantum Mechanics of Many-Body Systems** D. J. Thouless, 2013-10-22 The Quantum Mechanics of Many Body Systems provides an introduction to that field of theoretical physics known as many body theory It is concerned with problems that are common to nuclear physics atomic physics the electron theory of metals and to the theories of liquid helium three and four and it describes the methods which have recently been developed to solve such problems The aim has been to produce a unified account of the field rather than to describe all the parallel methods that have been developed as a result a number of important papers are not mentioned The main emphasis is on the theories of atomic nuclei the electron gas and liquid helium there is no discussion of molecular theory or of solid helium The reader is expected to be familiar with the principles of nonrelativistic quantum mechanics and of statistical mechanics but a knowledge of field theory and a detailed knowledge of nuclear and solid state physics are not assumed

**Many-body Theory Exposed! Propagator Description Of Quantum Mechanics In Many-body Systems (2nd Edition)** Willem Hendrik Dickhoff, Dimitri V Y Van Neck, 2008-05-02 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 Quantum Mechanics of Many-body Systems** D. J. Thouless, 1964      **Quantum Field Theory of Many-body Systems** Xiao-Gang Wen, 2004      **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

**Many-body Theory Exposed!** Willem Hendrik Dickhoff, 2008      **Many-Body Theory Exposed (3rd Ed)** Dimitri Van Neck Willem H Dickhoff, 2025-09-30      **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 physical 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 sufficiently detailed and self contained sometimes admittedly at the cost of a certain elegance to permit individual 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 of coupled quantum mechanical equations of motion Schrodinger equations which however 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

**Methods of Electronic Structure Theory** Henry F. Schaefer, 2013-06-29 These two volumes deal with the quantum theory of the electronic structure of molecules Implicit in the term *ab initio* is the notion that approximate solutions of Schrödinger's equation are sought from the beginning i.e. without recourse to experimental data From a more pragmatic viewpoint the distinguishing feature of *ab initio* theory is usually the fact that no approximations are involved in the evaluation of the required molecular integrals Consistent with current activity in the field the first of these two volumes contains chapters dealing with methods *per se* while the second concerns the application of these methods to problems of chemical interest In a sense the motivation for these volumes has been the spectacular recent success of *ab initio* theory in resolving important chemical questions However these applications have only become possible through the less visible but equally important efforts of those developing new theoretical and computational methods and models Henry F. Schaefer VII Contents Contents of Volume 4 XIX Chapter 1 Gaussian Basis Sets for Molecular Calculations Thom H. Dunning Jr and P. Jeffrey Hay 1 1 1 Slater Functions and the Hydrogen Molecule 1 1 2 Gaussian Functions and the Hydrogen Atom 3 2 Hartree Fock Calculations on the First Row Atoms 5 2 1 Valence States of the First Row Atoms 6 7 2 2 Rydberg States of the First Row Atoms 9 2 3

**Nuclear Science Abstracts**, 1974 [Advanced Topics in Theoretical Chemical Physics](#) J. Maruani, Roland Lefebvre, Erkki J. Brändas, 2013-11-27 [Advanced Topics in Theoretical Chemical Physics](#) is a collection of 20 selected papers from the scientific presentations of the Fourth Congress of the International Society for Theoretical Chemical Physics ISTCP held at Marly le Roi France in July 2002 [Advanced Topics in Theoretical Chemical Physics](#) encompasses a broad spectrum in which scientists place special emphasis on theoretical methods in chemistry and physics The chapters in the book are divided into five sections I Advances Chemical Thermodynamics II Electronic Structure of Molecular Systems III Molecular Interaction and Dynamics IV Condensed Matter V Playing with Numbers This book is an invaluable resource for all academics and researchers interested in theoretical quantum or statistical chemical physics or physical chemistry It presents a selection of some of the most advanced methods results and insights in this exciting area

*Air Force Research Resumés* ,     **AI for Physics** Volker Knecht, 2022-08-29 Written in accessible language without mathematical formulas this short book provides an overview of the wide and varied applications of artificial intelligence AI across the spectrum of physical sciences Focusing in particular on AI's ability to extract patterns from data known as machine learning ML the book includes a chapter on important machine learning algorithms and their respective applications in physics It then explores the use of ML across a number of important sub fields in more detail ranging from particle molecular and condensed matter physics to astrophysics cosmology and the theory of everything The book covers such applications as the search for new particles and the detection of gravitational waves from the merging of black holes and concludes by discussing what the future may hold     Perturbation Theory Giuseppe Gaeta, 2022-12-16 This volume in the Encyclopedia of Complexity and Systems Science Second Edition is devoted to the fundamentals of Perturbation Theory PT as well as key applications areas such as Classical and Quantum Mechanics Celestial Mechanics and Molecular Dynamics Less traditional fields of application such as Biological Evolution are also discussed Leading scientists in each area of the field provide a comprehensive picture of the landscape and the state of the art with the specific goal of combining mathematical rigor explicit computational methods and relevance to concrete applications New to this edition are chapters on Water Waves Rogue Waves Multiple Scales methods legged locomotion Condensed Matter among others while all other contributions have been revised and updated Coverage includes the theory of Poincare Birkhoff Normal Forms aspects of PT in specific mathematical settings Hamiltonian KAM theory Nekhoroshev theory and symmetric systems technical problems arising in PT with solutions convergence of series expansions diagrammatic methods parametric resonance systems with nilpotent real part PT for non smooth systems and on PT for PDEs write out this acronym partial differential equations Another group of papers is focused specifically on applications to Celestial Mechanics Quantum Mechanics and the related semiclassical PT Quantum Bifurcations Molecular Dynamics the so called choreographies in the N body problem as well as Evolutionary Theory Overall this unique volume serves to demonstrate the wide utility of PT while creating a foundation for innovations from a new generation of graduate students and professionals in Physics Mathematics Mechanics Engineering and the Biological Sciences     *Principles of the Theory of Solids* J. M. Ziman, 1979-11-29 Professor Ziman's classic textbook on the theory of solids was first published in 1964 This paperback edition is a reprint of the second edition which was substantially revised and enlarged in 1972 The value and popularity of this textbook is well attested by reviewers opinions and by the existence of several foreign language editions including German Italian Spanish Japanese Polish and Russian The book gives a clear exposition of the elements of the physics of perfect crystalline solids In discussing the principles the author aims to give students an appreciation of the conditions which are necessary for the appearance of the various phenomena A self contained mathematical account is given of the simplest model that will demonstrate each principle A grounding in quantum mechanics and knowledge of elementary facts about solids is assumed This is therefore a textbook for advanced

undergraduates and is also appropriate for graduate courses      Symmetries in Atomic Nuclei Alejandro Frank, Jan Jolie, Pieter Van Isacker, 2019-08-28 The revised edition of this established work presents an extended overview of recent applications of symmetry to the description of atomic nuclei including a pedagogical introduction to symmetry concepts using simple examples Following a historical overview of the applications of symmetry in nuclear physics attention turns to more recent progress in the field Special emphasis is placed on the introduction of neutron proton and boson fermion degrees of freedom Their combination leads to a supersymmetric description of pairs and quartets of nuclei Expanded and updated throughout the book now features separate chapters on the nuclear shell model and the interacting boson model the former including discussion of recent results on seniority in a single  $j$  shell Both theoretical aspects and experimental signatures of dynamical super symmetries are carefully discussed This book focuses on nuclear structure physics but its broad scope makes it suitable for final year or post graduate students and researchers interested in understanding the power and beauty of symmetry methods in physics Review of the 1st Edition The subject of this book symmetries in physical systems with particular focus on atomic nuclei is of the utmost importance in modern physical science In contrast to most treatments frequently characterized by fearsome formalism this book leads the reader step by step in an easily understandable way through this fascinating field this book is remarkably accessible to both theorists and experimentalists Indeed I view it as essential reading for experimental nuclear structure physicists This is one of the finest volumes on this subject I have ever encountered Prof R F Casten Yale University      **Spectral Theory and Mathematical Physics: A Festschrift in Honor of Barry Simon's 60th Birthday** Fritz Gesztesy, 2007 This Festschrift had its origins in a conference called SimonFest held at Caltech March 27-31 2006 to honor Barry Simon's 60th birthday It is not a proceedings volume in the usual sense since the emphasis of the majority of the contributions is on reviews of the state of the art of certain fields with particular focus on recent developments and open problems The bulk of the articles in this Festschrift are of the survey form and a few review Simon's contributions to a particular area Part 1 contains surveys in the areas of Quantum Field Theory Statistical Mechanics Nonrelativistic Two Body and  $N$  Body Quantum Systems Resonances Quantum Mechanics with Electric and Magnetic Fields and the Semiclassical Limit Part 2 contains surveys in the areas of Random and Ergodic Schrodinger Operators Singular Continuous Spectrum Orthogonal Polynomials and Inverse Spectral Theory In several cases this collection of surveys portrays both the history of a subject and its current state of the art A substantial part of the contributions to this Festschrift are survey articles on the state of the art of certain areas with special emphasis on open problems This will benefit graduate students as well as researchers who want to get a quick yet comprehensive introduction into an area covered in this volume

**An Assessment of Four Divisions of the Physical Measurement Laboratory at the National Institute of Standards and Technology** National Academies of Sciences, Engineering, and Medicine, Division on Engineering and Physical Sciences, Laboratory Assessments Board, Committee on NIST Technical Programs, Panel on Review of Four Divisions

of the Physical Measurement Laboratory at the National Institute of Standards and Technology, 2018-10-31 An Assessment of Four Divisions of the Physical Measurement Laboratory at the National Institute of Standards and Technology Fiscal Year 2018 assesses the scientific and technical work performed by four divisions of the National Institute of Standards and Technology NIST Physical Measurement Laboratory This publication reviews technical reports and technical program descriptions prepared by NIST staff and summarizes the findings of the authoring panel **Geometry, Mechanics, and Control in Action for the Falling Cat** Toshihiro Iwai, 2021-04-23 The falling cat is an interesting theme to pursue in which geometry mechanics and control are in action together As is well known cats can almost always land on their feet when tossed into the air in an upside down attitude If cats are not given a non vanishing angular momentum at an initial instant they cannot rotate during their motion and the motion they can make in the air is vibration only However cats accomplish a half turn without rotation when landing on their feet In order to solve this apparent mystery one needs to thoroughly understand rotations and vibrations The connection theory in differential geometry can provide rigorous definitions of rotation and vibration for many body systems Deformable bodies of cats are not easy to treat mechanically A feasible way to approach the question of the falling cat is to start with many body systems and then proceed to rigid bodies and further to jointed rigid bodies which can approximate the body of a cat In this book the connection theory is applied first to a many body system to show that vibrational motions of the many body system can result in rotations without performing rotational motions and then to the cat model consisting of jointed rigid bodies On the basis of this geometric setting mechanics of many body systems and of jointed rigid bodies must be set up In order to take into account the fact that cats can deform their bodies three torque inputs which may give a twist to the cat model are applied as control inputs under the condition of the vanishing angular momentum Then a control is designed according to the port controlled Hamiltonian method for the model cat to perform a half turn and to halt the motion upon landing The book also gives a brief review of control systems through simple examples to explain the role of control inputs



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