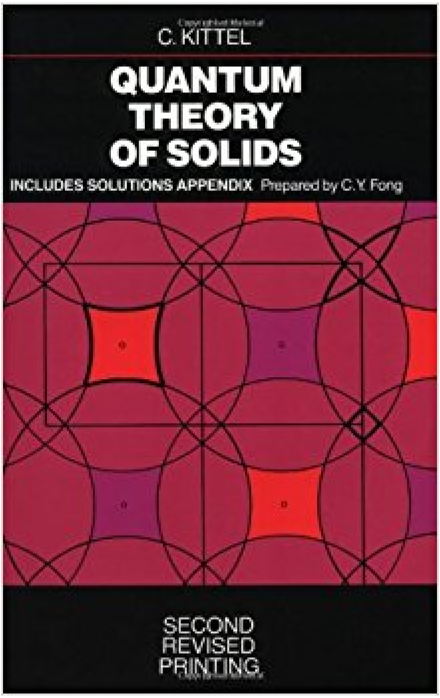
Quantum Theory Of Solids



Synopsis

A modern presentation of theoretical solid state physics that builds directly upon Kittel’s Introduction to Solid State Physics. Treats phonon, electron, and magnon fields, culminating in the BCS theory of superconductivity. Considers Fermi surfaces and electron wave functions and develops the group theoretical description of Brillouin zones. Applies correlation functions to time-dependent effects in solids, with an introduction to Green’s functions. With 110 problems, the text is well-suited for the classroom or for self-instruction.

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Customer Reviews

Quantum Theory of Solids is a modern presentation of theoretical solid state physics it builds directly on the same author?s Introduction to Solid State Physics and is planned as a one year graduate course for experimental and theoretical physicists it is well-suited for self study because the text contains 110 problems. The first part of the book treats phonon, electron, and magnon fields, culminating in the BCS theory of superconductivity. The second part considers Fermi surfaces and electron wave functions, and develops the group theoretical description of Brillouin zones. The third part applies correlation functions to time-dependent effects in solids, with an introduction to Green?s functions.

About the author...Charles Kittel taught solid state physics at the University of California Berkeley from 1951 to 1978. Earlier he had been a member of the solid state physics group at Bell

Laboratories. His undergraduate work in physics was a M.I.T. and at the Cavendish Laboratory of Cambridge University. His PhD was from the University of Wisconsin. He has been awarded the Oliver Buckley Prize for Solid State Physics and the Oersted Medal of the American Association of Physics Teachers He is a member of the National Academy of Science and of the American Academy of Arts and Sciences. He is the author of a widely used introductory book on solid state physics.

The book mostly consists of theorems formalizing the mathematical foundations for study in solid-state physics. It best serves as a reference together with another book that is more pedagogical, for example Ashcroft & Mermin or the introductory book on solid state physics by the same author (Charles Kittel).That said, this is a great, concise reference for anyone creating models and simulations because it bridges instructive texts and books on pure mathematical methods.

C. Kittel’s book can still be considered the main reference book on theoretical solid state physics, even after more than 40 years of the original release. Of course, the field has grown bigger from this time and some new concepts has been developed (e.g. high temperature superconductivity) and some totally has changed, but still this book can guarantee the adequate background level (of course, when it is supported by some books about newer concpets). I’d highly recommend it to anyone who is looking for a reference to start from.

It is too bad this book is out of print, for it gives a good introduction to the quantum theory as applied to condensed matter, despite the many advances that have taken place since the date of publication, such as high-temperature superconductivity, the fractional quantum Hall effect, and nanoscale physics. Therefore, if a copy can be found, it is still worth perusing and having on one’s shelf. I only read the first 8 chapters of the book, so my review will be confined to them. After a brief introduction to the mathematics needed in the book, the author begins in chapter 2 with a treatment of acoustic phonons, which arise from the canonical quantization of the transverse motion of a continuous elastic line under tension. This object is handled using the Lagrangian formalism, and after finding the Hamiltonian density, employing a canonical transformation, the (bosonic) creation and annihilation operators are found: phonon excitations. Both longitudinal and transverse modes are shown to exist in general. Bogoliubov transformations are then used to show how phonons may arise in a system of weakly interacting particles. The author then derives the expression for the velocity of "second sound" in a phonon gas. Experimental evidence for second sound in liquid helium was known at the time of publication, but since then evidence has accumulated in Bose gases and in certain types of crystals, such as KTaO and SrTiO. The phenomenon of second sound has also been of considerable interest in the study of nonlinear optical phenomena in smectic liquid crystals. The author also discusses the occurence of van Hove singularities in the phonon frequency distribution function, and points to their connection with Morse theory. In chapter 3 the author concentrates his attention on plasmons, which arises from longitudinal excitations in an electron gas, and optical phonons in ionic crystals. He then extends the latter analysis to include the interaction of optical phonons with photons, which he also treats using quantum field theory, giving what he calls a quantum theory of a classical dielectric. The theory of spin waves, or "magnons" is discussed in chapter 4, wherein the author first treats ferromagnetic magnons via the consideration of the Hamiltonian consisting of nearest-neighbor exchange and Zeeman contributions. The dispersion relation for both optical and acoustical magnons in a spin system forming a Bravais lattice is derived and compared with experiment for magnetite. The author then treats antiferromagnetic magnons and discusses the zero-point sublattice magnetization and the heat capacity of antiferromagnets. He then returns to ferromagnetic magnons but from a more macroscopic point of view, treating the magnetization as a macroscopic field, rather than dealing with individual spins. Lastly, he considers the excitation of ferromagnetic magnons by parallel pumping and the temperature dependence of effective exchange. After a short review of the Hartree-Fock approximation in chapter 5, the author considers the all-important electron gas in chapter 6. The electron gas, particularly in two dimensions, has been the subject of great interest since this book was first published, not only because of its technological importance, but also its role in the quantum Hall effect and the fractional quantum Hall effect. Although density functional and renormalization group methods are the current favored ones for studying the electron gas, readers can still gain much from the reading of the chapter. The author concentrates his attention on the approximate calculation of the correlation energy of the degenerate electron gas, particularly at high density. To do this he uses the self-consistent field approach and he exploits the frequency and wavevector dielectric constant as a tool for studying many-body interactions. Several bread-and-butter topics in quantum many-body theory appear in this chapter, such as the linked cluster expansion, which appear in other more complicated (relativistic) contexts, such as high energy physics. The author introduces polarons in chapter 7 as a consequence of any deformation of the ideal periodic lattice of positive ion cores on the motion of conduction electrons, and notes that even the zero-point motion of phonons effects this motion. The interaction of an electron with the lattice results in a "lattice polarization field" around the electron, and the resulting composite particle is the polaron, which, as expected, has a larger effective mass then the electron in an unperturbed lattice. The electron-phonon interaction results in resistivity, results in attenuation of ultrasonic waves in metals, and results in some cases to an attractive interaction between electrons, this being one of the precursors of superconductivity. The problem of electron-phonon interaction in metals has been the subject of much study in attempts to give quantum field theory a rigorous mathematical foundation, particularly via the study of the "jellium model". Chapter 8 is very important, and its content reveals again the age of the book. The phenomenon of superconductivity, and its description by the Bardeen-Cooper-Schrieffer theory, is known as one of the triumphs of the quantum theory of solids. Of course, when this book was published, superconducting materials at high temperature, were not known. The author though gives a detailed overview of the BCS theory, starting with the Hamiltonian for the electrons, phonons, and their first-order interactions (the strength measured by a certain real constant D). Using a canonical transformation, the author reduces the Hamiltonian to one with no off-diagonal terms of order D. This results in an expression for an electron-electron interaction which can be attractive for excitation energies in a certain range (involving the Debye energy). Keeping only this interaction in the Hamiltonian, for wave vectors that satisfy this range constraint, the author studies the properties of bound electron pairs, and shows how they bring about superconductivity. He also outlines an alternative solution to the BCS equation, using what he calls the equation-of-motion method. More modern treatments of superconductivity employ the use of Higgs fields and the renormalization group, these approaches shedding light on whether one can indeed view superconductivity as a "macroscopic manifestation of quantum physics".

very fast, receive it next day. as a gift to my colleague, as the price. Love! Sharp, cuts well, and feels balanced. great and good experience.

A good book in addition to another introductory text. I covers the subject manner in an orderly fashion and reviews the theory in an intricate fashion. However, the mathematical notation is not what one would expect from other Solid State texts however the same conventions are used from his introductory book on Solid State Physics. An excellent investment for those interested.

This book contains all the necessary formalism to become aquainted with many-body theory and Green’s functions. The writing is clear and to the point.

Advanced Molecular Quantum Mechanics: An Introduction to Relativistic Quantum Mechanics and the Quantum Theory of Radiation (Studies in Chemical Physics) Quantum Theory of Solids The Mathematical Theory of Symmetry in Solids: Representation Theory for Point Groups and Space Groups (Oxford Classic Texts in the Physical Sciences) Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles Covariant Loop Quantum Gravity: An Elementary Introduction to Quantum Gravity and Spinfoam Theory (Cambridge Monographs on Mathematical Physics) The Quantum Mechanics Solver: How to Apply Quantum Theory to Modern Physics Electrons and Phonons: The Theory of Transport Phenomena in Solids (Oxford Classic Texts in the Physical Sciences) Band Theory and Electronic Properties of Solids (Oxford Master Series in Physics) Quantum Ontology: A Guide to the Metaphysics of Quantum Mechanics Quantum Nanoelectronics: An introduction to electronic nanotechnology and quantum computing Introduction to Topological Quantum Matter & Quantum Computation Quantum Mechanics: Re-engineering Your Life With Quantum Mechanics & Affirmations Quantum Runes: How to Create Your Perfect Reality Using Quantum Physics and Teutonic Rune Magic (Creating Magick with The Universal Laws of Attraction Book 1) Delirious, A Quantum Novel (Quantum Series Book 6) Quantum Thermodynamics: Emergence of Thermodynamic Behavior Within Composite Quantum Systems (Lecture Notes in Physics) Quantum Space (Quantum Series Book 1) Quantum Incident (Quantum Series Book 0) The Pediatrician's Guide to Feeding Babies and Toddlers: Practical Answers To Your Questions on Nutrition, Starting Solids, Allergies, Picky Eating, and More (For Parents, By Parents) Change It!: Solids, Liquids, Gases and You (Primary Physical Science) What Is the World Made Of?: All About Solids, Liquids, and Gases (Let's-Read-and-Find-Out Science 2)