

Problems Of Condensed Matter Physics Quantum Coherence Phenomena In Electron Hole And Coupled Matter Light Systems International Series Of Monographs On Physics

This book is dedicated to Professor Leonid V Keldysh. His brilliant contributions to condensed matter physics include the Franz-Keldysh effect, an electron-hole liquid, the nonequilibrium (Keldysh) diagram technique, Bose-Einstein condensation (of excitons) and a "metal-dielectric" transition, acoustically-induced superlattices, multi-photon transitions and impact ionization in solids. In many respects, his work influenced and formed the paradigm of modern condensed matter physics. As a result, many famous researchers in the field have enthusiastically provided unique contributions to the book.

An introduction to the area of condensed matter in a nutshell. This textbook covers the standard topics, including crystal structures, energy bands, phonons, optical properties, ferroelectricity, superconductivity, and magnetism.

In this revised and expanded edition, in addition to a comprehensible introduction to the theoretical foundations of quantum tunneling based on different methods of formulating and solving tunneling problems, different semiclassical approximations for multidimensional systems are presented. Particular attention is given to the tunneling of composite systems, with examples taken from molecular tunneling and also from nuclear reactions. The interesting and puzzling features of tunneling times are given extensive coverage, and the possibility of measurement of these times with quantum clocks are critically examined. In addition, by considering the analogy between evanescent waves in waveguides and in quantum tunneling, the times related to electromagnetic wave propagation have been used to explain certain aspects of quantum tunneling times. These topics are treated in both non-relativistic as well as relativistic regimes. Finally, a large number of examples of tunneling in atomic, molecular, condensed matter and nuclear physics are presented and solved. Contents: A Brief History of Quantum Tunneling Some Basic Questions Concerning Quantum Tunneling Simple Solvable Problems Time-Dependence of the Wave Function in One-Dimensional

Tunneling Semiclassical Approximations Generalization of the Bohr-Sommerfeld Quantization Rule and Its Application to Quantum Tunneling Gamow's Theory, Complex Eigenvalues, and the Wave Function of a Decaying State Tunneling in Symmetric and Asymmetric Local Potentials and Tunneling in Nonlocal and Quasi-Solvable Barriers Classical Descriptions of Quantum Tunneling Tunneling in Time-Dependent Barriers Decay Width and the Scattering Theory The Method of Variable Reflection Amplitude Applied to Solve Multichannel Tunneling Problems Path Integral and Its Semi-Classical Approximation in Quantum Tunneling Heisenberg's Equations of Motion for Tunneling Wigner Distribution Function in Quantum Tunneling Decay Widths of Siegert States, Complex Scaling and Dilatation Transformation Multidimensional Quantum Tunneling Group and Signal Velocities Time-Delay, Reflection Time Operator and Minimum Tunneling Time More About Tunneling Time Tunneling of a System with Internal Degrees of Freedom Motion of a Particle in a Waveguide with Variable Cross Section and in a Space Bounded by a Dumbbell-Shaped Object Relativistic Formulation of Quantum Tunneling Inverse Problems of Quantum Tunneling Some Examples of Quantum Tunneling in Atomic and Molecular Physics Some Examples in Condensed Matter Physics Alpha Decay Readership: Graduate students and researchers in theoretical, mathematical, condensed matter and nuclear physics, as well as theoretical chemistry. Keywords: Quantum Tunneling; Quantum Clocks; Electromagnetic Wave Propagation; Semiclassical Approximations

This book introduces aspects of topology and applications to problems in condensed matter physics. Basic topics in mathematics have been introduced in a form accessible to physicists, and the use of topology in quantum, statistical and solid state physics has been developed with an emphasis on pedagogy. The aim is to bridge the language barrier between physics and mathematics, as well as the different specializations in physics. Pitched at the level of a graduate student of physics, this book does not assume any additional knowledge of mathematics or physics. It is therefore suited for advanced postgraduate students as well. A collection of selected problems will help the reader learn the topics on one's own, and the broad range of topics covered will make the text a valuable resource for practising researchers in the field. The book consists of two parts: one corresponds to developing the necessary mathematics and the other discusses applications to physical problems. The section on mathematics is a quick, but more-or-less complete, review of topology. The focus is on explaining fundamental concepts rather than dwelling on details of proofs while retaining the mathematical flavour. There is an overview chapter at the beginning and a recapitulation chapter on group theory. The physics section starts with an introduction and then goes on to topics in quantum mechanics, statistical mechanics of polymers, knots, and vertex models, solid state physics, exotic excitations such as Dirac quasiparticles, Majorana modes, Abelian and non-Abelian anyons. Quantum spin liquids and quantum information-processing are also covered in some detail.

Solid state physics, the study of the physical properties of solid matter, was the most populous subfield of Cold War American physics. Despite prolific contributions to consumer and medical technology, such as the transistor and magnetic resonance imaging, it garnered less professional prestige and public attention than nuclear and particle physics. *Solid State Insurrection* argues that solid state physics was essential to securing the vast social, political, and financial capital Cold War physics enjoyed in the twentieth century. Solid state's technological bent, and its challenge to the "pure science" ideal many physicists cherished, helped physics as a whole respond more readily to Cold War social, political, and economic pressures. Its research kept physics economically and technologically relevant, sustaining its cultural standing and policy influence long after the sheen of the Manhattan Project had faded. With this book, Joseph D. Martin brings a new perspective to some of the most enduring questions about the role of physics in American history.

The discovery of a duality between Anti-de Sitter spaces (AdS) and Conformal Field Theories (CFT) has led to major advances in our understanding of quantum field theory and quantum gravity. String theory methods and AdS/CFT correspondence maps provide new ways to think about difficult condensed matter problems. String theory methods based on the AdS/CFT correspondence allow us to transform problems so they have weak interactions and can be solved more easily. They can also help map problems to different descriptions, for instance mapping the description of a fluid using the Navier-Stokes equations to the description of an event horizon of a black hole using Einstein's equations. This textbook covers the applications of string theory methods and the mathematics of AdS/CFT to areas of condensed matter physics. Bridging the gap between string theory and condensed matter, this is a valuable textbook for students and researchers in both fields.

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

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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 superconductivity, Nanotechnology Offers a diverse number of Experimental techniques clearly simplified Features end of chapter problems

The development of transistors, the integrated circuit, liquid-crystal displays, and even DVD players can be traced back to fundamental research pioneered in the field of condensed-matter and materials physics (CMPP). The United States has been a leader in the field, but that status is now in jeopardy. Condensed-Matter and Materials Physics, part of the Physics 2010 decadal survey project, assesses the present state of the field in the United States, examines possible directions for the 21st century, offers a set of scientific challenges for American researchers to tackle, and makes recommendations for effective spending of federal funds. This book maintains that the field of CMPP is certain to be principle to both scientific and economic advances over the next decade and the lack of an achievable plan would leave the United States behind. This book's discussion of the intellectual and technological challenges of the coming decade centers around six grand challenges concerning energy demand, the physics of life, information technology, nanotechnology, complex phenomena, and behavior far from equilibrium. Policy makers, university administrators, industry research and development executives dependent upon developments in CMPP, and scientists working in the field will find this book of interest.

An introduction to the application of Feynman diagram techniques for researchers and advanced undergraduate students in condensed matter theory and many-body physics.

This book identifies opportunities, priorities, and challenges for the field of condensed-matter and materials physics. It highlights exciting recent scientific and technological developments and their societal impact and identifies outstanding questions for future research. Topics range from the science of modern technology to new materials and structures, novel quantum phenomena, nonequilibrium physics, soft condensed matter, and new experimental and computational tools. The book also addresses structural challenges for the field, including nurturing its intellectual vitality, maintaining a healthy mixture of large and small research facilities, improving the field's integration with other disciplines, and developing new ways for scientists in academia, government laboratories, and industry to work together. It will be of interest to scientists, educators, students, and policymakers.

Publisher Description

Problems of Condensed Matter Physics Quantum Coherence Phenomena in Electron-hole and Coupled Matter-light Systems Oxford University Press

Soft matter (polymers, colloids, surfactants, liquid crystals) are an important class of materials for modern and future technologies. They are complex materials that behave neither like a fluid nor a solid. This book describes the characteristics of such materials and how we can understand such characteristics in the language of physics.

Presenting the physics of the most challenging problems in condensed matter using the conceptual framework of quantum field theory, this book is of great interest to physicists in condensed matter and high energy and string theorists, as well as mathematicians. Revised and updated, this second edition features new chapters on the renormalization group, the Luttinger liquid, gauge theory, topological fluids, topological insulators and quantum entanglement. The book begins with the basic concepts and tools, developing them gradually to bring readers to the issues currently faced at the frontiers of research, such as topological phases of matter, quantum and classical critical phenomena, quantum Hall effects and superconductors. Other topics covered include one-dimensional strongly correlated systems, quantum ordered and disordered phases, topological structures in condensed matter and in field theory and fractional statistics.

This graduate-level textbook is the first pedagogical synthesis of the field of topological insulators and superconductors, one of the most exciting areas of research in condensed matter physics. Presenting the latest developments, while providing all the calculations necessary for a self-contained and complete description of the discipline, it is ideal for graduate students and researchers preparing to work in this area, and it will be an essential reference both within and outside the classroom. The book begins with simple concepts such as Berry phases, Dirac fermions, Hall conductance and its link to topology, and the Hofstadter problem of lattice electrons in a magnetic field. It moves on to explain topological phases of matter such as Chern insulators, two- and three-dimensional topological insulators, and Majorana p-wave wires. Additionally, the book covers zero modes on vortices in topological superconductors, time-reversal topological superconductors, and topological responses/field theory and topological indices. The book also analyzes recent topics in condensed matter theory and concludes by surveying active subfields of research such as insulators with point-group symmetries and the stability of topological semimetals. Problems at the end of each chapter offer opportunities to test knowledge and engage with frontier research issues. Topological Insulators and Topological Superconductors will provide graduate students and researchers with the physical understanding and mathematical tools needed to embark on research in this rapidly evolving field.

Much progress has been made in the understanding of the general properties of the dielectric function and in the calculation of this quantity for many classes of media. This volume gathers together the considerable information available and presents a detailed overview of the present status of the theory of electromagnetic response functions, whilst simultaneously covering a wide range of problems in its application to condensed matter physics. The following subjects are covered: - the dielectric function of the homogeneous electron gas, of crystalline systems, and of inhomogeneous matter; - electromagnetic fluctuations and molecular forces in condensed matter; - electrodynamics of superlattices.

On February 2, 2015 the Offices of High Energy Physics (HEP) and Basic Energy Sciences (BES) convened a Round Table discussion among a group of physicists on 'Common Problems in Condensed Matter and High Energy Physics'. This was motivated by the realization that both fields deal with quantum many body problems, share many of the same challenges, use quantum field theoretical approaches and have productively interacted in the past. The meeting brought together physicists with intersecting interests to explore recent developments

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and identify possible areas of collaboration ... Several topics were identified as offering great opportunity for discovery and advancement in both condensed matter physics and particle physics research. These included topological phases of matter, the use of entanglement as a tool to study nontrivial quantum systems in condensed matter and gravity, the gauge-gravity duality, non-Fermi liquids, the interplay of transport and anomalies, and strongly interacting disordered systems. Many of the condensed matter problems are realizable in laboratory experiments, where new methods beyond the usual quasi-particle approximation are needed to explain the observed exotic and anomalous results. Tools and techniques such as lattice gauge theories, numerical simulations of many-body systems, and tensor networks are seen as valuable to both communities and will likely benefit from collaborative development.

When does physics depart the realm of testable hypothesis and come to resemble theology? Peter Woit argues that string theory isn't just going in the wrong direction, it's not even science. Not Even Wrong shows that what many physicists call superstring "theory" is not a theory at all. It makes no predictions, not even wrong ones, and this very lack of falsifiability is what has allowed the subject to survive and flourish. Peter Woit explains why the mathematical conditions for progress in physics are entirely absent from superstring theory today, offering the other side of the story.

Is the universe infinite, or does it have an edge beyond which there is, quite literally, nothing? Do we live in the only possible universe? Why does it have one time and three space dimensions - or does it? What is it made of? What does it mean when we hear that a new particle has been discovered? Will quantum mechanics eventually break down and give way to a totally new description of the world, one whose features we cannot even begin to imagine? This book aims to give the non-specialist reader a general overview of what physicists think they do and do not know in some representative frontier areas of contemporary physics. After sketching out the historical background, A. J. Leggett goes on to discuss the current situation and some of the open problems of cosmology, high-energy physics, and condensed-matter physics. Unlike most other accounts, this book focuses not so much on recent achievements as on the fundamental problems at the heart of the subject, and emphasizes the provisional nature of our present understanding of things.

The application of field theoretic techniques to problems in condensed matter physics has generated an array of concepts and mathematical techniques to attack a range of problems such as the theory of quantum phase transitions, the quantum Hall effect, and quantum wires. While concepts such as the renormalization group, topology, and bosonization h

In the last years there have been great advances in the applications of topology and differential geometry to problems in condensed matter physics. Concepts drawn from topology and geometry have become essential to the understanding of several phenomena in the area.

Physicists have been creative in producing models for actual physical phenomena which realize mathematically exotic concepts and new phases have been discovered in condensed matter in which topology plays a leading role. An important classification paradigm is the concept of topological order, where the state characterizing a system does not break any symmetry, but it defines a topological phase in the sense that certain fundamental properties change only when the system passes through a quantum phase transition. The main purpose of this book is to provide a brief, self-contained introduction to some mathematical ideas and methods from differential geometry and topology, and to show a few applications in condensed matter. It conveys to physicists the basis for many mathematical concepts, avoiding the detailed formality of most textbooks.

Explore a comprehensive, one-stop reference on biological soft matter written and edited by leading voices in the field Biological Soft Matter: Fundamentals, Properties and Applications delivers a unique and indispensable compilation of up-to-date knowledge and material on biological soft matter. The book presents a thorough overview about biological soft matter, beginning with different substance classes, including proteins, nucleic acids, lipids, and polysaccharides. It goes on to describe a variety of superstructures and aggregated and how they are formed by self-assembly processes like protein folding or crystallization. The distinguished editors have included materials with a special emphasis on macromolecular assembly, including how it applies to lipid membranes, DNA condensation, and DNA fibrillization. Biological Soft Matter is a crucial resource for anyone working in the field, compiling information about all important substance classes and their respective roles in forming superstructures. The book is ideal for beginners and experts alike and makes the perfect guide for chemists, physicists, and life scientists with an interest in the area. Readers will also benefit from the inclusion of: An introduction to DNA nano-engineering and DNA-driven nanoparticle assembly Explorations of polysaccharides and glycoproteins, engineered biopolymers, and engineered hydrogels Discussions of macromolecular assemblies, including liquid membranes and small molecule inhibitors for amyloid aggregation A treatment of inorganic nanomaterials as promoters and inhibitors of amyloid fibril formation An examination of a wide variety of natural and artificial polymers Perfect for materials scientists, biochemists, polymer chemists, and protein chemists, Biological Soft Matter: Fundamentals, Properties and Applications will also earn a place in the libraries of biophysicists and physical chemists seeking a one-stop reference summarizing the rapidly evolving topic of biological soft matter.

This is a first undergraduate textbook in Solid State Physics or Condensed Matter Physics. While most textbooks on the subject are extremely dry, this book is written to be much more exciting, inspiring, and entertaining.

The book provides a review of some of the most important and 'hot' topics in condensed matter physics today. It includes contributions by internationally leading experts such as V M Agranovich, B L Altshuler, E Burstein, V L Ginzburg, K Von Klitzing, P B Littlewood, M Pepper etc, and can serve as a guide-book to modern condensed matter physics.

The 1970's and 1980's can be considered the third stage in the explosive development of condensed matter physics. After the very intensive research of the 1930's and 1940's, which followed the formulation of quantum mechanics, and the path-breaking activity of the 1950's and 1960's, the problems being faced now are much more complex and not always susceptible to simple modelling. The (subjectively) open problems discussed here are: high temperature superconductivity, its properties and the possible new mechanisms which lead to it; the integral and fractional quantum Hall effects; new forms of order in condensed-matter systems; the physics of disorder, especially the problem of spin glasses; the physics of complex anisotropic systems; the theoretical prediction of stable and metastable states of matter; the physics of highly correlated states (heavy fermions); the physics of artificially made structures, in particular heterostructures and highly metastable states of matter; the determination of the microscopic structure of surfaces; and chaos and highly nonlinear phenomena. 82 refs.

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.

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. Based on an established course and covering the fundamentals, central areas and contemporary topics of this diverse field, *Fundamentals of Condensed Matter Physics* is a much-needed textbook for graduate students. The book begins with an introduction to the modern conceptual models of a solid from the points of view of interacting atoms and elementary excitations. It then provides students with a thorough grounding in electronic structure and many-body interactions as a starting point to understand many properties of condensed matter systems - electronic, structural, vibrational, thermal, optical, transport, magnetic and superconducting - and methods to calculate them. Taking readers through the concepts and techniques, the text gives both theoretically and experimentally inclined students the knowledge needed for research and teaching careers in this field. It features 246 illustrations, 9 tables and 100 homework problems, as well as numerous worked examples, for students to test their understanding. Solutions to the problems for instructors are available at www.cambridge.org/cohenlouie.

Presentation of the basic theoretical formulation of Green's functions, followed by specific applications: transport coefficients of a metal, Coulomb gas, Fermi liquids, electrons and phonons, superconductivity, superfluidity, and magnetism. 1984 edition.

Now in paperback, this book provides an overview of the physics of condensed matter systems. Assuming a familiarity with the basics of quantum mechanics and statistical mechanics, the book establishes a general framework for describing condensed phases of matter, based on symmetries and conservation laws. It explores the role of spatial dimensionality and microscopic interactions in determining the nature of phase transitions, as well as discussing the structure and properties of materials with different symmetries. Particular attention is given to critical phenomena and renormalization group methods. The properties of liquids, liquid crystals, quasicrystals, crystalline solids, magnetically ordered systems and amorphous solids are investigated in terms of their symmetry, generalised rigidity, hydrodynamics and topological defect structure. In addition to serving as a course text, this book is an essential reference for students and researchers in physics, applied physics, chemistry, materials science and engineering, who are interested in modern condensed matter physics.

This book aims to present a concise introduction, for graduate students and researchers, to powerful techniques and important concepts in condensed matter physics. Key conceptual elements include the fluctuation-dissipation theorem, the theory of critical phenomena (both classical and quantum) and the renormalization group. The book focuses on the Green's functions method and the real space renormalization group (RG). The Green's function method has been used extensively to study a large variety of problems in physics. In the book we present a generalized version of this method that allows one to use perturbation theory including time dependent perturbations. This can be used to treat a variety of new fundamental problems in condensed matter, such as quantum and topological phase transitions. The real space renormalization group is a highly intuitive method to introduce main concepts in statistical mechanics and the theory of phase transitions. The book discusses the notion of scale invariance, stable and unstable fixed points, flow in parameter space, crossover and relevant and irrelevant perturbations. These will be illustrated with several examples. The book illustrates that the real space RG is very useful for treating problems such as percolation and localized magnetism as described, for example, by the Ising model. The book considers problems in both pure and disordered condensed matter systems and discusses the new effects introduced by the latter. The book presents the solutions of some fundamental problems in condensed matter physics using the methods and tools introduced in the chapters. The calculations will be carried out with step-by-step details to help readers master the techniques. Finally, the book explores how the Green's functions and real space RG techniques detailed can be used to study modern problems arising from the consideration of topological aspects of condensed matter. Key Features: Provides a generalization of the Green's function method that allows for the treatment of a much larger variety of problems, which should encourage people to study and use it. Suitable for readers who want to learn about real space renormalization group (RG), whilst avoiding Feynman diagrams and perturbation expansions. The ideas and methods will be introduced by considering different examples. Contains material that can be covered within a semester and is therefore not too long. Provides the reader with the tools to tackle their own problems. Considers actual problems in condensed matter physics such as; quantum phase transition, topological aspects of condensed matter and the effect of disorder on physical properties.

``Physics of Radiation Effects in Crystals'' is presented in two parts. The first part covers the general background and theory of radiation effects in crystals, including the theory describing the generation of crystal lattice defects by radiation, the kinetic approach to the study of the disposition of these defects and the effects of the diffusion of these defects on alloy compositions and phases. Specific problems of current interest are treated in the second part and include anisotropic dimensional changes in x-uranium, zirconium and graphite, acceleration of thermal creep in reactor materials, and radiation damage of semiconductors and superconductors.

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

This successful and widely-reviewed book covering the physics of condensed matter systems is now available in paperback.

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.

A balanced combination of introductory and advanced topics provides a new and unique perspective on the quantum field theory approach to condensed matter physics. Beginning with the basics of these subjects, such as static and vibrating lattices, independent and interacting electrons, the functional formulation for fields and different generating functionals and their roles, this book presents a unified viewpoint illustrating the connections and relationships among various physical concepts and mechanisms. Advanced and newer topics bring the book up to date with current developments and include sections on cuprate and pnictide superconductors, graphene, Weyl semimetals, transition metal dichalcogenides and topological insulators. Finally, well-known subjects such as the quantum Hall effect, superconductivity, Mott and Anderson insulators, and the Anderson–Higgs mechanism are examined within a unifying QFT-CMP approach. Presenting new insights on traditional topics, this text allows graduate students and researchers to master the proper theoretical tools required in a variety of condensed matter physics systems.

This book approaches condensed matter physics from the perspective of quantum information science, focusing on systems with strong interaction and unconventional order for which the usual condensed matter methods like the Landau paradigm or the free fermion framework break down. Concepts and tools in quantum information science such as entanglement, quantum circuits, and the tensor network representation prove to be highly useful in studying such systems. The goal of this book is to introduce these techniques and show how they lead to a new systematic way of characterizing and classifying quantum phases in condensed matter systems. The first part of the book introduces some basic concepts in quantum information theory which are then used to study the central topic explained in Part II: local Hamiltonians and their ground states. Part III focuses on one of the major new phenomena in strongly interacting systems, the topological order, and shows how it can essentially be defined and characterized in terms of entanglement. Part IV shows that the key entanglement structure of topological states can be captured using the tensor network representation, which provides a powerful tool in the classification of quantum phases. Finally, Part V discusses the exciting prospect at the intersection of quantum information and condensed matter physics – the unification of information and matter. Intended for graduate students and researchers in condensed matter physics, quantum information science and related fields, the book is self-contained and no prior knowledge of these topics is assumed.

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.

A pioneering treatise presenting how the mathematical techniques of holographic duality can unify the fundamental theories of physics.

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