Interacting Electrons And Quantum Magnetism

The process of realizing the ground state of some typical (frustrated) quantum many-body systems, starting from the 'disordered' or excited states, can be formally mapped to the search of solutions for computationally hard problems. The dynamics through the critical point, in between, are therefore extremely crucial. In the context of such computational optimization problems, the dynamics (of rapid quenching or slow annealing), while tuning the appropriate elds or uctuations, in particular while crossing the quantum critical point, are extremely intriguing and are being investigated these days intensively. Several successful methods and tricks are now well established. This volume gives a collection of introductory reviews on such developments written by well-known experts. It concentrates on quantum phase transitions and their dynamics as the transition or critical points are crossed. Both the quenching and annealing dynamics are extensively covered. We hope these timely reviews will inspire the young researchers to join and c- tribute to this fast-growing, intellectually challenging, as well as technologically demanding eld. We are extremely thankful to the contributors for their intensive work and pleasant cooperations. We are also very much indebted to Kausik Das for his help in compiling this book. Finally, we express our gratitude to Johannes Zittartz, Series Editor, LNP, and Christian Caron of physics editorial department of Springer for their encouragement and support.

This thesis explores ultracold quantum gases of bosonic and fermionic atoms in optical lattices. The highly controllable experimental setting discussed in this work, has opened the door to new insights into static and dynamical properties of ultracold quantum matter. One of the highlights reported here is the development and application of a novel time-resolved spectroscopy technique for quantum many-body systems. By following the dynamical evolution of a many-body system after a quantum quench, the author shows how the important energy scales of the underlying Hamiltonian can be measured with high precision. This achievement, its application, and many other exciting results make this thesis of interest to a broad audience ranging from quantum optics to condensed matter physics. A lucid style of writing accompanied by a series of excellent figures make the work accessible to readers outside the rapidly growing research field of ultracold atoms.

Solid state physics continues to be the most rapidly growing subdiscipline in physics. As a result, entering graduate students wishing to pursue research in this field face the daunting task of not only mastering the old topics but also gaining competence in the problems of current interest, such as the fractional quantum Hall effect, strongly correlated electron systems, and quantum phase transitions. This book is written to serve the needs of such students. I have attempted in this book to present some of the standard topics in a way that makes it possible to move smoothly to current material. Hence, all the interesting topics are not presented at the end of the book. For example, immediately after the first 50 pages, Anderson's analysis of local magnetic moments is presented as an application of Hartree-Fock theory; this affords a discussion of the relationship with the Kondo model and how scaling ideas can be used to uncloak low-energy physics. As the key problems of current interest in solid state involve some aspects of electron-electron interactions or disorder or both, I have focused on the archetypal problems in which such physics is central. However, only those problems in which there is a consensus view are discussed extensively. In addition, I have placed the emphasis on physics rather than on techniques. Consequently, I focus on a clear presentation of the phenomenology along with a pedagogical derivation of the relevant equations. A key goal of the detailed derivations is to make it possible for the students who have read this book to immediately comprehend research papers on related topics. A key omission in this book is magnetism beyond the Stoner criterion and local magnetic moments. This omission has arisen primarily because the topic is adequately treated in the book by Assa

Auerbach.

An understanding of the effects of electronic correlations in quantum systems is one of the most challenging problems in physics, partly due to the relevance in modern high technology. Yet there exist hardly any books on the subject which try to give a comprehensive overview on the field covering insulators, semiconductors, as well as metals. The present book tries to fill that gap. It intends to provide graduate students and researchers a comprehensive survey of electron correlations, weak and strong, in insulators, semiconductors and metals. This topic is a central one in condensed matter and beyond that in theoretical physics. The reader will have a better understanding of the great progress which has been made in the field over the past few decades. Contents:IntroductionIndependent ElectronsHomogeneous Electron GasDensity Functional TheoryWavefunction-Based MethodsCorrelated Ground-State WavefunctionsQuasiparticle ExcitationsIncoherent ExcitationsCoherent-Potential ApproximationsStrongly Correlated ElectronsTransition MetalsTransition-Metal OxidesHeavy QuasiparticlesExcitations with Fractional ChargesSuperconductivity Readership: Graduate students and researchers in condensed matter physics. Keywords:Electron Correlations;Many-body Theory;Quasi-Particles;Fractional Charges;Superconductivity;Many-Body WavefunctionsKey Features:Besides approaches based on Density Functional Theory, the importance of many-body wavefunction and projection methods is emphasizedConsiderable space is devoted to systems with strong electron correlations evident in high-Tc superconducting cupratesTransition metals and their oxides are discussed as well as compounds with heavy quasiparticlesDifferent competing methods for describing correlation effects are presentedAt various places a connection to relevant experiments is madeReviews: “Peter Fulde's book is well suited as an introduction to the general field of correlated electron systems… For this purpose some elementary chapters are included. Finally, the book is hard work but also fun to read because of its personal style.” Prof. Dr. Joachim Keller Institut für Theoretische Physik Universität Regensburg “Written with great pedagogical skill, it will be of interest to both experts in the field and graduate students. The book presents a consistent description of a new branch of solid state physics — the theory of strongly correlated systems which cannot be treated by conventional approaches as the density functional theory being successful for many years in describing band structure of solids. In this respect it can be used as a textbook for a university course on this new and fascinating branch of solid state physics.” Professor Nikolay Pladika Joint Institute for Nuclear Research “Peter Fulde provides an excellent introduction to this field. This book provides a very careful treatment of an extraordinarily wide range of topics, and is particularly strong on transition-metal oxides and heavy fermion systems. This carefully written book can be recommended to a very wide readership.” Contemporary Physics

An accessible overview of the concepts and tools essential to the physics of materials, with applications, exercises, and color figures.

In the excitement and rapid pace of developments, writing pedagogical texts has low priority for most researchers. However, in transforming my lecture l notes into this book, I found a personal benefit: the organization of what I understand in a (hopefully simple) logical sequence. Very little in this text is my original contribution. Most of the knowledge was collected from the research literature. Some was acquired by conversations with colleagues; a kind of physics oral tradition passed between disciples of a similar faith. For many years, diagramatic perturbation theory has been the major theoretical tool for treating interactions in metals, semiconductors, itiner ant magnets, and superconductors. It is in essence a weak coupling expan sion about free quasiparticles. Many experimental discoveries during the last decade, including heavy fermions, fractional quantum Hall effect, high temperature superconductivity, and quantum spin chains, are not readily accessible from the weak coupling point of view. Therefore, recent years have seen vigorous development of alternative,

nonperturbative tools for handling strong electron-electron interactions. I concentrate on two basic paradigms of strongly interacting (or con strained) quantum systems: the Hubbard model and the Heisenberg model. These models are vehicles for fundamental concepts, such as effective Ha miltonians, variational ground states, spontaneous symmetry breaking, and quantum disorder. In addition, they are used as test grounds for various nonperturbative approximation schemes that have found applications in diverse areas of theoretical physics.
We are all agreed that your theory is crazy. The question which divides us is whether it is crazy enough. Niels Bohr Superstring theory has emerged as the most promising candidate for a quan tum theory of all known interactions. Superstrings apparently solve a problem that has defied solution for the past 50 years, namely the unification of the two great fundamental physical theories of the century, quantum field theory and general relativity. Superstring theory introduces an entirely new physical picture into theoretical physics and a new mathematics that has startled even the mathematicians. Ironically, although superstring theory is supposed to provide a unified field theory of the universe, the theory itself often seems like a confused jumble offolklore, random rules of thumb, and intuition. This is because the develop ment of superstring theory has been unlike that of any other theory, such as general relativity, which began with a geometry and an action and later evolved into a quantum theory. Superstring theory, by contrast, has been evolving backward for the past 20 years. It has a bizarre history, beginning with the purely accidental discovery of the quantum theory in 1968 by G. Veneziano and M. Suzuki. Thumbing through old math books, they stumbled by chance on the Beta function, written down in the last century by mathematician Leonhard Euler.
"Solid-State Theory - An Introduction" is a textbook for graduate students of physics and material sciences. Whilst covering the traditional topics of older textbooks, it also takes up new developments in theoretical concepts and materials that are connected with such breakthroughs as the quantum-Hall effects, the high-Tc superconductors, and the low-dimensional systems realized in solids. Thus besides providing the fundamental concepts to describe the physics of the electrons and ions comprising the solid, including their interactions, the book casts a bridge to the experimental facts and gives the reader an excellent insight into current research fields. A compilation of problems makes the book especially valuable to both students and teachers.

Physics of Condensed Matter is designed for a two-semester graduate course on condensed matter physics for students in physics and materials science. While the book offers fundamental ideas and topic areas of condensed matter physics, it also includes many recent topics of interest on which graduate students may choose to do further research. The text can also be used as a one-semester course for advanced undergraduate majors in physics, materials science, solid state chemistry, and electrical engineering, because it offers a breadth of topics applicable to these majors. The book begins with a clear, coherent picture of simple models of solids and properties and progresses to more advanced properties and topics later in the book. It offers a comprehensive account of the modern topics in condensed matter physics by including introductory accounts of the areas of research in which intense research is underway. The book assumes a working knowledge of quantum mechanics, statistical mechanics, electricity and magnetism and Green's function formalism (for the second-semester curriculum). Covers many advanced topics and recent developments in condensed matter physics which are not included in other texts and are hot areas: Spintronics, Heavy fermions, Metallic nanoclusters, Zno, Graphene and graphene-based electronic, Quantum hall effect, High temperature superdonductivity, Nanotechnology Offers a diverse number of Experimental techniques clearly simplified Features end of chapter problems

Max, who is based on physicist James Clerk Maxwell's Demon, is from Tachyonia, a planet in the black hole at the center of the Milky Way. He's brainy, nerdy and has the ability to see atoms. Max is on a mission to Earth to help stop environmental calamity but to do so he must first learn earth physics. With the aid of time traveling, Max meets the physicists Count Rumford, Sadi Carnot, Ludvig Boltzman, and Richard Fenyman, who teach him about the 1st and 2nd Laws of Thermodynamics. Along the way there is romance, villainy and near catastrophe. Finally, the fate of the Earth comes down to Max's playing a game of high stakes roulette.

This first of a kind textbook provides computational tools in Fortran 90 that are fundamental to quantum information, quantum computing, linear algebra and one dimensional spin half condensed matter systems. Over 160 subroutines are included, and the numerical recipes are aided by detailed flowcharts. Suitable for beginner and advanced readers alike, students and researchers will find this textbook to be a helpful guide and a compendium. Key Features: Includes 160 subroutines all of which can be used either as a standalone program or integrated with any other main program without any issues. Every parameter in the input, output and execution has been provided while keeping both beginner and advanced users in mind. The output of every program is explained thoroughly with detailed examples. A detailed dependency chart is provided for every recipe.

Quantum field theory provides the theoretical backbone to most modern physics. This book is designed to bring quantum field theory to a wider audience of physicists. It is packed with worked examples, witty diagrams, and applications intended to introduce a new audience to this revolutionary theory.

Of interest to advanced students, this book focuses on Green's functions for obtaining simple and general solutions to basic problems in quantum physics. It demonstrates the unifying formalism of Green's functions across many applications, including transport properties, carbon nanotubes, and photonics and photonic crystals.

This thesis develops new techniques for simulating the low-energy behaviour of quantum spin systems in one and two dimensions. Combining these developments, it subsequently uses the formalism of tensor network states to derive an effective particle description for one- and two-dimensional spin systems that exhibit strong quantum correlations. These techniques arise from the combination of two themes in many-particle physics: (i) the concept of quasiparticles as the effective low-energy degrees of freedom in a condensed-matter system, and (ii) entanglement as the characteristic feature for describing quantum phases of matter. Whereas the former gave rise to the use of effective field theories for understanding many-particle systems, the latter led to the development of tensor network states as a description of the entanglement distribution in quantum low-energy states.

This bookis based on some of the lectures duringthe Paci?c Institute of Theoretical Physics (PITP) summer school on “Quantum Magnetism”, held during June 2006 in Les Houches, in the French Alps. The school was funded jointly by NATO, the CNRS, and PITP, and entirely organized by PITP. Magnetism is a somewhat peculiar research ?eld. It clearly has a quant-mechanical basis – the microscopic exchange interactions arise entirely from the exclusion principle, in conjunction with repulsive interactions between electrons. And yet until recently the vast majority of magnetism researchersand users of m-netic phenomena around the world paid no attention to these quantum-mechanical roots. Thus, e.g., the huge ($400 billion per annum) industry which manufactures hard discs, and other components in the information technology sector, depends entirely on room-temperature properties of magnets – yet at the macroscopic or mesoscopic scales of interest to this industry, room-temperature magnets behave entirely classically.

'a superb introduction to this fascinating field.' Physics Today

Now updated—the leading single-volume introduction to solid state and soft condensed matter physics This Second Edition of the unified treatment of condensed matter physics keeps the best of the first, providing a basic foundation in the subject while addressing many recent discoveries. Comprehensive and authoritative, it consolidates the critical advances of the past fifty years, bringing together an exciting collection of new and classic topics, dozens of new figures, and new experimental data. This updated edition offers a thorough treatment of such basic topics as band theory, transport theory, and semiconductor physics, as well as more modern areas such as quasicrystals, dynamics of phase separation, granular materials, quantum dots, Berry phases, the quantum Hall effect, and Luttinger liquids. In addition to careful study of electron dynamics, electronics, and superconductivity, there is much material drawn from soft matter physics, including liquid crystals, polymers, and fluid dynamics. Provides frequent comparison of theory and experiment, both when they agree and when problems are still unsolved Incorporates many new images from experiments Provides end-of-chapter problems including computational exercises Includes more than fifty data tables and a detailed forty-page index Offers a solutions manual for instructors Featuring 370 figures and more than 1,000 recent and historically significant references, this volume serves as a valuable resource for graduate and undergraduate students in physics, physics professionals, engineers, applied mathematicians, materials scientists, and researchers in other fields who want to learn about the quantum and atomic underpinnings of materials science from a modern point of view.

The exciting field of nanostructured materials offers many challenging perspectives for fundamental research and technological applications. The combination of quantum mechanics, interaction, phase coherence, and magnetism are important for understanding many physical phenomena in these systems. This book provides an overview of many aspects of interacting electrons in nanostructures, including such interesting topics as quantum dots, quantum wires, molecular electronics, dephasing, spintronics, and nanomechanics. The content reflects the current research in this area and is written by leading experts in the field.

Quantum tunneling is an essential issue in quantum physics. Especially, the rapid development of nanotechnology in recent years promises a lot of applications in condensed matter physics, surface science and nanodevices, which are growing interests in fundamental issues, computational techniques and potential applications of quantum tunneling. The book involves two relevant topics. One is quantum tunneling theory in condensed matter physics, including the basic concepts and methods, especially for recent developments in mesoscopic physics and computational formulation. The second part is the field electron emission theory, which covers the basic field emission concepts, the Fowler Nordheim theory, and recent developments of the field emission theory especially in some fundamental concepts and computational formulation, such as quantum confinement effects, Dirac fermion, Luttinger liquid, carbon nanotubes, coherent emission current, quantum tunneling time problem, spin polarized field electron emission and non-equilibrium Green's function method for field electron emission. This book presents in both academic and pedagogical styles, and is as possible as self-complete to make it suitable for researchers and graduate students in condensed matter physics and vacuum nanoelectronics. Contents: Introduction"Quantum Tunneling Theory: "Quantum Physics and Quantum FormalismBasic Physics of Quantum Scattering and TunnelingWave Function Matching MethodWKB MethodLippmann-Schwinger FormalismNon-Equilibrium Green's Function MethodSpin TunnelingApplications"Field Electron Emission Theory: "IntroductionTheoretical Model and MethodologyFowler-Nordheim TheoryField Emission from SemiconductorsSurface Effects and ResonanceThermionic Emission TheoryTheory of Dynamical Field EmissionTheory of Spin Polarized Field EmissionTheory of Field Electron Emission from NanomaterialsComputer Simulations of Field EmissionThe Empirical Theory of Field EmissionFundamental Physics of Field Electron Emission Readership: Graduate students and researchers in vacuum nanoelectronics and physics. "

This thesis investigates ultracold molecules as a resource for novel quantum many-body physics, in particular by utilizing their rich internal structure and strong, long-range dipole-dipole interactions. In addition, numerical methods based on matrix product states are analyzed in detail, and general algorithms for investigating the static and dynamic properties of essentially arbitrary one-dimensional quantum many-body systems are put forth. Finally, this thesis covers open-source implementations of matrix product state algorithms, as well as educational material designed to aid in the use of understanding such methods.

Comprehensive and accessible coverage from the basics to advanced topics in modern quantum condensed matter physics.

Recent progress in the theory and computation of electronic structure is bringing an unprecedented level of capability for research. Many-body methods are becoming essential tools vital for quantitative calculations and understanding materials phenomena in physics, chemistry, materials science and other fields. This book provides a unified exposition of the most-used tools: many-body perturbation theory, dynamical mean field theory and quantum Monte Carlo simulations. Each topic is introduced with a less technical overview for a broad readership, followed by in-depth descriptions and mathematical formulation. Practical guidelines, illustrations and exercises are chosen to enable readers to appreciate the complementary approaches, their relationships, and the advantages and disadvantages of each method. This book is designed for graduate students and researchers who want to use and understand these advanced computational tools, get a broad overview, and acquire a basis for participating in new developments.

Aimed at graduate students and researchers, this book covers the key aspects of the modern quantum theory of solids, including up-to-date ideas such as quantum fluctuations and strong electron correlations. It presents in the main concepts of the modern quantum theory of solids, as well as a general description of the essential theoretical methods required when working with these systems. Diverse topics such as general theory of phase transitions, harmonic and anharmonic lattices, Bose condensation and superfluidity, modern aspects of magnetism including resonating valence bonds, electrons in metals, and strong electron correlations are treated using unifying concepts of order and elementary excitations. The main theoretical tools used to treat these problems are introduced and explained in a simple way, and their applications are demonstrated through concrete examples.

Based on an established course, this comprehensive textbook on advanced quantum condensed matter physics covers one-body, many-body and topological perspectives. Discussing modern topics and containing end-of-chapter exercises throughout, it is ideal for graduate students studying advanced condensed matter physics.

This highly interdisciplinary thesis covers a wide range of topics relating to the interface of cold atoms, quantum simulation, quantum magnetism and disorder. With a self-contained presentation, it provides a broad overview of the rapidly evolving area of cold atoms and is of interest to both undergraduates and researchers working in the field. Starting with a general introduction to the physics of cold atoms and optical lattices, it extends the theory to that of systems with different multispecies atoms. It advances the theory of many-body quantum systems in excited bands (of optical lattices) through an extensive study of the properties of both the mean-field and strongly correlated regimes. Particular emphasis is given to the context of quantum simulation, where as shown here, the orbital degree of freedom in excited bands allows the study of exotic models of magnetism not easily achievable with the previous alternative systems. In addition, it proposes a new model Hamiltonian that serves as a quantum simulator of various disordered systems in different symmetry classes that can easily be reproduced experimentally. This is of great interest, especially for the study of disorder in 2D quantum systems.

Introduces students to the key research topics within modern solid state physics with the minimum of mathematics.

The superb book describes the modern theory of the magnetic properties of solids. Starting from fundamental principles, this copiously illustrated volume outlines the theory of magnetic behaviour, describes experimental techniques, and discusses current research topics. The book is intended for final year undergraduate students and graduate students in the physical sciences.

Magnetism is one of the oldest and most fundamental problems of Solid State

Physics although not being fully understood up to now. On the other hand it is one of the hottest topics of current research. Practically all branches of modern technological developments are based on ferromagnetism, especially what concerns information technology. The book, written in a tutorial style, starts from the fundamental features of atomic magnetism, discusses the essentially single-particle problems of dia- and paramagnetism, in order to provide the basis for the exclusively interesting collective magnetism (ferro, ferri, antiferro). Several types of exchange interactions, which take care under certain preconditions for a collective ordering of localized or itinerant permanent magnetic moments, are worked out. Under which conditions these exchange interactions are able to provoke a collective moment ordering for finite temperatures is investigated within a series of theoretical models, each of them considered for a very special class of magnetic materials. The book is written in a tutorial style appropriate for those who want to learn magnetism and eventually to do research work in this field. Numerous exercises with full solutions for testing own attempts will help to a deep understanding of the main aspects of collective ferromagnetism.

An understanding of the quantum mechanical nature of magnetism has led to the development of new magnetic materials which are used as permanent magnets, sensors, and information storage. Behind these practical applications lie a range of fundamental ideas, including symmetry breaking, order parameters, excitations, frustration, and reduced dimensionality. This superb new textbook presents a logical account of these ideas, staring from basic concepts in electromagnetsim and quantum mechanics. It outlines the origin of magnetic moments in atoms and how these moments can be affected by their local environment inside a crystal. The different types of interactions which can be present between magnetic moments are described. The final chapters of the book are devoted to the magnetic properties of metals, and to the complex behaviour which can occur when competing magnetic interactions are present and/or the system has a reduced dimensionality. Throughout the text, the theorectical principles are applied to real systems. There is substantial discussion of experimental techniques and current reserach topics. The book is copiously illustrated and contains detailed appendices which cover the fundamental principles.

Closing a gap in the literature, this volume is intended both as an introductory text at postgraduate level and as a modern, comprehensive reference for researchers in the field. Provides a full working description of the main fundamental tools in the theorists toolbox which have proven themselves on the field of quantum magnetism in recent years. Concludes by focusing on the most important cuurent materials form an experimental viewpoint, thus linking back to the initial theoretical concepts.

This book provides an attempt to convey the colorful facets of condensed matter systems with reduced dimensionality. Some of the specific features predicted for interacting one-dimensional electron systems, such as charge- and spin-density waves, have been observed in many quasi-one-dimensional materials. The two-dimensional world is even richer: besides d-wave superconductivity and the Quantum Hall Effect - perhaps the most spectacular phases explored during the last two decades - many collective charge and spin states have captured the interest of researchers, such as charge stripes or spontaneously generated circulating currents. Recent years have witnessed important progress in material preparation, measurement techniques and theoretical methods. Today larger and better samples, higher flux for neutron beams, advanced light sources, better resolution in electron spectroscopy, new computational algorithms, and the development of field-theoretical approaches allow an in-depth analysis of the complex many-body behaviour of low-dimensional materials. The epoch when simple mean-field arguments were sufficient for describing the gross features observed experimentally is definitely over. The Editors' aim is to thoroughly explain a number of selected topics: the application of dynamical probes, such as neutron scattering, optical absorption and photoemission, as well as transport studies, both electrical and thermal. Some of the more theoretical chapters are directly relevant for experiments, such as optical spectroscopy, transport in one-dimensional models, and the phenomenology of charge inhomogeneities in layered materials, while others discuss more general topics and methods, for example the concept of a Luttinger liquid and bosonization, or duality transformations, both promising tools for treating strongly interacting many-body systems.

This primer thoroughly covers the fundamentals needed to understand the interaction of light with magnetically ordered matter and it focuses on "cavity optomagnonics" which is a topic undergoing intense study in current research.The book is unique in combining elements of electromagnetism, quantum magnetism, and quantum optics and it is intended for advanced undergraduate or graduate students.

In this book the author extends the concepts introduced in his Quantum Field Theory in Condensed Matter Physics to situations in which the strong electronic correlations are crucial for the understanding of the observed phenomena. Starting from a model field theory to illustrate the basic ideas, more complex systems are analyzed in turn. A special chapter is devoted to the description of antiferromagnets, doped Mott insulators, and quantum Hall liquids from the point of view of gauge theory.

The topic of lattice quantum spin systems is a fascinating and by now well established branch of theoretical physics. Based on a set of lectures, this book has a level of detail missing from others, and guides the reader through the fundamentals of the field.

Solid State Physics emphasizes a few fundamental principles and extracts from them a wealth of information. This approach also unifies an enormous and diverse subject which seems to consist of too many disjoint pieces. The book starts with the absolutely minimum of formal tools, emphasizes the basic principles, and employs physical reasoning (" a little thinking and imagination" to quote R. Feynman) to obtain results. Continuous comparison with experimental data leads naturally to a gradual refinement of the concepts and to more sophisticated methods. After the initial overview with an

emphasis on the physical concepts and the derivation of results by dimensional analysis, The Physics of Solids deals with the Jellium Model (JM) and the Linear Combination of Atomic Orbitals (LCAO) approaches to solids and introduces the basic concepts and information regarding metals and semiconductors.
Exercises after each chapter
Readership: Graduate students and researchers in condensed matter physics.
This volume attempts to fill the gap between standard introductions to solid state physics, and textbooks which give a sophisticated treatment of strongly correlated systems. Starting with the basics of the microscopic theory of magnetism, one proceeds with relatively elementary arguments to such topics of current interest as the Mott transition, heavy fermions, and quantum magnetism. The basic approach is that magnetism is one of the manifestations of electron–electron interaction, and its treatment should be part of a general discussion of electron correlation effects. Though the text is primarily theoretical, a large number of illustrative examples are brought from the experimental literature. There are many problems, with detailed solutions. The book is based on the material of lectures given at the Diploma Course of the International Center for Theoretical Physics, Trieste, and later at the Technical University and the R. Eötvös University of Budapest, Hungary. Contents:Atoms, Ions, and MoleculesCrystal Field TheoryMott Transition and Hubbard ModelMott InsulatorsHeinsenberg MagnetsItinerant Electron MagnetismFerromagnetism in Hubbard ModelsThe Gutzwiller Variational MethodThe Correlated Metallic StateMixed Valence and Heavy FermionsQuantum Hall EffectHydrogen AtomSingle-Spin-Flip AnsatzGutzwiller ApproximationSchrieffer–Wolff Transformation Readership: Graduate students and researchers in condensed matter physics. keywords:Mott Transition;Quantum Magnetism;Orbital Order;Quadrupolar and Multipolar Order;Ferromagnetism;Mixed Valence;Mott Insulators;Correlated Metal;Fâ€"Electron and Dâ€"Electron Systems;Pedagogical Introduction to Electron Correlation