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Superconductivity, Superfluids and Condensates
Electronic Properties of Luttinger Liquid with Electron-phonon Interaction
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Atlas of Point Contact Spectra of Electron-Phonon Interactions in Metals
Physical Properties of High Temperature Superconductors IV
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Length-Scale Dependent Phonon Interactions World Scientific
NUCLEAR ELECTRONICS WITH QUANTUM CRYOGENIC DETECTORS An ideal, comprehensive reference on quantum cryogenic detector instrumentation for the semiconductor and nuclear electronics industries Quantum nuclear electronics is an important scientific and technological field that overviews the development of the most advanced analytical instrumentation. This instrumentation covers a broad range of applications such as astrophysics, fundamental nuclear research facilities, chemical nano-spectroscopy laboratories, remote sensing, security systems, forensic investigations, and more. In the years since the first edition of this popular resource, the discipline has developed from demonstrating the unprecedented energy resolving power of individual devices to building large frame cameras with hundreds of thousands of pixel arrays capable of measuring and processing massive information flow. Building upon its first edition, the second edition of Nuclear Electronics with Quantum Cryogenic Detectors reflects the latest advances by focusing on novel microwave kinetic inductance detection devices (MKIDs), the microwave superconducting quantum interferometers (MSQUIDs) extending by orders of magnitude the scalability of cryogenic detectors implementing newly developed multiplexing techniques and decoding algorithms. More, it reflects on the interaction of quantum cryogenic detectors—which in turn can be paired with semiconductor large frame cameras to provide a broad picture of a sky or chemical sample—and quantum devices, making this second edition of Nuclear Electronics a one-stop reference for the combined technologies. The book also provides an overview of latest developments in front-end electronics, signal processing channels, and cryogenics—all components of quantum spectroscopic systems—and provides guidance on the design and applications of the future quantum cryogenic ultra-high-resolution spectrometers. Nuclear Electronics with Quantum Cryogenic Detectors readers will also find: Fully revised material from the first edition relating to cryogenic requirements Brand new chapters on semiconductor radiation sensors, cooling and magnetic shielding for cryogenic detector systems; front-end readout electronic circuits for quantum cryogenic detectors; energy resolution of quantum cryogenic spectrometers; and applications of spectrometers based on cryogenic detectors A number of brand-new chapters dedicated to applications using MSQUID multiplexing technique, an area that will dominate the cryogenic detector field in the next decades Nuclear Electronics with Quantum Cryogenic Detectors provides a comprehensive overview of the entire discipline for researchers, industrial engineers, and graduate students involved in the development of high-precision nuclear measurements, nuclear analytical instrumentation, and advanced superconductor primary sensors. It is also a helpful resource for electrical and electronic engineers and physicists in the nuclear industry, as well as specialist researchers or professionals working in cryogenics applications like biomagnetism, quantum computing, gravitation measurement, and more.
Excitation Energy Transfer Processes in Condensed Matter Cambridge University Press
Applying a unified quantum approach, contributors offer fresh insights into the theoretical developments in the excitation energy transfer processes in condensed matter. This comprehensive volume examines Frenkel and Wannier excitonic processes; rates of excitonic processes; theory of laser sputter and polymer ablation; and polarons, excitonic polarons and self-trapping.
Scientific and Technical Aerospace Reports Allied Publishers
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
Nuclear Electronics with Quantum Cryogenic Detectors CRC Press
This volume is an integrated work with a full exposition of the Bardeen-Cooper-Schrieffer theory, the Ginzburg-Landau theory, and the Gor’kov treatment of superconductivity. It discusses the fundamental experiments on macroscopic quantum phenomena and the Josephson effect.
Electron-Phonon Interactions and Phase Transitions Springer Science & Business Media
Superconductivity, provides a basic introduction to one of the most innovative areas in condensed matter physics today. This book includes ample tutorial material, including illustrations, chapter summaries, graded problem sets, and concise examples. This book is part of the Oxford Master Series in Condensed Matter Physics.
Notes on the electron-phonon interaction Springer Science & Business Media
The ELOISATRON (ELN) Project aims at a future proton supercollider with 100-500 TeV energy per beam and 1034-1036 cm-2s-1 luminosity. While the Large Hadron Collider (LHC) is being implemented at CERN, it is very timely to study the feasibility of the next generation of hadron colliders at the extreme limits of energy and luminosity. In this respect, the achievement of extremely high magnetic fields and the production of accelerating rf cavities with very low losses are a crucial point in the actual construction design of such a collider. The search for superconducting materials with suitable properties to be used in this field has gained a new impulse after the discovery of the so-called high temperature superconducting compounds (HTSCs) with superconducting critical temperatures higher than 100 K. Besides the critical temperatures, the transport performances of this class of compounds are still very far from allowing applications in extremely high energy colliders. On the other hand, in the last few years, the technological and scientific improvements obtained for both the HTSCs and the conventional superconducting materials are very promising.This book reviews the recent status of R&D on the rising generation of superconducting materials for accelerator magnets and cavities, and discusses novel aspects and ideas in this domain.
Proceedings of the Yamada Conference XVIII on Superconductivity in Highly Correlated Fermion Systems World Scientific
Understanding the mechanism of the high-temperature superconductors has been a very important topic in condensed matter physics. Researchers have been trying to explain the role of electron-phonon interaction (EPI) in cuprates. Some important properties of the cuprates could not be

explained by conventional BCS theory. This book contains the experimental and theoretical studies on the EPI. The experimental part covers the results of angle-resolved photoemission spectroscopy (ARPES), isotopic effect, elastic neutron scattering study of electron-phonon, lattice role and so on. The theoretical part covers the electron-phonon, polaron and bipolaron, effect of lattice, fine structure in the tunnelling spectra of electron-doped cuprates, identification of the bulk pairing symmetry in high-temperature superconductors.Students and researchers interested in high-temperature superconductors, especially the EPI in cuprates will find this title very useful.
Superconductivity, Superfluids and Condensates Litres
This NATO Advanced Study Institute was the fourth in a series devoted to the subject of phase transitions and instabilities with particular attention to structural phase transforma~ions. Beginning wi th the first Geilo institute in 19'(1 we have seen the emphasis evolve from the simple quasiharmonic soft mode description within the Landau theory, through the unexpected spectral structure re presented by the "central peak" (1973), to such subjects as melting, turbulence and hydrodynamic instabilities (1975). Sophisticated theoretical techniques such as scaling laws and renormalization group theory developed over the same period have brought to this wide range of subjects a pleasing unity. These institutes have been instrumental in placing structural transformations clearly in the mainstream of statistical physics and critical phenomena. The present Geilo institute retains some of the counter cul tural flavour of the first one by insisting whenever possible upon peeking under the skirts of even the most successful phenomenology to catch a glimpse of the underlying microscopic processes. Of course the soft mode remains a useful concept, but the major em phasis of this institute is the microscopic cause of the mode softening. The discussions given here illustrate that for certain important classes of solids the cause lies in the electron phonon interaction. Three major types of structural transitions are considered. In the case of metals and semimetals, the electron phonon interaction relie6 heavily on the topology of the Fermi surface.
Academic Press
Proceedings of the April 1997 seminar. The designation strong fields applies to external static magnetic and/or electric fields that are sufficiently intense to cause alterations in atomic or molecular structure and dynamics. Thirty-eight contributions discuss the behavior and properties of atoms in strong static fields, the fundamental aspects and electronic structure of molecules in strong magnetic fields, the dynamics and aspects of chaos in highly excited Rydberg atoms in external fields, matter in the atmosphere of astrophysical objects (white dwarfs, neutron stars), and quantum nanostructures in strong magnetic fields. Contributors hail from such disparate fields as atomic and molecular physics, theoretical chemistry, and astrophysics. Annotation copyrighted by Book News, Inc., Portland, OR
Electronic Properties of Luttinger Liquid with Electron-phonon Interaction Springer Science & Business Media
These proceedings cover the possible manifestations of electron-phonon interactions in understanding high Tc superconductivity. The results of measurements of different experimental methods have been analysed, and the role played by electrons in superconductivity, taking into account the van Hove singularity, has also been discussed. The pairing of electrons by other bosonic excitations, as well as the effects of strong local electron-lattice interactions are reviewed. Another important point is the ab initio calculations discussed by several authors that remark the importance of electron-phonon effects for high Tc superconductivity.
ELECTRON-PHONON INTERACTION AND ITS EFFECTS IN HEAVY FERMION SYSTEMS Exploring Electron-electron and Electron-phonon Interactions in Strongly Interacting Quantum SystemsElectron-electron and electron-phonon interactions play fundamental roles in condensed matter physics. Strong correlations among electrons and between electrons and phonons lead to beautiful emergent phenomena both in materials and in the models used to describe them. Unfortunately, the complexity induced from the combination of interactions and large numbers of degrees of freedom makes analytically solving these models very difficult, even when greatly simplified. As a consequence, many important questions in many-body physics remain open. For example, the discoveries of charge density wave (CDW) in the pseudogap phase of the unconventional high-temperature cuprate superconductors motivate on-going research on electron-phonon interactions and its effects on the off-diagonal long-range order (ODLRO). In conventional superconductors, the attractive interaction between electrons which is mediated by the electron-phonon interaction is essential for the formation of Cooper pairs. However, if the electron-phonon interaction is sufficiently strong, charge order emerges near commensurate filling to compete with superconductivity. In this thesis, we use a combination of numerical and analytical methods to understand this sort of interplay between different types of order in the microscopic and macroscopic behavior of many-body systems. In Chapter 1, we introduce the Hubbard and Holstein Hamiltonians and the some of the exotic phases and phase transitions which they describe. We also build up some of the connections between numerical solutions of these models and experimental results for superconducting, charge, and spin order. In Chapter 2 and 3, we set up the frameworks of quantum Monte Carlo (QMC) algorithms and machine learning (ML) methods. We show how to translate a quantum-mechanical problem into an algorithm with analytical analysis encoded in it, which can be widely applied to various models and physics. In Chapter 4 and 5, we quantitatively determine the phase diagrams of one dimensional electron-phonon models where electrons have a long-range coupling to phonons as well as repulsive electron-electron interactions. We analyze the resulting metallic, Mott insulator, Peierls insulator phases, as well as the phase separation which we show often arises from momentum-dependent electron-phonon coupling. Although much work has been done on the extended Hubbard model, our research on including electron-phonon interactions pushes the field in a new direction. In Chapter 6, we describe the first study of the interplay between electron-phonon interaction and the effects of randomness. Our central result is a somewhat unexpected one: the suppression of the charge density wave correlations in the half-filled Holstein model by disorder can stabilize a superconducting phase. In Chapter 7, we use QMC and cutting-edge ML methods to identify phase transitions involving 'off-diagonal' order parameters using 'diagonal' order parameter descriptors. Our study has implications for the exploration of strong correlations using quantum gas microscopy (QGM). Chapter 8 summarizes some of the key results of this thesis, and points areas of investigation which would be important to pursue further. The material presented in Chapters 3, 4 and 5 of this dissertation is based on two published articles in Physical Review B, references [1, 2], and one manuscript which has been submitted and is under

review at Physical Review Letters, reference [3]. Chapter 7 is based on reference [4], which is in preparation.Electron-phonon Interactions in Low-dimensional Structures
Electron-electron and electron-phonon interactions play fundamental roles in condensed matter physics. Strong correlations among electrons and between electrons and phonons lead to beautiful emergent phenomena both in materials and in the models used to describe them. Unfortunately, the complexity induced from the combination of interactions and large numbers of degrees of freedom makes analytically solving these models very difficult, even when greatly simplified. As a consequence, many important questions in many-body physics remain open. For example, the discoveries of charge density wave (CDW) in the pseudogap phase of the unconventional high-temperature cuprate superconductors motivate on-going research on electron-phonon interactions and its effects on the off-diagonal long-range order (ODLRO). In conventional superconductors, the attractive interaction between electrons which is mediated by the electron-phonon interaction is essential for the formation of Cooper pairs. However, if the electron-phonon interaction is sufficiently strong, charge order emerges near commensurate filling to compete with superconductivity. In this thesis, we use a combination of numerical and analytical methods to understand this sort of interplay between different types of order in the microscopic and macroscopic behavior of many-body systems. In Chapter 1, we introduce the Hubbard and Holstein Hamiltonians and the some of the exotic phases and phase transitions which they describe. We also build up some of the connections between numerical solutions of these models and experimental results for superconducting, charge, and spin order. In Chapter 2 and 3, we set up the frameworks of quantum Monte Carlo (QMC) algorithms and machine learning (ML) methods. We show how to translate a quantum-mechanical problem into an algorithm with analytical analysis encoded in it, which can be widely applied to various models and physics. In Chapter 4 and 5, we quantitatively determine the phase diagrams of one dimensional electron-phonon models where electrons have a long-range coupling to phonons as well as repulsive electron-electron interactions. We analyze the resulting metallic, Mott insulator, Peierls insulator phases, as well as the phase separation which we show often arises from momentum-dependent electron-phonon coupling. Although much work has been done on the extended Hubbard model, our research on including electron-phonon interactions pushes the field in a new direction. In Chapter 6, we describe the first study of the interplay between electron-phonon interaction and the effects of randomness. Our central result is a somewhat unexpected one: the suppression of the charge density wave correlations in the half-filled Holstein model by disorder can stabilize a superconducting phase. In Chapter 7, we use QMC and cutting-edge ML methods to identify phase transitions involving 'off-diagonal' order parameters using 'diagonal' order parameter descriptors. Our study has implications for the exploration of strong correlations using quantum gas microscopy (QGM). Chapter 8 summarizes some of the key results of this thesis, and points areas of investigation which would be important to pursue further. The material presented in Chapters 3, 4 and 5 of this dissertation is based on two published articles in Physical Review B, references [1, 2], and one manuscript which has been submitted and is under review at Physical Review Letters, reference [3]. Chapter 7 is based on reference [4], which is in preparation.

Phonon Scattering in Condensed Matter VII Springer Science & Business Media

Heat in most semiconductor materials, including the traditional group IV elements (Si, Ge, diamond), III–V compounds (GaAs, wide-bandgap GaN), and carbon allotropes (graphene, CNTs), as well as emerging new materials like transition metal dichalcogenides (TMDCs), is stored and transported by lattice vibrations (phonons). Phonon generation through interactions with electrons (in nanoelectronics, power, and nonequilibrium devices) and light (optoelectronics) is the central mechanism of heat dissipation in nanoelectronics. This book focuses on the area of thermal effects in nanostructures, including the generation, transport, and conversion of heat at the nanoscale level. Phonon transport, including thermal conductivity in nanostructured materials, as well as numerical simulation methods, such as phonon Monte Carlo, Green’s functions, and first principles methods, feature prominently in the book, which comprises four main themes: (i) phonon generation/heat dissipation, (i) nanoscale phonon transport, (iii) applications/devices (including thermoelectrics), and (iv) emerging materials (graphene/2D). The book also covers recent advances in nanophononics—the study of phonons at the nanoscale. Applications of nanophononics focus on thermoelectric (TE) and tandem TE/photovoltaic energy conversion. The applications are augmented by a chapter on heat dissipation and self-heating in nanoelectronic devices. The book concludes with a chapter on thermal transport in nanoscale graphene ribbons, covering recent advances in phonon transport in 2D materials. The book will be an excellent reference for researchers and graduate students of nanoelectronics, device engineering, nanoscale heat transfer, and thermoelectric energy conversion. The book could also be a basis for a graduate special topics course in the field of nanoscale heat and energy.
Electron Phonon Interactions World Scientific
The total scattering rate and the transition probability for electron-phonon interaction in 1-D and 2-D semiconductor materials are calculated in taking into account the finite dimensions of the structure. Although noticeable, size effects on the scattering rate are generally small, with more pronounced features for 1-D structures than for 2-D structures. For 2-D layers, our theory agrees with recent experimental results whereas it contradicts the previous theory predicting large size effects and mass-independent electron-phonon scattering rates. In 1-D structures singularities in the phonon emission rate appear as a natural consequence of the 1-D density of states. However, for high energy the 1-D emission rate is found smaller than the corresponding 3-D rate. An additional consequence of the confinement is the quenching of the phonon absorption rate. Keywords include: Scattering, Electron-phonon, Synthetic semiconductors, Molecular beam epitaxy, and Metalorganic chemical vapor deposition.

Quantum Transport Theory Springer Science & Business Media

This three-volume book provides a comprehensive review of experiments in very strong magnetic fields that can only be generated with very special magnets. The first volume is entirely devoted to the technology of laboratory magnets: permanent, superconducting, high-power water-cooled and hybrid; pulsed magnets, both nondestructive and destructive (megagauss fields). Volumes 2 and 3 contain reviews of the different areas of research where strong magnetic fields are an essential research tool. These volumes deal primarily with solid-state physics; other research areas covered are biological systems, chemistry, atomic and molecular physics, nuclear resonance, plasma physics and astrophysics (including QED).

Electron-phonon Interactions in Novel Nanoelectronics World Scientific
Solid State Physics
Field Theories in Condensed Matter Physics Nova Science Publishers
This book presents a comprehensive description of phonons and their interactions in systems with different dimensions and length scales. Internationally-recognized leaders describe theories and measurements of phonon interactions in relation to the design of materials with exotic properties such as metamaterials, nano-mechanical systems, next-generation electronic, photonic, and acoustic devices, energy harvesting, optical information storage, and applications of phonon lasers in a variety of fields. The emergence of techniques for control of semiconductor properties and geometry has enabled engineers to design structures in which functionality is derived from controlling electron behavior. As manufacturing techniques have greatly expanded the list of available materials and the range of attainable length scales, similar opportunities now exist for designing devices whose functionality is derived from controlling phonon behavior. However, progress in this area is hampered by gaps in our knowledge of phonon transport across and along arbitrary interfaces, the scattering of phonons with crystal defects, interface roughness and mass-mixing, delocalized electrons/collective electronic excitations, and solid acoustic vibrations when these occur in structures with small physical dimensions. This book provides a comprehensive description of phonons and their interactions in systems with different dimensions and length scales. Theories and measurements of phonon interactions are described in relation to the design of materials with exotic properties such as metamaterials, nano-mechanical systems, next-generation electronic, photonic, and acoustic devices, energy harvesting, optical information storage, and applications of phonon lasers in a variety of fields.
Solid State Physics North Holland
This monograph is a radical departure from the conventional quantum mechanical approach to electron-phonon interactions. It translates the customary quantum mechanical analysis of the electron-phonon interactions carried out in Fourier space into a predominantly classical analysis carried out in real space. Various electron-phonon interactions such as the polar and nonpolar optical phonons, acoustic phonons that interact via deformation potential and via the piezoelectric effect and phonons in metals, are treated in this monograph by a single, relatively simple “classical” model. This model is shown to apply to electron interactions with the deep lying X-ray levels of atoms, with plasmons and with Cerenkov radiation. The unifying concept that applies to all of these phenomena is a new definition of a coupling constant. The essentially classical interaction of an electron with its surrounding is clearly brought out to be the cause of spontaneous emission of phonons. The same concept also applies to the case of spontaneous emission of photons. While the bulk of this monograph deals with quanta of phonons and quanta of photons, a discussion of the acousto electric effect which is a purely classical phenomenon is presented. The newly defined coupling constant turns out to be valid too for this discussion. This universality of the coupling constant goes far beyond. It is equally applicable to amorphous materials. This significant application gives an analytic formulation of mobility in amorphous materials. Contents: Energy Losses of Hot ElectronsField and Temperature Dependence of Electronic TransportEnergy Losses by Hot Electrons in Solids: A Semiclassical Approach Readership: Physicists, solid state physicists and electronic engineers.
Cooperative Phenomena Springer Science & Business Media
Alkali-doped fullerides have attracted strong interest since their production became possible about fifteen years ago. This book presents recent work which may solve intriguing problems arising from a variety of remarkable properties. For example, these solids are superconductors with high transition temperatures, although the similarity between the electronic and phonon energy scales should suppress superconductivity. Moreover, the Ioffe-Regel condition for electrical conductivity is strongly violated. The book shows why superconductivity is nevertheless possible, owing to a local pairing mechanism. The Ioffe-Regel condition is derived quantum-mechanically, and it is explained why the underlying assumptions are violated for fullerides and high-Tc cuprates, for example. The book treats electronic and transport properties, reviewing theoretical and experimental results. It focuses on superconductivity, electrical conductivity and metal-insulator transitions, emphasizing the electron-electron and electron-phonon interactions as well as the Jahn-Teller effect.
Size Effects on Polar Optical Phonon Scattering of 1-D and 2-D Electron Gas in Synthetic Semiconductors CRC Press
This monograph is a radical departure from the conventional quantum mechanical approach to electron-phonon interactions. It translates the customary quantum mechanical analysis of the electron-phonon interactions carried out in Fourier space into a predominantly classical analysis carried out in real space. Various electron-phonon interactions such as the polar and nonpolar optical phonons, acoustic phonons that interact via deformation potential and via the piezoelectric effect and phonons in metals, are treated in this monograph by a single, relatively simple ?classical? model. This model is shown to apply to electron interactions with the deep lying X-ray levels of atoms, with plasmons and with Cerenkov radiation. The unifying concept that applies to all of these phenomena is a new definition of a coupling constant. The essentially classical interaction of an electron with its surrounding is clearly brought out to be the cause of spontaneous emission of phonons. The same concept also applies to the case of spontaneous emission of photons. While the bulk of this monograph deals with quanta of phonons and quanta of photons, a discussion of the acousto electric effect which is a purely classical phenomenon is presented. The newly defined coupling constant turns out to be valid too for this discussion. This universality of the coupling constant goes far beyond. It is equally applicable to amorphous materials. This significant application gives an analytic formulation of mobility in amorphous materials.
High Magnetic Fields Cambridge University Press
These notes are a result of a series of lectures given to the MS and PhD students of the Department of Physics, Moscow State Pedagogical University. They deal with the subject of electron-phonon interaction in pure threedimensional metals. The goal was to show how one could calculate the temperature dependence of the electron-phonon-interaction time from first principles within a simple model. Students wishing to expand their knowledge of the subject of condensed matter are invited to study any book on solid-state physics (for example by J.M. Ziman, or N.W. Ashcroft and N.D. Mermin.

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