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Ginzburg-Landau Phase Transition Theory and Superconductivity

Ginzburg-Landau Phase Transition Theory and Superconductivity

Nelson Thornes *This monograph compiles, rearranges, and refines recent research results in the complex G-L theory with or without immediate applications to the theory of superconductivity. An authoritative reference for applied mathematicians, theoretical physicists and engineers interested in the quantitative description of superconductivity using Ginzburg-Landau theory.*

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The Physics of Solids

Oxford University Press *This comprehensive text covers the basic physics of the solid state starting at an elementary level suitable for undergraduates but then advancing, in stages, to a graduate and advanced graduate level. In addition to treating the fundamental elastic, electrical, thermal, magnetic, structural, electronic, transport, optical, mechanical and compositional properties, we also discuss topics like superfluidity and superconductivity along with special topics such as strongly correlated systems, high-temperature superconductors, the quantum Hall effects, and graphene. Particular emphasis is given to so-called first principles calculations utilizing modern density functional theory which for many systems now allow accurate calculations of the electronic, magnetic, and thermal properties.*

Collected Papers of L.D. Landau

Elsevier *Collected Papers of L. D. Landau brings together the collected papers of L. D. Landau in the field of physics. The discussion is divided into the following sections: low-temperature physics (including superconductivity); solid-state physics; plasma physics; hydrodynamics; astrophysics; nuclear physics and cosmic rays; quantum mechanics; quantum field theory; and miscellaneous works. Topics covered include the intermediate state of supraconductors; the absorption of sound in solids; the properties of metals at very low temperatures; and production of showers by heavy particles. This volume is comprised of 100 chapters and begins with Landau's paper on the theory of the spectra of diatomic molecules, followed by his studies on the damping problem in wave mechanics; quantum electrodynamics in configuration space; electron motion in crystal lattices; and the internal temperature of stars. Some of Landau's theories, such as those of stars, energy transfer on collisions, phase transitions, and specific heat anomalies are discussed. Subsequent chapters focus on the structure of the undisplaced scattering line; the transport equation in the case of Coulomb interactions; scattering of light by light; and the origin of stellar energy. This book will be a valuable resource for physicists as well as physics students and researchers.*

On Superconductivity and Superfluidity

A Scientific Autobiography

Springer Science & Business Media *A Nobel Laureate presents his view of developments in the field of superconductivity, superfluidity and related theory. The book contains Ginzburg's amended version of the Nobel lecture in Physics 2003, as well as his expanded autobiography.*

Ginzburg-Landau Phase Transition Theory and Superconductivity

Birkhäuser *This monograph compiles, rearranges, and refines recent research results in the complex G-L theory with or without immediate applications to the theory of superconductivity. An authoritative reference for applied mathematicians, theoretical physicists and engineers interested in the quantitative description of superconductivity using Ginzburg-Landau theory.*

Theory Of Superconductivity

CRC Press *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.*

Introduction to Unconventional Superconductivity

CRC Press *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.*

Theory of Fluctuations in

Superconductors

OUP Oxford *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.*

Numerical Mathematics

Springer Science & Business Media "*In truth, it is not knowledge, but learning, not possessing, but production, not being there, but travelling there, which provides the greatest pleasure. When I have completely understood something, then I turn away and move on into the dark; indeed, so curious is the insatiable man, that when he has completed one house, rather than living in it peacefully, he starts to build another. " Letter from C. F. Gauss to W. Bolyai on Sept. 2, 1808 This textbook adds a book devoted to applied mathematics to the series "Grundwissen Mathematik. " Our goals, like those of the other books in the series, are to explain connections and common viewpoints between various mathematical areas, to emphasize the motivation for studying certain prob lem areas, and to present the historical development of our subject. Our aim in this book is to discuss some of the central problems which arise in applications of mathematics, to develop constructive methods for the numerical solution of these problems, and to study the associated questions of accuracy. In doing so, we also present some theoretical results needed for our development, especially when they involve material which is beyond the scope of the usual beginning courses in calculus and linear algebra. This book is based on lectures given over many years at the Universities of Freiburg, Munich, Berlin and Augsburg.*

Superconductivity

In Two Parts:

Routledge *First published in 1969. CRC Press is an imprint of Taylor & Francis.*

Superconductivity

Physics and Applications

John Wiley & Sons *Superconductivity: Physics and Applications brings together major developments that have occurred within the field over the past twenty years. Taking a truly modern approach to the subject the authors provide an interesting and accessible introduction. Brings a fresh approach to the physics of superconductivity based both on the well established and convergent picture for most low-Tc superconductors, provided by the BCS theory at the microscopic level, and London and Ginzburg-Landau theories at the phenomenological level, as well as on experiences gathered in high-Tc research in recent years. Includes end of chapter problems and numerous relevant examples Features brief interviews with key researchers in the field A prominent feature of the book is the use of SI units throughout, in contrast to many of the current textbooks on the subject which tend to use cgs units and are considered to be outdated*

Modern Aspects Of Superconductivity: Theory Of Superconductivity (Second Edition)

World Scientific *This book is devoted to superconductivity, which is one of the most interesting problems in physics. In accordance with the outline of the book, it treats the key problems in the field of superconductivity, in particular, it discusses the mechanism(s) of superconductivity. This book is useful for researchers and graduate students in the fields of solid state physics, quantum field theory, and many-body theory.*

Superconductivity

Academic Press *Superconductivity covers the nature of the phenomenon of superconductivity. The book discusses the fundamental principles of superconductivity; the essential features of the superconducting state-the phenomena of zero resistance and perfect diamagnetism; and the properties of the various classes of superconductors, including the organics, the buckministerfullerenes, and the precursors to the cuprates. The text also describes superconductivity from the viewpoint of thermodynamics and provides expressions for the free energy; the Ginzburg-Landau and BCS theories; and the structures of the*

high temperature superconductors. The band theory; type II superconductivity and magnetic properties; and the intermediate and mixed states are also considered. The book further tackles critical state models; various types of tunneling and the Josephson effect; and other transport properties. The text concludes by looking into spectroscopic properties. Physicists and astronomers will find the book invaluable.

Superconductivity, Superfluids and Condensates

Oxford University Press *This textbook series has been designed for final year undergraduate and first year graduate students, providing an overview of the entire field showing how specialized topics are part of the wider whole, and including references to current areas of literature and research.*

Finite-Size Scaling

Elsevier *Over the past few years, finite-size scaling has become an increasingly important tool in studies of critical systems. This is partly due to an increased understanding of finite-size effects by analytical means, and partly due to our ability to treat larger systems with large computers. The aim of this volume was to collect those papers which have been important for this progress and which illustrate novel applications of the method. The emphasis has been placed on relatively recent developments, including the use of the &egr;-expansion and of conformal methods.*

Phase Transition Approach to High Temperature Superconductivity

Universal Properties of Cuprate Superconductors

World Scientific *The discovery of superconductivity at 30 K by Bednorz and Müller in 1986 ignited an explosion of interest in high temperature superconductivity. The initial development rapidly evolved into an intensive worldwide research effort — which still persists after more than a decade — to understand the phenomenon of cuprate superconductivity, to search for ways to raise the transition temperature and to produce materials which have the potential for technological applications. During the past decade of research on this subject, significant progress has been made on both the fundamental science and technological application fronts. A great deal of experimental data is now available on the cuprates, and various properties have been well characterized using high quality single crystals and thin films. Despite this enormous research effort, however, the underlying mechanisms responsible for*

superconductivity in the cuprates are still open to question. This book offers an understanding from the phase transition point of view, surveys and identifies thermal and quantum fluctuation effects, identifies material-independent universal properties and provides constraints for the microscopic description of the various phenomena. The text is presented in a format suitable for use in a graduate level course. Contents:Ginzburg–Landau PhenomenologyGaussian Thermal FluctuationsSuperfluidity and the n-Vector ModelUniversality and Scaling Theory of Classical Critical Phenomena at Finite TemperatureExperimental Evidence for Classical Critical BehaviorQuantum Phase TransitionsImplicationsMean Field TreatmentXY ModelQuantum Phase TransitionsBCS TheorySuperconducting Properties of the Attractive Hubbard Model Readership: Researchers and graduate students interested in superconductivity. Keywords:High Temperature Superconductivity;Cuprate Superconductors;Ginzburg-Landau Phenomenology;Gaussian Thermal Fluctuations

Ginzburg-Landau Analysis of D-wave Superconductivity

Superconductivity of Metals and Cuprates

CRC Press *Superconductivity of Metals and Cuprates covers the basic physics of superconductivity, both the theoretical and experimental aspects. The book concentrates on important facts and ideas, including Ginzburg-Landau equations, boundary energy, Green's function methods, and spectroscopy. Avoiding lengthy or difficult presentations of theory, it is written in a clear and lucid style with many useful, informative diagrams. The book is designed to be accessible to senior undergraduate students, making it a helpful tool for teaching superconductivity as well as serving as an introduction to those entering the field.*

Theory of Superconductivity

World Scientific *This book discusses the most important aspects of the theory. The phenomenological model is followed by the microscopic theory of superconductivity, in which modern formalism of the many-body theory is used to treat most important problems such as superconducting alloys, coexistence of superconductivity with the magnetic order, and superconductivity in quasi-one-dimensional systems. It concludes with a discussion on models for exotic and high temperature superconductivity. Its main aim is to review, as complete as possible, the theory of superconductivity from classical models and methods up to the 1987 results on high temperature superconductivity. Contents:Phenomenological Theory of Superconductivity:Experimental FactsGorter-Casimir Two-Fluid ModelElectrodynamics of SuperconductorsGinzburg-Landau Theory of*

SuperconductivityJosephson TunnellingInfluence of FluctuationsType-II SuperconductorsMicroscopic Theory of Superconductivity:Cooper Instability of Fermi GasSelf-Consistent Field Method — Gor'kov EquationsLinear Response to Magnetic FieldMicroscopic Derivation of Ginzburg-Landau EquationsQuasiclassical ApproximationStrong — Coupling Theory of SuperconductivitySpin Fluctuations in SuperconductorsTriplet PairingTheory of Superconducting Alloys:Influence of Impurities on the Superconducting StateInfluence of Correlated Spins on the Critical Temperature SuperconductorNonmagnetic Localized States in Superconducting AlloysKondo Effect in SuperconductorsLocalization and SuperconductivitySuperconductors in a Magnetic Field:Paramagnetic Effects in SuperconductorsCritical Fields of a SuperconductorSuperconductivity and Magnetic Order:Superconductivity and FerromagnetismSuperconductivity and AntiferromagnetismMagnetic Structures in SuperconductorsSuperconductivity in Quasi-One-Dimensional Systems:Superconductivity and Charge-Density-WavesCoexistence Between Spin-Density-Waves and SuperconductivityUnconventional Superconductivity:Non-Phononic MechanismsHeavy-Fermions SuperconductivityHigh-Temperature Superconductivity Readership: Condensed matter physicists, theoretical physicists and chemical physicists. Keywords:Fenomenological Theory;Microscopic Theory;Effect of Impurities;Coexistence between Superconductivity and Magnetic Order;Critical Fields;Effect of Magnetic Field;Nonconventional Superconductivity

Advances in Solid State Theory

Morgan & Claypool Publishers *This book will introduce advanced concepts and topics of solid-state theory. To this end we need a tool box that enables us to treat electron–electron interactions, and possibly also electron–phonon or phonon–phonon interactions in some well-defined, appro*

Phase Transition Dynamics

Springer Science & Business Media *This book is an introduction to a comprehensive and unified dynamic transition theory for dissipative systems and to applications of the theory to a range of problems in the nonlinear sciences. The main objectives of this book are to introduce a general principle of dynamic transitions for dissipative systems, to establish a systematic dynamic transition theory, and to explore the physical implications of applications of the theory to a range of problems in the nonlinear sciences. The basic philosophy of the theory is to search for a complete set of transition states, and the general principle states that dynamic transitions of all dissipative systems can be classified into three categories: continuous, catastrophic and random. The audience for this book includes advanced graduate students and researchers in mathematics and physics as well as in other related fields.*

Novel Superfluids

Oxford University Press *This book reports on the latest developments in the field of Superfluidity, one of the most fundamental, interesting, and important problems in physics, with applications ranging from metals, helium liquids, photons in cavities, excitons in semiconductors, to the interior of neutron stars and the present state of the Universe as a whole.*

Connectivity and Superconductivity

Springer Science & Business Media *The motto of connectivity and superconductivity is that the solutions of the Ginzburg–Landau equations are qualitatively in?uenced by the topology of the boundaries. Special attention is given to the “zero set”,the set of the positions (usually known as “quantum vortices”) where the order parameter vanishes. The paradigm of connectivity and superconductivity is the Little– Parks e?ect,discussed in most textbooks on superconductivity. This volume is intended to serve as a reference book for graduate students and researchers in physics or mathematics interested in superconductivity, or in the Schr¨ odinger equation as a limiting case of the Ginzburg–Landau equations. The e?ects considered here usually become important in the regime where the coherence length is of the order of the dimensions of the sample. While in the Little–Parks days a lot of ingenuity was required to achieve this regime, present microelectronic techniques have transformed it into a routine. Mo- over,measurement and visualization techniques are developing at a pace which makes it reasonable to expect veri?cation of distributions,and not only of global properties. Activity in the ?eld has grown and diversi?ed substantially in recent years. We have therefore invited experts ranging from experimental and theoretical physicists to pure and applied mathematicians to contribute articles for this book. While the skeleton of the book deals with superconductivity,micron- works and generalizations of the Little–Parks situation,there are also articles which deal with applications of the Ginzburg–Landau formalism to several fundamental topics,such as quantum coherence,cosmology,and questions in materials science.*

Statistical Mechanics of Phase Transitions

Clarendon Press *The book provides an introduction to the physics which underlies phase transitions and to the theoretical techniques currently at our disposal for understanding them. It will be useful for advanced undergraduates, for post-graduate students undertaking research in related fields, and for established researchers in experimental physics, chemistry, and metallurgy as an exposition of current theoretical understanding. - ;Recent developments have led to a good understanding of universality; why phase transitions in systems as diverse as magnets, fluids, liquid crystals, and superconductors can be brought under the same*

theoretical umbrella and well described by simple models. This book describes the physics underlying universality and then lays out the theoretical approaches now available for studying phase transitions. Traditional techniques, mean-field theory, series expansions, and the transfer matrix, are described; the Monte Carlo method is covered, and two chapters are devoted to the renormalization group, which led to a break-through in the field. The book will be useful as a textbook for a course in `Phase Transitions', as an introduction for graduate students undertaking research in related fields, and as an overview for scientists in other disciplines who work with phase transitions but who are not aware of the current tools in the armoury of the theoretical physicist. - ;Introduction; Statistical mechanics and thermodynamics; Models; Mean-field theories; The transfer matrix; Series expansions; Monte Carlo simulations; The renormalization group; Implementations of the renormalization group. -

Introduction to Superconductivity Second Edition

Courier Corporation *Accessible to graduate students and experimental physicists, this volume emphasizes physical arguments and minimizes theoretical formalism. Topics include the Bardeen-Cooper-Schrieffer and Ginzburg-Landau theories, magnetic properties of classic type II superconductors, the Josephson effect, fluctuation effects in classic superconductors, high-temperature superconductors, and nonequilibrium superconductivity. 109 figures. 1996 edition.*

Topological Insulators and Topological Superconductors

Princeton University Press *This graduate-level textbook is the first pedagogical synthesis of the field of topological insulators and superconductors, one of the most exciting areas of research in condensed matter physics. Presenting the latest developments, while providing all the calculations necessary for a self-contained and complete description of the discipline, it is ideal for graduate students and researchers preparing to work in this area, and it will be an essential reference both within and outside the classroom. The book begins with simple concepts such as Berry phases, Dirac fermions, Hall conductance and its link to topology, and the Hofstadter problem of lattice electrons in a magnetic field. It moves on to explain topological phases of matter such as Chern insulators, two- and three-dimensional topological insulators, and Majorana p-wave wires. Additionally, the book covers zero modes on vortices in topological superconductors, time-reversal topological superconductors, and topological responses/field theory and topological indices. The book also analyzes recent topics in condensed matter theory and concludes by surveying active subfields of research such as insulators with point-group symmetries and the stability of topological semimetals. Problems at the end of each*

chapter offer opportunities to test knowledge and engage with frontier research issues. Topological Insulators and Topological Superconductors will provide graduate students and researchers with the physical understanding and mathematical tools needed to embark on research in this rapidly evolving field.

Handbook of Superconductivity

Elsevier *The field of superconductivity has tremendous potential for growth and further development in industrial applications. The subject continues to occupy physicists, chemists, and engineers interested in both the phenomena itself and possible financially viable industrial devices utilizing the physical concepts. For the past five years, within the publications of the American Physical Society, for example, 40%-60% of all articles submitted to major journals in the area of Solid State Physics have been on the subject of superconductivity, including the newer, extremely important subfield of high temperature superconductivity (high Tc). The present volume is the first handbook to address this field. It covers both "classic" superconductivity-related topics and high Tc. Numerous properties, including thermal, electrical, magnetic, mechanical, phase diagrams, and spectroscopic crystallographic structures are presented for many types of superconductors. Critical fields, critical currents, coherence lengths, penetration depths, and transition temperatures are tabulated. First handbook on Superconductivity Coherence lengths and depths are tabulated Crystallographic structures of over 100 superconductor types Main results of several theories are submitted Phase diagrams for synthesizing new superconductors are included*

Order, Disorder and Criticality

Advanced Problems of Phase Transition Theory

World Scientific *This book reviews some of the classic aspects in the theory of phase transitions and critical phenomena, which has a long history. Recently, these aspects are attracting much attention due to essential new contributions. The topics presented in this book include: mathematical theory of the Ising model; equilibrium and non-equilibrium criticality of one-dimensional quantum spin chains; influence of structural disorder on the critical behaviour of the Potts model; criticality, fractality and multifractality of linked polymers; field-theoretical approaches in the superconducting phase transitions. The book is based on the review lectures that were given in Lviv (Ukraine) in March 2002 at the “Ising lectures” — a traditional annual workshop on phase transitions and critical phenomena which aims to bring together scientists working in the field of phase transitions with university students and those who are interested in the subject. Contents:Mathematical Theory of the Ising Model and Its Generalizations: An Introduction (Y Kozitsky)Relaxation in Quantum Spin Chains: Free Fermionic Models (D Karevski)Quantum Phase*

Transitions in Alternating Transverse Ising Chains (O Derzhko)Phase Transitions in Two-Dimensional Random Potts Models (B Berche & C Chatelain)Scaling of Miktoarm Star Polymers (C von Ferber)Field Theoretic Approaches to the Superconducting Phase Transition (F S Nogueira & H Kleinert) Readership: Researchers, academics and graduate students in condensed matter physics. Keywords:Phase Transitions;Disorder;Critical Phenomena;Renormalization Group;Ising Model;Potts Model

Stochastic Transport in Complex Systems

From Molecules to Vehicles

Elsevier *The first part of the book provides a pedagogical introduction to the physics of complex systems driven far from equilibrium. In this part we discuss the basic concepts and theoretical techniques which are commonly used to study classical stochastic transport in systems of interacting driven particles. The analytical techniques include mean-field theories, matrix product ansatz, renormalization group, etc. and the numerical methods are mostly based on computer simulations. In the second part of the book these concepts and techniques are applied not only to vehicular traffic but also to transport and traffic-like phenomena in living systems ranging from collective movements of social insects (for example, ants) on trails to intracellular molecular motor transport. These demonstrate the conceptual unity of the fundamental principles underlying the apparent diversity of the systems and the utility of the theoretical toolbox of non-equilibrium statistical mechanics in interdisciplinary research far beyond the traditional disciplinary boundaries of physics. Leading industry experts provide a broad overview of the interdisciplinary nature of physics Presents unified descriptions of intracellular, ant, and vehicular traffic from a physics point of view Applies theoretical methods in practical everyday situations Reference and guide for physicists, engineers and graduate students*

Ginzburg-Landau Vortices

World Scientific *The Ginzburg-Landau equation us a mathematical model of superconductors has become an extremely useful tool in many areas of physics where vortices carrying a topological charge appear. The remarkable progress in the mathematical understanding of this equation involves a combined use of mathematical tools from many branches of mathematics. The Ginzburg-Landau model has been an amazing source of new problems and new ideas in analysis, geometry and topology. This collection will meet the urgent needs of the specialists, scholars and graduate students working in this area or related areas.*

Topological Defects and the Non-Equilibrium Dynamics of Symmetry Breaking Phase Transitions

Springer Science & Business Media *Topological defects formed at symmetry-breaking phase transitions play an important role in many different fields of physics. They appear in many condensed-matter systems at low temperature; examples include vortices in superfluid helium-4, a rich variety of defects in helium-3, quantized mag netic flux tubes in type-II superconductors, and disclination lines and other defects in liquid crystals. In cosmology, unified gauge theories of particle interactions suggest a sequence of phase transitions in the very early uni verse some of which may lead to defect formation. In astrophysics, defects play an important role in the dynamics of neutron stars. In 1997 the European Science Foundation started the scientific network "Topological defects" headed by Tom Kibble. This network has provided us with a unique opportunity of establishing a collaboration between the representatives of these very different branches of modern physics. The NATO-ASI (Advanced Study Institute), held in Les Houches in February 1999 thanks to the support of the Scientific Division of NATO, the European Science Foundation and the CNRS, represents a key event of this ESF network. It brought together participants from widely different fields, with diverse expertise and vocabulary, fostering the exchange of ideas. The lectures given by particle physicists, cosmologists and condensed matter physicists are the result of the fruitful collaborations established since 1997 between groups in several European countries and in the U.S.A.*

Introduction to Liquid Crystals

Springer Science & Business Media *The existence of liquid crystals has been known for nearly a centu ry; yet it is only in the last ten years that their unique optical, electri cal, electro-optic, and thermal properties have been exploited to any significant extent in such technological applications as digital d~ plays and thermography. Digital watches equipped with liquid-crys tal displays (LCD's) have recently made their debut in the electronic watch market, and the large-scale use of LCD's in a variety of other applications requiring reliable, low-power digital displays is immi nent. There is good reason to believe that liquid crystals will be the first electro-optic materials to find widespread commercial use. Apart from applications, liquid crystals are unique among the phases of matter. Lurking beneath their garish display of color and texture is a great complexity of physical and chemical interaction that is only now beginning to unfold in the face of a decade-old resurgence in all aspects of liquid~rystal research. RCA Laboratories has participated in this resurgence from its beginning in the early 1960's and at present maintains active liquid-crystal programs both in basic re search and in device engineering. In*

view of the widespread interest in liquid crystals at RCA Labo ratories, an in-house weekly seminar devoted to the subject of liquid crystals was organized in the fall of 1973. The resulting lectures were subsequently published in three issues of the RCA Review and, with the incorporation of much additional material, eventually grew into the present volume.

Introduction to Many-Body Physics

Cambridge University Press *A modern, graduate-level introduction to many-body physics in condensed matter, this textbook explains the tools and concepts needed for a research-level understanding of the correlated behavior of quantum fluids. Starting with an operator-based introduction to the quantum field theory of many-body physics, this textbook presents the Feynman diagram approach, Green's functions and finite-temperature many-body physics before developing the path integral approach to interacting systems. Special chapters are devoted to the concepts of Fermi liquid theory, broken symmetry, conduction in disordered systems, superconductivity and the physics of local-moment metals. A strong emphasis on concepts and numerous exercises make this an invaluable course book for graduate students in condensed matter physics. It will also interest students in nuclear, atomic and particle physics.*

Quantum Phase Transitions and Enhancement of Superconductivity by a Parallel Magnetic Field in Two Dimensional Superconductors

ABSTRACT: This dissertation describes several studies of superconducting phenomena in two dimensions. We have investigated the superconductor:insulator quantum phase transitions (SITs) tuned by several parameters, namely disorder (d), magnetic field (B), and magnetic impurities (MI). The films have been examined through electrical transport measurements and tunneling spectroscopy. Our experiments are carried out in a unique experimental setup which has allowed us to study these three SITs in situ on the same sample. There are two major theoretical frameworks to describe the superconductor:insulator transitions. One theory calls for a transition from a superconductor to a fermionic insulator. The other points to an bosonic insulator with localized Cooper pairs and itinerant vortices. Our experimental capabilities let us make direct comparisons of the SITs and comment on the nature of transition. We consider the MI:tuned SIT a canonical example of an SIT in the fermionic framework. The resistive transitions in the superconducting state are sharp, the phase boundary is well defined, and the insulating state shows weakly insulating behavior. The B:tuned SIT is representative of a bosonic SIT. In this case, the resistive transitions broaden as magnetic field strength is increased and there is

no distinct boundary between the superconducting and insulating phases. Transport reveals a likely activated behavior just on the insulating side of the transition indicative of localized superconductivity. At higher magnetic fields, the temperature dependence weakens, possibly to logarithmic, signaling a break up of Cooper pairs into single electrons. Direct evidence of localized Cooper pairs comes via tunneling spectroscopy measurements on d:tuned granular films where full, bulk superconducting energy gaps are measured in the global insulating state. We have performed transport and tunneling spectroscopy measurements of the d:tuned SIT on amorphous Pb films. The transport behavior is qualitatively similar to what we observed for the MI:tuned SIT. We will also show that our observations of the B:tuned SIT on amorphous Pb films are analogous to the d:tuned SIT on granular films. One goal of our studies was to use tunneling spectroscopy to probe the nature of the insulating states of the d:tuned and MI:tuned SITs. We were only able to complete preliminary measurements on the d:tuned transition, however they are consistent with previous experiments in which increasing disorder leads to a decrease of TC and a concomitant suppression of the normal state density of state (DOS). Our in:house designed and fabricated sample rotation system affords us the opportunity to study the same sample in both perpendicular and parallel magnetic field orientations in situ without breaking vacuum. This capability led us to the observation of parallel magnetic field enhanced superconductivity in amorphous Pb films and the 2:D electron gas at the heteroepitaxial interface of the band insulators LaAlO3 and SrTiO3. We found that the mean field TC of the a:Pb films can be enhanced by as much as 13% above the zero:field value. A qualitatively similar field:enhancement effect has been observed in the LaAlO3/SrTiO3 interfacial superconductor. Moreover, our experiments show the field:enhancement is strongly dependent on the film thickness and magnetic impurity concentration. Clearly, the Bardeen Cooper Schrieffer (BCS) and Ginzburg:Landau (GL) theories of superconductivity do not contain the physics which would account for field:enhanced superconductivity. Presently, we do not have a complete theoretical understanding of the enhancement effect. However, our experimental results have placed significant constraints on any viable theoretical model. In this dissertation, several theoretical explanations of parallel field:enhanced superconductivity are discussed and compared with our observations.

Superconductivity

Part 2 (In Two Parts)

CRC Press *This book contains a full exposition of the Bardeen-Cooper-Schrieffer (BCS) theory and its experimental verification, the Ginzburg-Landau theory, and the Gor'kov treatment of superconductivity. It discusses the fundamental experiments on macroscopic quantum phenomena and the Josephson effect.*

Composite Superconductors

CRC Press *This reference examines the tremendous benefits produced by the use of superconductivity, including the realization of a commercial fusion reactor for the generation of electricity. Providing a comprehensive coverage of superconductivity and magnet design - incorporating background information for beginners as well as research advances for specialists - this work: discusses the historical development of superconductivity and its engineering applications; explains the mechanical properties of the metal matrix composite; describes the important electromagnetic factors for the design of composite superconductors; analyzes the fabrication and optimization of various composite superconductors; and assesses the future development of high Tc oxide superconductors for engineering applicaitons.;This title is intended for: physicists; metallurgists; materials scientists; materials, electrical, mechanical, cryogenic and medical engineers; and graduate students in these disciplines.*

The Physics of Superconductors

Vol. I. Conventional and High-Tc Superconductors

Springer Science & Business Media *This is the first volume of a comprehensive two-volume treatise on superconductivity that represents the first such publication since the earlier work by R. Parks. It systematically reviews the basic physics and recent advances in the field. Leading researchers describe the state of the art in conventional phonon-induced superconductivity, high-Tc superconductivity, and novel superconductivity. After an introduction and historical overview, the leaders in the special fields of research give a comprehensive survey of the basics and the state of the art in chapters covering the entire field of superconductivity, including conventional and unconventional superconductors. Important new results are reported in a manner intended to stimulate further research. Numerous illustrations, diagrams and tables make this book especially useful as a reference work for students, teachers, and researchers. The second volume treats novel superconductors.*

Advanced Ceramics and Future Materials

John Wiley & Sons *Starting out from the fundamentals, this book covers the chemistry and physics of ceramic materials, as well as their behavior and resulting properties, including bio-inspired approaches and microstructural aspects. As such, it presents production methods as well as the scientific background, teaching all*

important mathematical methods: classical, quantum-mechanical, phenomenological, and model-based approaches. Further emphasis is laid upon the current state of the art and possible developments and challenges within the near future.