Theory Of Fluctuations In Superconductors Internat

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Theory Of Superconductivity Springer Science & Business Media
This is a monograph on the fluctuational theory of superconductivity. The theory was originally developed by M. A. Savchenko in 1964 in response to the work of B. T. Matthias, the discoverer of superconductive compounds. Further development of the theory led to the prediction of the existence of high-temperature superconductors among magnetic and nonmagnetic compounds of rare-earth metals, ceramics, and polymers. In 1987 this prediction was experimentally verified by the discovery of high-Tc superconducting rare-earth metal oxides by I. Bednorz and K. Muller. To date, this is the only account that explains consistently all the available data. The theory of high-temperature superconductivity is based on the concept of an enhanced electron-phonon interaction which leads to an attraction between electrons forming superconducting pairs. This interaction is due to the exchange spin fluctu ations (exchange enhancement effect). In compounds in which there is no magnetic ordering except at very low temperatures, such as in rare-earth metal oxides, the electron-phonon interaction is strengthened due to fluctuations in the spins of the conducting electrons. If there is magnetic ordering in a superconductor at a tempera ture higher than or of the same order as the critical superconducting temperature Tc, then the attraction in the electron pairs will be further increased because the Coulomb repulsion is overwhelmed by fluctuations in the spins forming the long-range anti fer romagnetic order.

The Gap Symmetry and Fluctuations in High-Tc Superconductors Springer Science & Business Media
In this dissertation we focus on the investigation of the pairing mechanism in the recently discovered high-temperature superconductor, iron pnictides. Due to the proximity to magnetic instability of the system, we considered short-range spin fluctuations as the major mediating source to induce superconductivity. Our calculation supports the magnetic fluctuations as a strong candidate that drives Cooper-pair formation in this material. We find the corresponding order parameter to be of the so-called ss-wave type and show its evolution with temperature as well as the capability of supporting high transition temperature up to several tens of Kelvin. On the other hand, our itinerant model calculation shows pronounced spin correlation at the observed antiferromagnetic ordering wave vector, indicating the underlying electronic structure in favor of antiferromagnetic state. Therefore, the electronic degrees of freedom could participate both in the magnetic and in the superconducting properties. Our work shows that the interplay between magnetism and superconductivity plays an important role to the understanding of the rich physics in this material. The magnetic-excitation spectrum carries important information on the nature of magnetism and the characteristics of superconductivity. We analyze the spin excitation spectrum in the normal and superconducting states of iron pnictides in the magnetic scenario. As a consequence of the sign-reversed gap structure obtained in the above, a spin resonance mode appears below the superconducting transition temperature. The calculated resonance energy, scaled with the gap magnitude and the magnetic correlation length, agrees well with the inelastic neutron scattering (INS) measurements.

More interestingly, we find a common feature of those short-range spin fluctuations that are capable of inducing a fully gapped ss state is the momentum anisotropy with elongated span along the direction transverse to the antiferromagnetic momentum transfer. This calculated intrinsic anisotropy exists both in the normal and in the superconducting state, which naturally explains the elliptically shaped magnetic responses observed in INS experiments. Our detailed calculation further shows that the magnetic resonance mode exhibits an upward dispersion-relation pattern but anisotropic along the transverse and longitudinal directions. We also perform a qualitative analysis on the relationship between the anisotropic momentum structure of the magnetic fluctuations and the stability of superconducting phase by intraorbital but interband pair scattering to show the consistency of the magnetic mechanism for superconductivity. As discussed for cuprates, an important identification of the mediating boson is from the fermionic spectrum. We study the spectral function in the normal and superconducting state. Not only do we extract the gap magnitude on the electron- and hole-pockets to show the momentum structure of the gap, but also find a peak-dip-hump feature in the electron spectrum, which reflects the feedback from the spin excitations on fermions. This serves as an interpretation of the kink structure observed in ARPES measurements.

Theory of Superconductivity BoD – Books on Demand

Since the discovery of superconductivity, a great number of theoretical and experimental efforts have been made to describe this new phase of matter that emerged in many body systems. In this regard, theoretical models have been presented; the most famous of which was the BCS theory that can only describe conventional superconductors. With the discovery of new class superconductors, the superconducting mechanism became a new challenge in the field of condensed matter physics. This unexpected discovery opened a new area in the history of superconductivity, and experimental researchers started trying to find new compounds in this class of superconductors. These superconductors are often characterized by the anisotropic character in the superconducting gap function with nodes along a certain direction in the momentum space. Since the pairing interaction has an important role in the superconducting gap structure, its determination is very important to explain the basic pairing mechanism.In this regard, this book includes valuable theoretical and experimental discussions about the properties of superconductors. Here you will find valuable research describing the properties of unconventional superconductors.

Modern Aspects Of Superconductivity: Theory Of Superconductivity (Second Edition) Springer Science & Business Media

Since the 1980s, a general theme in the study of high-temperature superconductors has been to test the BCS theory and its predictions against new data. At the same time, this process has engendered new physics, new materials, and new theoretical frameworks. Remarkable advances have occurred in sample quality and in single crystals, in hole and electron doping in the development of sister compounds with lower transition temperatures, and in instruments to probe structure and dynamics. Handbook of High-Temperature Superconductvity is a comprehensive and in-depth treatment of both experimental and theoretical methodologies by the the world's top leaders in the field. The Editor, Nobel Laureate J. Robert Schrieffer, and Associate Editor James S. Brooks, have produced a unified, coherent work providing a global view of high-temperature superconductivity covering the materials, the relationships with heavy-fermion and organic systems, and the many formidable challenges that remain.

The Effect of Fluctuations in Superconducting Alloys Above the Transition Temperature John Wiley & Sons

Since the discovery in 1986 of high temperature superconductors by J. G. Bednorz and K. A. Müller, a considerable progress has been made and several important scientific problems have emerged. Within this NATO Advanced Study Institute our intention was to focus mainly on the controversial topic of the symmetry of the superconducting gap and given the very short coherence length, the role of fluctuations. The Institute on 'The Gap Symmetry and Fluctuations in High- Superconductors' took place in the "Institut d'Etudes Scientifiques de Cargèse" in Corsica, France, between 1 - 13 September 1997. The 110 participantsfrom 18 countries (yet 30 nationalities) including 23 full time lecturers, have spent two memorable weeks in this charming Mediterranean resort. All lecturers were asked to prepare pedagogical papers to clearly present the central physical idea behind specific model or experiment. The better understanding of physics of high temperature superconductivity is certainly needed to guide the development of applications of these materials in high and weak current devices.

Theory of Unconventional Superconductors World Scientific Publishing

A strong spin-orbit interaction and Coulomb repulsion featuring strongly correlated d- and f-electron systems lead to various exotic phase transition including unconventional superconductivity and magnetic multipole order. However, their microscopic origins are long standing problem since they could not be explained based on conventional Migdal-Eliashberg theorem. The book focuses on many-body correlation effects beyond conventional theory for the d- and f-electron systems, and theoretically demonstrates the correlations to play significant roles in "mode-coupling" among multiple quantum fluctuations, which is called U-VC here. The following key findings are described in-depth: (i) spin triplet superconductivity caused by U-VC, (ii) being more important U-VC in f-electron systems due to magnetic multipole degrees of freedom induced by a spin-orbit interaction, and (iii) s-wave superconductivity stabilized cooperatively by antiferromagnetic fluctuations and electron-phonon interaction contrary to conventional understanding. The book provides meaningful step for revealing essential roles of many-body effects behind long standing problems in strongly correlated materials.

Fluctuation Phenomena in High Temperature Superconductors OUP Oxford

The conference on Fluctuations in Superconductors was held at the Asilomar Conference Grounds, Pacific Grove, California, on March 13-15, 1968. It was sponsored by Office of Naval Research, Physics Branch; National Aeronautics and Space Administration, Ames Research Center; and Stanford Research Institute. The scientific staff on ONR and NASA are due special thanks for realizing the desirability of having a small conference in this young and important research area. The purpose of the Conference on Fluctuations in Superconductors was to discuss the theoretical and experimental state-of-the-art of fluctuations in superconductors and to attempt to help optimize the results of future research in this field. Further, one session at the conference was devoted to superfluid helium. The superfluid transition in helium and the transition to superconductivity are very similar and since much basic research has been done on the helium transition region, it was felt a review would be worthwhile. Also, liquid helium usually provides the thermal environment for superconductors so fluctuations in the helium might be a source of noise measured in superconducting circuits. (Author).

Spin Fluctuations in Eliashberg Theory [microform] Springer Nature

Superconductivity; spin-fluctuations; density functional theory; iron based superconductors

Proceedings of the Conference on Fluctuations in Superconductors, Asilomar Conference Grounds, Pacific Grove California, March 13-15, 1968 Springer Science & Business Media

Theory of Superconductivity is primarily intended to serve as a background for reading the literature in which detailed applications of the microscopic theory of superconductivity are made to specific problems.

Spin Fluctuations in High Temperature Superconductors Springer Science & Business Media

High-Temperature Superconductors provides an up-to-date and comprehensive review of the properties of these fascinating materials. Much has been learned about the behavior and mechanism of this novel type of superconductivity over the past five years, but many questions remain unanswered. This book gives an invaluable survey which will help students and researchers to consolidate their knowledge and build upon it. A large number of illustrations and tables give valuable information for specialists. A critical comparison of different theoretical models involving strong electron correlations, spin fluctuations, phonons and excitons provides a background for understanding modern trends in the theory of high-temperature superconductivity.

Introduction to Superconductivity Cambridge University Press

This book describes the theory of superconducting fluctuations, which connects two major topics in statistical physics - the theory of phase transitions and the theory of superconductivity. It presents a complete encyclopedia of superconducting fluctuations, summarising the last thirty-five years of work in the field.

Theory of Multipole Fluctuation Mediated Superconductivity and Multipole Phase CRC Press

This book presents a complete encyclopedia of superconducting fluctuations, summarising the last thirty-five years of work in the field. The first part of the book is devoted to an extended discussion of the Ginzburg-Landau phenomenology of fluctuations in its thermodynamical and time-dependent versions and its various applications. The second part deals with microscopic justification of the Ginzburg-Landau approach and presents the diagrammatic theory of fluctuations. The third part is devoted to a less-detailed review of the manifestation of fluctuations in observables: diamagnetism, magnetoconductivity, various tunneling characteristics, thermoelectricity, and NMR relaxation. The final chapters turn to the manifestation of fluctuations in unconventional superconducting systems: nanodrops, nanorings, Berezinsky-Kosterlitz-Thouless state, quantum phase transition between superconductor and insulator, and thermal and quantum fluctuations in weak superconducting systems. The book ends with a brief discussion on theories of high temperature superconductivity, where fluctuations appear as the possible protagonist of this exciting phenomenon.

Theory on the Pseudogap, Charge Density Wave, Time Reversal Symmetry Breaking Fluctuation, Fermi Arc Formation, and Superconductivity in High Temperature Cuprate Superconductors Springer Science & Business Media

Unconventional superconductivity (or superconductivity with a nontrivial Cooper pairing) is believed to exist in many heavy-fermion materials as well as in high temperature superconductors, and is a subject of great theoretical and experimental interest. The remarkable progress achieved in this field has not been reflected in published monographs and textbooks, and there is a gap between current research and the standard education of solid state physicists in the theory of superconductivity. This book is intended to meet this information need and includes the authors' original results.

Superconducting Fluctuations in Reduced Dimensions Springer Science & Business Media

This thesis combines highly accurate optical spectroscopy data on the recently discovered iron-based high-temperature superconductors with an incisive theoretical analysis. Three outstanding results are reported: (1) The superconductivity-induced modification of the far-infrared conductivity of an iron arsenide with minimal chemical disorder is quantitatively described by means of a strong-coupling theory for spin fluctuation mediated Cooper pairing. The formalism developed in this thesis also describes prior spectroscopic data on more disordered compounds. (2) The same materials exhibit a sharp superconductivity-induced anomaly for photon energies around 2.5 eV, two orders of magnitude larger than the superconducting energy gap. The author provides a qualitative interpretation of this unprecedented observation, which is based on the multiband nature of the superconducting state. (3) The thesis also develops a comprehensive description of a superconducting, yet optically transparent iron chalcogenide compound. The author shows that this highly unusual behavior can be explained as a result of the nanoscopic coexistence of insulating and superconducting phases, and he uses a combination of two complementary experimental methods - scanning near-field optical microscopy and low-energy muon spin rotation - to directly image the phase coexistence and quantitatively determine the phase composition. These data have important implications for the interpretation of data from other experimental probes.

Theory of Heavy Fermions and Valence Fluctuations OUP Oxford

"High-Tc Superconductivity" is based on a meeting held in Kiev and contains contributions discussing the most recent achievements in this field. The book includes reviews and original papers covering theoretical and experimental aspects of the subject. Keywords: electronic and magnetic properties, metallization processes, emission and optic spectra, lavitation, pinning, frustration and fluctuations, thin films

On the Properties of Novel Superconductors Courier Corporation

This book covers the important contributions of the Chinese during the development of high-temperature superconductors (HTS). The study of Y-based HTS, which was the first to be reported internationally at a liquid nitrogen temperature above 90 K, has retained the world record for superconducting transition temperatures. The book covers the study of superconducting energy gap, microscopic electron non-uniformity, ARPES research, 'kinks' research, eHigh-T^c. In order to provide a comprehensive introduction to the physical properties of condensed matter, this book also includes studies on the thermodynamic properties of high-temperature superconductors, low-temperature heat transport, and Raman spectroscopy. In addition, this book includes important topics in theoretical studies, including the study of the magnetic and superconductivity of iron-based materials, the non-diagonal long procedure in condensed quantum phases, and the creation of oxygen sites in the CuO_2 plane. Rotational fluctuations lead to the study of superconducting states. This book is suitable for researchers and graduate students in condensed matter physics, materials science, optics and other fields.

Fluctuational Superconductivity of Magnetic Systems Springer Science & Business Media

This extensive and comprehensive handbook systematically reviews the basic physics, theory and recent advances in superconductivity. Covering the entire field, this unparalleled resource carefully blends theoretical studies with experimental results to provide an indispensable foundation for further research. Leading researchers, including Nobel laureates, describe the state of the art in conventional and unconventional superconductors. In addition to full-coverage of novel materials and underlying mechanisms, the handbook reflects continued, intense research into electron-phone based superconductivity.

Functional Integral Methods in the Study of Critical Fluctuations in Superconductors Springer Science & Business Media

This book presents the anisotropy and multiband effects in newly discovered unconventional superconductors: cuprate superconductors, borocarbides, magnezium-diboride and oxypnictides. The physical properties of these unconventional superconductors and the application of the two-band Ginzburg-Landau theory to these superconducting compounds are explained. Temperature dependencies of fundamental superconducting parameters are calculated using the GL theory taking into account multiband-and anisotropy effects. A comparision of theoretical results and experimental data is conducted. Additionally, the analytical solution of the microscopical Eliashberg theory and of the BCS theory is developed for two-band and anisotropic superconductors. Fluctuation effects in newly discovered superconductors are also discussed.

Theory of Spin-fluctuation Induced Superconductivity in Iron-based Superconductors Springer Science & Business Media

These Proceedings of a NATO-ARW (HTECH ARW 96 00 52) held at the International Center for Theoretical Physics, Trieste, Italy from Aug 5 till Aug 9, 1996 resulted from many discussions between various workers, concerning the need for a gathering of all (if possible) who were concerned about the subject of superconductivity fluctuations in High critical Temperature Superconductors (HTS). It appeared to many that the Skocpol-Tinkham work of 1975 had to be revitalized in view of the discovery of the new superconducting ceramics and the enormous amount of work having already taken place. The study of HTS is one of the most prominent research subject in solid state sciences. The understanding of the role of fluctuations is also thought to be necessary before technological applications since the fluctuations may destroy the superconducting state. The workshop discussions have touched upon (i) Superconducting fluctuations in the vicinity of the critical transition, (ii) Superconductivity fluctuations near the percolation transition, and (iii) Fluctuations of the vortex lattice at the lattice melting temperature. These topics served as initiators for a very great amount of discussions with many comments from the audience. More than forty "long lectures" and two "poster sessions" were held. Private discussions going unrecorded but obviously took place at many locations : lecture halls, staircases, cafetaria, bedrooms, bars, beach, . . .

Ginzburg-Landau Theory of Transport Properties and Fluctuations in Type-II Superconductors Springer Nature

This thesis makes significant advances towards an understanding of superconductivity in the cuprate family of unconventional, high-temperature superconductors. Even though the high-temperature superconductors were discovered over 35 years ago, there is not yet a general consensus on an acceptable theory of superconductivity in these materials. One of the early proposals suggested that collective magnetic excitations of the conduction electrons could lead them to form pairs, which in turn condense to form the superconducting state at a critical temperature Tc. Quantitative calculations of Tc using experimental data were, however, not available to verify the applicability of this magnetic mechanism. In this thesis, the author constructed an angle-resolved photoemission apparatus that could provide sufficiently accurate data of the electronic excitation spectra of samples in the normal state, data which was furthermore unusually devoid of any surface contamination. The author also applied the Bethe-Salpeter method to his uncommonly pristine and precise normal state data, and was able to predict the approximate superconducting transition temperatures of different samples. This rare combination of experiment with sophisticated theoretical calculations leads to the conclusion that antiferromagnetic correlations are a viable candidate for the pairing interaction in the cuprate superconductors.