Condensed Matter In A Nutshell

This is volume 1 of two-volume book that presents an excellent, comprehensive exposition of the multi-faceted subjects of modern condensed matter physics, unified within an original and coherent conceptual framework. Traditional subjects such as band theory and lattice dynamics are tightly organized in this framework, while many new developments emerge spontaneously from it. In this volume,? Basic concepts are emphasized; usually they are intuitively introduced, then more precisely formulated, and compared with correlated concepts.? A plethora of new topics, such as quasicrystals, photonic crystals, GMR, TMR, CMR, high Tc superconductors, Bose-Einstein condensation, etc., are presented with sharp physical insights.? Bond and band approaches are discussed in parallel, breaking the barrier between physics and chemistry.? A highly accessible chapter is included on correlated electronic states ? rarely found in an introductory text.? Introductory chapters on tunneling, mesoscopic phenomena, and quantum-confined nanostructures constitute a sound foundation for nanoscience and nanotechnology.? The text is profusely illustrated with about 500 figures.

For non-specialist students and researchers, this is a broad and concise introduction to the many-body

theory of condensed-matter systems.
Publisher Description
Independent electrons and static crystals -- Vibrating crystals -- Interacting electrons -- Interactions in action -- Functional formulation of quantum field theory -- Quantum fields in action -- Symmetries: explicit or secret -- Classical topological excitations -- Quantum topological excitations -- Duality, bosonization and generalized statistics -- Statistical transmutation -- Pseudo quantum electrodynamics -- Quantum field theory methods in condensed matter -- Metals, Fermi liquids, Mott and Anderson insulators -- The dynamics of polarons -- Polyacetylene -- The Kondo effect -- Quantum magnets in 1D: Fermionization, bosonization, Coulomb gases and 'all that' -- Quantum magnets in 2D: nonlinear sigma model, CP1 and 'all that' -- The spin-fermion system: a quantum field theory approach -- The spin glass -- Quantum field theory approach to superfluidity -- Quantum field theory approach to superconductivity -- The cuprate high-temperature superconductors -- The pnictides: iron based superconductors -- The quantum Hall effect -- Graphene -- Silicene and transition metal dichalcogenides -- Topological insulators -- Non-abelian statistics and quantum computation
This is an approachable introduction to the important topics and recent developments in the field of condensed matter physics. First, the general

language of quantum field theory is developed in a way appropriate for dealing with systems having a large number of degrees of freedom. This paves the way for a description of the basic processes in such systems. Applications include various aspects of superfluidity and superconductivity, as well as a detailed description of the fractional quantum Hall liquid.

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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.

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.

Condensed Matter in a Nutshell is the most concise, accessible, and self-contained introduction to this exciting and cutting-edge area of modern physics. This premier textbook covers all the standard topics, including crystal structures, energy bands, phonons, optical properties, ferroelectricity, superconductivity, and magnetism. It includes in-depth discussions of transport theory, nanoscience, and semiconductors, and also features the latest experimental advances in this fast-developing field, such as high-temperature superconductivity, the quantum Hall effect, graphene, nanotubes, localization, Hubbard models, density functional theory, phonon focusing, and Kapitza resistance. Rich in detail and full of examples and problems, this textbook is the complete resource for a two-semester graduate course in condensed matter and material physics. Covers standard topics like crystal structures, energy bands, and phonons Features the latest advances like high-temperature superconductivity and more Full of instructive examples and challenging problems Solutions manual (available only to teachers)

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

Condensed Matter in a NutshellPrinceton University Press

An advanced textbook covering important modern developments in depth rather than attempting an encyclopaedic approach.

A selection of papers by Pierre-Gilles de Gennes - 1991 Nobel Prize winner in Physics - which have had a long-lasting impact on our understanding of condensed matter. Ideas on polymers, liquid crystals and interfaces are described. The author has added some afterthoughts to the main papers.

Modern Condensed Matter Physics brings together the most important advances in the field of recent decades. It provides instructors teaching graduate-level condensed matter courses with a comprehensive and in-depth textbook that will prepare graduate students for research or further study as well as reading more advanced and specialized books and research literature in the field. This textbook covers the basics of crystalline solids as well as analogous optical lattices and photonic crystals, while discussing cutting-edge topics such as disordered systems, mesoscopic systems, many-body systems, quantum magnetism, Bose–Einstein condensates, quantum entanglement, and superconducting quantum bits. Students are provided with the appropriate mathematical background to understand the topological concepts that have been permeating the field, together with numerous physical examples ranging from the fractional quantum Hall effect to topological insulators, the toric code, and majorana fermions. Exercises, commentary boxes, and appendices afford guidance and feedback for beginners and experts alike.

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The physics of condensed matter, in contrast to quantum physics or cosmology, is not traditionally associated with deep philosophical questions. However, as science - largely thanks to more powerful computers - becomes capable of analysing and modelling ever more complex

many-body systems, basic questions of philosophical relevance arise. Questions about the emergence of structure, the nature of cooperative behaviour, the implications of the second law, the quantum-classical transition and many other issues. This book is a collection of essays by leading physicists and philosophers. Each investigates one or more of these issues, making use of examples from modern condensed matter research. Physicists and philosophers alike will find surprising and stimulating ideas in these pages.
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.

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 concise, class-tested book was refined over the authors' 30 years as instructors at MIT and the University Federal of Minas Gerais (UFMG) in Brazil. The approach centers on the conviction that teaching group theory along with applications helps students to learn, understand and use it for their own needs. Thus, the theoretical background is confined to introductory chapters. Subsequent chapters develop new theory alongside applications so that students can retain new concepts, build on concepts already learned, and see interrelations between topics. Essential problem sets between chapters aid retention of new material and consolidate material learned in previous chapters.

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.

This book is a course in modern quantum field theory as seen through the eyes of a theorist working in condensed matter physics. It contains a gentle introduction to the subject and therefore can be used even by graduate students. The introductory parts include a derivation of the path integral representation, Feynman diagrams and elements of the theory of metals including a discussion of Landau–Fermi liquid theory. In later chapters the discussion gradually turns to more advanced methods used in the theory of strongly correlated systems. The book contains a thorough exposition of such non-perturbative techniques as 1/N-expansion, bosonization (Abelian and non-Abelian), conformal field theory and theory of integrable systems. The book is intended for graduate students, postdoctoral associates and independent researchers working in condensed matter physics.

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

There is no doubt that we have, during the last decade, moved into a "golden age" of condensed matter science. The sequence of discoveries of novel new states of matter and their rapid assimilation into experimental and theoretical research, as well as devices, has been remarkable. To name but a few: spin glasses; incommensurate, fractal, quasicrystal structures; synthetic metals; quantum well fabrication; fractional quantum Hall effect: solid state chaos; heavy fermions; and most spectacularly high-temperature superconductivity. This rapid evolution has been marked by the need to address the reality of materials in "extreme" conditions - - disordered, nonlinear systems in reduced dimensions, restricted geometries and at mesoscopic scales, often with striking competitions between several length and frequency scales, and between strong electron-phonon and electron-electron interactions. In such new territory it is not surprising that very interdisciplinary approaches are being explored and traditional boundaries between subjects and disciplines re-defined. In theory, this is evident, for instance, in attempts: (1) to advance the state of the art for elec tronic structure calculations so as to handle strongly interacting many-body systems and delicate competitions for collective ground states (spin models or many-electron Hamiltoni ans, field theory, band structure, quantum chemistry and numerical approaches); or (2) to understand pattern formation and complex (including chaotic) dynamics in extended sys tems. This demands close involvement with applied mathematics, numerical simulations and statistical mechanics techniques. The aim of this book is to introduce a graduate student to selected concepts in condensed matter physics for which the language of field theory is ideally suited. The examples considered in this book are those of superfluidity for weakly interacting bosons, collinear magnetism, and superconductivity. Quantum phase transitions are also treated in the context of quantum dissipative junctions and interacting fermions constrained to one-dimensional position space. The style of presentation is sufficiently detailed and comprehensive that it only presumes familiarity with undergraduate physics.

More than a graduate text and advanced research guide on condensed matter physics, this volume emphasizes applications to a variety of systems rather than theoretical derivations and techniques. 1991 edition.

This practical book provides recipes for the construction of devices used in low temperature experimentation. It emphasizes what works, rather than what might be the optimum method, and lists current sources for purchasing components and equipment.

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

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. 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.

Unlike existing texts, this book blends for the first time three topics in physics - symmetry, condensed matter physics and computational methods - into one pedagogical textbook. It includes new concepts in mathematical crystallography; experimental methods capitalizing on symmetry aspects; non-conventional applications such as Fourier crystallography, color groups, quasicrystals and incommensurate systems; as well as concepts and techniques behind the Landau theory of phase transitions. Adopting a computational approach to the application of group theoretical techniques to solving symmetry related problems, it dramatically alleviates the need for intensive calculations usually found in the presentation of symmetry. Writing computer programs helps the student achieve a firm understanding of the underlying concepts, and sample programs, based on Mathematica, are presented throughout the book. Containing over 150 exercises, this textbook is ideal for graduate students in condensed matter physics, materials science, and chemistry. Solutions and computer programs are available online at www.cambridge.org/9780521828451.

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.

This new volume provides the necessary background material and brings into focus the fundamental concepts essential for advanced research in theoretical condensed matter physics and its interface with molecular biophysics. It is the outcome of the author's long teaching and research career in theoretical condensed matter physics and related interdisciplinary fields. The author aims to motivate students to take up research in condensed matter physics and march toward new frontiers. He writes: “My long understanding of students' attitude and orientation brings me to the conclusion that many of them are quite excited about the developments in the frontier research areas at the beginning of their career; however, a sizeable fraction of them start losing interest gradually as they are often unable to connect these developments with the basic physics they have studied. I have tried to fill this gap in this book.” To this end, special care has been taken to balance the physical concepts and mathematical expressions as well as proper mixing of theoretical and experimental aspects. He starts with the very well-known elementary ideas or basic concepts and goes forward so as to remove the apparent conceptual and technical gap between the known laws and various interesting, challenging, and novel experimental results and effects, some of which are amongst the latest discoveries. Key features: • Introduces a new way of looking at various important and fundamental phenomena in condensed matter from the perspective of microscopic theory • Explores a new interface of quantum condensed matter physics and molecular biophysics, highlighting research potentialities • Addresses the crucial questions surrounding these phenomena when they are mutually coexisting or competing in real condensed matter systems or materials, from both theoretical and experimental angles • Deals with biological molecules and some of their properties and processes and discusses the modeling of these with the help of condensed matter physics and statistical physics • Emphasizes fundamental concepts, particularly in condensed matter physics and making proper use of them

Soft condensed matter physics, which emerged as a distinct branch of physics in the 1990s, studies complex fluids: liquids in which structures with length scale between the molecular and the macroscopic exist. Polymers, liquid crystals, surfactant solutions, and colloids fall into this category. Physicists deal with properties of soft matter system

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

The goal of this text is to introduce, in a very elementary way, the concept of anti-de Sitter/Conformal Field Theory (AdS/CFT) correspondence to condensed matter physicists. This theory relates a gravity theory in a (d+1)-dimensional anti-de Sitter space

This volume is a translation and revision of the Original Russian version by Baryahktar. It covers all of the main fields involved in Condensed Matter Physics, such as crystallography, electrical properties, fluids, magnetism, material properties, optics, radiation, semiconductors, and superconductivity, as well as highlights of important related subjects such as quantum mechanics, spectroscopy, and statistical mechanics. Both theoretical and experimental aspects of condensed matter are covered in detail. The entries range from very short paragraphs on topics where definitions are needed, such as Bloch's law, clathrate compound, donor, domain,

Kondo lattice, mean free path, and Wigner crystal, to long discussions of more general or more comprehensive topics such as antiferromagnetism, crystal lattice dynamics, dislocations, Fermi surface, Josephson effect, luminescence, magnetic films, phase transitions and semiconductors. The main theoretical approaches to Condensed Matter Physics are explained. There are several long tables on, for example, Bravais lattices, characteristics of magnetic materials, units of physical quantities, symmetry groups. The properties of the main elements of the periodic table are given. Numerous entries not covered by standard Solid State Physics texts o Self-similarity o The adiabatic approximation o Bistability Emphasis on materials not discussed in standard texts o Activated carborn o Austenite o Bainite o Calamitics o Carbine o Delat phase o Discotics o Gunier-Preston zones o Heterodesmic structures o Heusler Alloys o Stress and strain deviators o Vicalloy · Each entry is fully cross-referenced to help tracking down all aspects of a topic under investigation Highly illustrated to clarify many concepts
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.