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Beyond the Crystalline State

An Emerging Perspective



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Beyond the Crystalline State Ganesan Venkataraman, Debendranath Sahoo, Venkataraman Balakrishnan, 2012-12-06
Condensed matter exhibits a rich variety of phases. Of these, the crystalline state has until recently received most attention. This is not surprising given the geometric regularity of crystals. At the other extreme, one has amorphous materials. In between, there are the various types of liquid crystals, the recently discovered quasicrystals, and so on. While the absence of the high degree of regularity that characterizes the crystalline phase is certainly a problem, these noncrystalline states have nevertheless been receiving some attention over the years. However, it is only during the last few years that something like a unified view of all these phases has begun to emerge through an application of various sophisticated concepts. Geometry and symmetry and unusual realizations of the latter provide a unifying thread in this new and emerging perspective. This book is an attempt to capture the flavour of some of these recent developments. The approach is substantially descriptive, being intended to be accessible not only to experimental physicists but also to chemists, materials scientists, metallurgists, and ceramicists whose work borders on physics. The prerequisites for a study of this book are a familiarity with basic solid state physics and in places, the elements of group theory and statistical mechanics. A few special topics are included at the end to aid those who wish to pursue further the subject matter treated here.

Introduction to Solid-State Theory Otfried Madelung, 2012-12-06
Introduction to Solid State Theory is a textbook for graduate students of physics and materials science. It also provides the theoretical background needed by physicists doing research in pure solid state physics and its applications to electrical engineering. The fundamentals of solid state theory are based on a description by delocalized and localized states and within the concept of delocalized states by elementary excitations. The development of solid state theory within the last ten years has shown that by a systematic introduction of these concepts, large parts of the theory can be described in a unified way. This form of description gives a pictorial formulation of many elementary processes in solids which facilitates their understanding.

Fundamentals of the Physics of Solids Jenő Sólyom, 2007-09-19
This book is the first of a three volume series written by the same author. It aims to deliver a comprehensive and self-contained account of the fundamentals of the physics of solids. In the presentation of the properties and experimentally observed phenomena together with the basic concepts and theoretical methods, it goes far beyond most classic texts. The essential features of various experimental techniques are also explained. The text provides material for upper level undergraduate and graduate courses. It will also be a valuable reference for researchers in the field of condensed matter physics.

Structure of Materials Marc De Graef, Michael E. McHenry, 2012-10-08
A new edition of the highly readable textbook applying the fundamentals of crystallography, symmetry, and diffraction to a range of materials.

High Magnetic Fields in Semiconductor Physics III Gottfried Landwehr, 2012-12-06
High magnetic fields have for a long time been an important tool in the investigation of the electronic structure of semiconductors. In recent years, studies of heterostructures and superlattices have predominated and

this emphasis is reflected in these proceedings The contributions concentrate on experiments using transport and optical methods but recent theoretical developments are also covered Special attention is paid to the quantum Hall effect including the problem of edge currents the influence of contacts and Wigner condensation in the fractional quantum Hall effect regime The 27 invited contributions by renowned experts provide an excellent survey of the field that is complemented by numerous contributed papers

Electron Correlations in Molecules and Solids Peter Fulde, 2012-12-06 Quantum chemistry and solid state theory are two important related fields of research that have grown up with almost no cross communication This book bridges the gap between the two In the first half new concepts for treating weak and strong correlations are developed and standard quantum chemical methods as well as density functional Green's function functional integral and Monte Carlo methods are discussed The second half discusses applications of the theory to molecules semiconductors homogeneous metallic systems transition metals and strongly correlated systems such as heavy fermion systems and the new high T_c superconducting materials

Physical Properties of Quasicrystals Zbigniew M. Stadnik, 2012-12-06 Quasicrystals are a new form of the solid state which differ from the other two known forms crystalline and amorphous by possessing a new type of long range translational order called quasiperiodicity and a noncrystallographic orientational order This book provides an up to date description of the unusual physical properties of these new materials Emphasis is placed on the experimental results which are compared with those of the corresponding crystalline and amorphous systems and discussed in terms of modern theoretical models Written by leading authorities in the field the book will be of great use both to experienced workers in the field and to uninitiated graduate students

Vortices in Unconventional Superconductors and Superfluids R.P. Huebener, N. Schopohl, G.E. Volovik, 2013-03-09 The physics of vortices in classical fluids has been a highly important subject for many years both in fundamental science and in engineering applications About 50 years ago vortices started to become prominent as quantum mechanical objects constructed from a macroscopic wavefunction Here the key developments are associated with the names R Feynman L Onsager L D Landau F London V L Ginzburg and A A Abrikosov Recently the physics of vortices has undergone a further important step of diversification namely in unconventional superconductors and superfluids which are characterized by an anisotropic and or spatially complex order parameter It is this latest evolutionary step of vortex physics that is addressed in this book The individual chapters are concerned with the microscopic structure and dynamics of vortices in diverse systems ranging from superfluids and superconductors to neutron stars Each of the 20 chapters is written by one or more experts on the particular subject Each chapter provides an introduction and overview emphasizing theoretical as well as experimental work and includes references to both recent and pioneering earlier developments In this way non expert readers will also benefit from these lecture notes Hence the book will be useful for all researchers and graduate students interested in the physics of vortices in unconventional superconductors and superfluids It may also serve as supplementary material for a graduate course on low temperature solid

state physics **Semiconductor Physics** Karlheinz Seeger, 2013-04-17 Televisions telephones watches calculators robots airplanes and space vehicles all depend on silicon chips Life as we know it would hardly be possible without semiconductor devices An understanding of how these devices work requires a detailed knowledge of the physics of semiconductors including charge transport and the emission and absorption of electromagnetic waves This book may serve both as a university textbook and as a reference for research and microelectronics engineering Each section of the book begins with a description of an experiment The theory is then developed as far as necessary to understand the experimental results Everyone with high school mathematics should be able to follow the calculations The band structure calculations for the diamond and zinc blende types of lattice are supplemented with a personal computer program Semiconductor physics developed most rapidly in the two decades following the invention of the transistor and naturally most of the references date from this time But recent developments such as the Gunn effect the acoustoelectric effect superlattices quantum well structures and the quantum Hall effect are also discussed The exercises provided answers to which are available will greatly assist the student in consolidating the material presented From the reviews This book is a must for any theoretical and experimental physicist working in the area of semiconductor physics Physicalia 1 *Optics of Semiconductors and Their*

Nanostructures Heinz Kalt, Michael Hetterich, 2013-04-09 In recent years the field of semiconductor optics has been pushed to several extremes The size of semiconductor structures has shrunk to dimensions of a few nanometers the semiconductor light interaction is studied on timescales as fast as a few femtoseconds and transport properties on a length scale far below the wavelength of light have been revealed These advances were driven by rapid improvements in both semiconductor and optical technologies and were further facilitated by progress in the theoretical description of optical excitations in semiconductors This book written by leading experts in the field provides an up to date introduction to the optics of semiconductors and their nanostructures so as to help the reader understand these exciting new developments It also discusses recently established applications such as blue light emitters as well as the quest for future applications in areas such as spintronics quantum information processing and third generation solar cells

Spectroscopy of Mott Insulators and Correlated Metals Atsushi Fujimori, Yoshinori Tokura, 2012-12-06 Extensive studies of high Tc cuprate superconductors have stimulated investigations into various transition metal oxides Mott transitions in particular provide fascinating problems and new concepts in condensed matter physics This book is a collection of overviews by well known active researchers in this field It deals with the latest developments with particular emphasis on the theoretical spectroscopic and transport aspects

Electronic Conduction in Oxides Nobuo Tsuda, Keiichiro Nasu, Akira Yanase, Kiiti Siratori, 2013-03-09 This book is a revised and up dated translation of Denki Dendōsei Sankabutsu Electronic Conduction in Oxides published by Shokabo in Tokyo in 1983 as the second volume of the Material Science Series which was edited for postgraduate students by T Suzuki S Chikazumi and S Nakajima Since the publication of the first edition we have witnessed the historic discovery of high Tc

superconductors by J G Bednorz and K A Müller The Shokabo edition has thus been thoroughly revised to accommodate the recent developments and K Nasu joined as the fourth author The constitution of the book is as follows After a short introductory chapter Chap 2 is devoted to a brief review of transport phenomena and electronic states in oxides It was written by Tsuda In Chap 3 the electron phonon and electron electron interaction are treated theoretically by Nasu and Yanase Nasu discusses the present status of theoretical studies of the electron phonon interaction in solids and Yanase explains the electron correlation Chapter 4 treats the physics of various representative oxides in detail Sections 4.1.5 and 4.10 were written by Tsuda and Sects 4.6.9 by Siratori This chapter is intended not as an exhaustive review of the properties of each oxide but rather as an illustration of the concepts which have developed out of the research into transport phenomena in conductive oxides Many of these concepts are due to N F Mott At the end of Chap 4

Magnetism in the Solid State Peter Mohn, 2002-11-13 This book presents a phenomenological approach to the field of solid state magnetism It surveys the various theories and discusses their applicability in different types of materials The text will be valuable as a text for graduate courses in magnetism and magnetic materials

Choice, 1992 Magnetism and the Electronic Structure of Crystals Vladimir A. Gubanov, Alexandr I. Liechtenstein, Andrei V. Postnikov, 2012-12-06 The quantum theory of magnetism is a well developed part of contemporary solid state physics The basic concepts of this theory can be used to describe such important effects as ferromagnetic ordering of localized magnetic moments in crystals and ferromagnetism of metals produced by essentially delocalized electrons as well as various types of mutual orientation of atomic magnetic moments in solids possessing different crystal lattices and compositions In recent years the spin fluctuation approach has been developed which can overcome some contradictions between localized and itinerant models in the quantum mechanics of magnetic crystals These are only some of the principal achievements of quantum magnetic theory Almost all of the known magnetic properties of solids can be qualitatively explained on the basis of its concepts Further developments should open up the possibility of reliable quantitative description of magnetic properties of solids Unfortunately such calculations based on model concepts appear to be very complicated and quite often not definite enough The rather small number of parameters of qualitative models are usually not able to take into account the very different types of magnetic interactions that appear in crystals Further development of magnetic theory requires quantitative information on electronic wave function in the crystal considered This can be proved by electronic band structure and cluster calculations In many cases the latter can be a starting point for quantitative calculations of parameters used in magnetic theory

Physical Effects of Geometric Phases Qian Niu, Ming-Che Chang, Biao Wu, Di Xiao, Ran Cheng, 2017-08-28 Berry phase has been widely used in condensed matter physics in the past two decades This volume is a timely collection of essential papers in this important field which is highlighted by 2016 Nobel Prize in physics and recent exciting developments in topological matters Each chapter has an introduction which helps readers to understand the reprints that follow

Superlattices and Other Heterostructures

Eougenious L. Ivchenko, Grigory Pikus, 2012-12-06 Superlattices and Other Heterostructures deals with optical properties of superlattices and quantum well structures with emphasis on phenomena governed by crystal symmetries After a brief introduction to group theory and symmetries methods to calculate spectra of electrons excitations and phonons in heterostructures are discussed Further chapters cover absorption and reflection of light under interband transitions cyclotron and electron spin resonance light scattering by free and bound carriers as well as by optical and acoustic phonons polarized photoluminescence optical spin orientation of electrons and excitations and nonlinear optical and photogalvanic effects

Products of Random Matrices Andrea Crisanti, Giovanni Paladin, Angelo Vulpiani, 2012-12-06 At the present moment after the success of the renormalization group in providing a conceptual framework for studying second order phase transitions we have a nearly satisfactory understanding of the statistical mechanics of classical systems with a non random Hamiltonian The situation is completely different if we consider the theory of systems with a random Hamiltonian or of chaotic dynamical systems The two fields are connected in fact in the latter the effects of deterministic chaos can be modelled by an appropriate stochastic process Although many interesting results have been obtained in recent years and much progress has been made we still lack a satisfactory understanding of the extremely wide variety of phenomena which are present in these fields The study of disordered or chaotic systems is the new frontier where new ideas and techniques are being developed More interesting and deep results are expected to come in future years The properties of random matrices and their products form a basic tool whose importance cannot be underestimated They play a role as important as Fourier transforms for differential equations This book is extremely interesting as far as it presents a unified approach for the main results which have been obtained in the study of random matrices It will become a reference book for people working in the subject The book is written by physicists uses the language of physics and I am sure that many physicists will read it with great pleasure

Physics and Engineering Applications of Magnetism Yoshikazu Ishikawa, Noboru Miura, 2012-12-06 This book was originally published in Japanese in honour of Professor S Chikazumi on the occasion of his retirement from the University of Tokyo in March 1982 Physicists who had been supervised by him or had closely collaborated with him wrote articles on recent developments in magnetism and its engineering applications In the preface of his excellent textbook Physics of Magnetism Wiley 1964 Professor Chikazumi says that recent research in magnetism deals with fundamental physical problems and at the same time with more secondary magnetic phenomena as well as with engineering applications of magnetic materials to electromagnetic machines permanent magnets and electronic computers and that the purpose of his textbook is to give a general view of these magnetic phenomena focusing its main interest at the center of such a broad field Always keeping such a viewpoint in mind Professor Chikazumi has contributed a great deal to both fundamental physics and applications of magnetism This is described in Chap 1 of this book Many books have been published on both the physics and applications of magnetism However no single book has a viewpoint covering both of them The recent development of high

technology needs such a broad viewpoint for scientists and engineers since it is a product of both fundamental science and technology Research in magnetism is based on the response which materials show to the application of magnetic fields

Self-Trapped Excitons K.S. Song, Richard T. Williams, 2013-03-08 Self Trapped Excitons discusses the structure and evolution of the self trapped exciton STE in a wide range of materials It includes a comprehensive review of experiments and extensive tables of data Emphasis is given throughout to the unity of the basic physics underlying various manifestations of self trapping with the theory being developed from a localized atomistic perspective The topics treated in detail in relation to STE relaxation include spontaneous symmetry breaking lattice defect formation radiation damage and electronic sputtering

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