Theory Of Nonequilibrium Superconductivity The Int

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.

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 me chanical 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 indi vidual 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 parti cular subject. Each chapter provides an introduction and overview, empha sizing theoretical as well as experimental work, and includes references to both recent and pioneering earlier developments. In this way non-expert rea ders will also benefit from these lecture notes. Hence, the book will be useful for all researchers and graduate students interested in the physics of vorti ces in unconventional superconductors and superfluids. It may also serve as supplementary material for a graduate course on low-temperature solid-state physics.

This book is aimed at students making the transition from a first course on general relativity to a specialized subfield. It presents a variety of topics under the general headings of gravitational waves in vacuo and in a cosmological setting, equations of motion, and black holes, all having a clear physical relevance and a strong emphasis on space-time geometry. Each chapter could be used as a basis for an early postgraduate project for those who are exploring avenues into research in general relativity and who have already accumulated the required technical knowledge. The presentation of each chapter is research monograph style, rather than text book style, in order to impress on interested students the need to present their research in a clear and concise format. Students with advanced preparation in general relativity theory might find a treasure trove here.

Since the discovery of superconductivity in 1911 by H. Kamerlingh Onnes, of the order of half a billion dollars has been spent on research directed toward understanding and utiliz ing this phenomenon. This investment has gained us fundamental understanding in the form of a microscopic theory of superconduc tivity. Moreover, superconductivity has been transformed from a laboratory curiosity to the basis of some of the most sensitive and accurate measuring devices known, a whole host of other elec tronic devices, a soon-to-be new international standard for the volt, a prototype generation of superconducting motors and gener ators, and magnets producing the highest continuous magnetic fields yet produced by man. The promise of more efficient means of power transmission and mass transportation, a new generation of superconducting motors and generators, and computers and other electronic devices with superconducting circuit elements is all too clear. The realization of controlled thermonuclear fusion is perhaps totally dependent upon the creation of enormous magnetic fields over large volumes by some future generation of supercon ducting magnets. Nevertheless, whether or not the technological promise of superconductivity comes to full flower depends as much, and perhaps more, upon economic and political factors as it does upon new technological and scientific breakthroughs. The basic science of superconductivity and its technological implications were the subject of a short course on "The Science and Technology of Superconductivity" held at Georgetown University, Washington, D. C. , during 13-26 August 1971.

Superconducting State

Nonequilibrium Electrons and Phonons in Superconductors

Selected Topics in Superconductivity

Layered Superconductors

Atmospheric Energy Budget from Satellite Remote Sensing

Even a hundred years after its discovery, superconductivity continues to bring us new surprises, from superconducting magnets used in MRI to quantum detectors in electronics. 100 Years of Superconductivity presents a comprehensive collection of topics on nearly all the subdisciplines of superconductivity. Tracing the historical developments in superconductivity, the book includes contributions from many pioneers who are responsible for important steps forward in the field. The text first discusses interesting stories of the discovery and gradual progress of theory and experimentation. Emphasizing key developments in the early 1950s and 1960s, the book looks at how superconductivity started to permeate society and how most of today's applications are based on the innovations of those years. It also explores the genuine revolution that occurred with the discovery of high temperature superconductors, leading to emerging applications in power storage and fusion reactors. Superconductivity has become a vast field and this full-color book shows how far it has come in the past 100 years. Along with reviewing significant research and experiments, leading scientists share their insight and experiences working in this exciting and evolving area.

This book addresses problems in three main developments in modern condensed matter physics – namely topological superconductivity, many-body localization and strongly interacting condensates/superfluids – by employing fruitful analogies from classical mechanics. This strategy has led to tangible results, firstly in superconducting nanowires: the density of states, a smoking gun for the long sought Majorana zero mode is calculated effortlessly by mapping the problem to a textbook-level classical point particle problem. Secondly, in localization theory even the simplest toy models that exhibit many-body localization are mathematically cumbersome and results rely on simulations that are limited by computational power. In this book an alternative viewpoint is developed by describing many-body localization in terms of quantum rotors that have incommensurate rotation frequencies, an exactly solvable system. Finally, the fluctuations in a strongly interacting Bose condensate and superfluid, a notoriously difficult system to analyze from first principles, are shown to mimic stochastic fluctuations of space-time due to quantum fields. This analogy not only allows for the computation of physical properties of the fluctuations in an elegant way, it sheds light on the nature of space-time. The book will be a valuable contribution for its unifying style that illuminates conceptually challenging developments in condensed matter physics and its use of elegant mathematical models in addition to producing new and concrete results.

This new book describes the basic physics of solar and infrared radiation in the atmosphere. Radiation theory is related to the development of climate prediction models, and to measurement techniques for monitoring the Earth's energy budget and making remote sensing observations from satellites.

The book is devoted to the physics of plasma at high density, which has been compressed so strongly that the effects of interparticle interactions and non-ideality govern its behavior. Interest in this non-traditional plasma has been generated in recent years when states of matter with high concentration of energy became accessible experimentally as the basis of modern technologies and facilities. The greatest part of the matter in the Universe is in this exotic state. In this book, the methods of generation and diagnostics of strongly coupled plasmas are presented, along with the main theoretical methods and experimental results on thermodynamical, kinetic and optical properties. Particular attention is given to fast developing modern directions of strongly coupled plasma physics such as metallization of dielectrics and dielectrization of metals, non-neutral plasmas, dusty plasmas and their crystallization. The book is written for physicists and astrophysicists, engineers, and material scientists.

Electrodynamic Theory of Superconductors

Second Edition

Mechanisms and Materials

Superconducting Electronics via COMSOL Modeling

Statistical Physics of Spin Glasses and Information Processing

Stellar magnetism is the study of the magnetic field of the Sun and other stars and is a rapidly developing field of astrophysics. This book, an authoritative account with broad astronomical scope, has grown out of the lifelong work of an outstanding researcher in the subject.

The field of ferroelectricity has greatly expanded and changed in recent times. In addition to classical organic and inorganic ferroelectrics, new fields and materials, unknown or inactive 20 to 40 years ago, have appeared. They are important for both basic science and applications, and show technological promise for novel multifunctional devices. New fields include multiferroic magnetoelectric systems, where spontaneous polarization and spontaneous magnetization are allowed to coexist; incommensurate ferroelectrics, where the periodicity of the order parameter is incommensurate to the periodicity of the underlying basic crystal lattice; ferroelectric liquid crystals; dipolar glasses; relaxor ferroelectrics; ferroelectric thin films; nanoferroelectrics. These new fields are not only of basic physical interest, but also of great technological importance, allowing the design of new memory devices, spintronic applications, and the design of electro-optic devices. They are also important for applications in acoustics, robotics, telecommunications and medicine. The book is primarily intended for material scientists working in research or industry. It is also intended for graduate and doctoral students and can be used as a textbook in graduate courses. Finally, it should be useful for anybody interested in following the developments in modern solid state physics.

Electron tunnelling spectroscopy as a research tool has strongly advanced understanding of superconductivity. This book explains the physics and instrumentation behind the advances illustrated in beautiful images of atoms, rings of atoms and exotic states in high temperature superconductors, and summarizes the state of knowledge that has resulted.

A number of new analytical techniques have been developed to establish a theory of spin glasses. This book provides a broad overview of the interdisciplinary field between statistical physics and information sciences/engineering.

Volume 1: Conventional and Unconventional Superconductors Volume 2: Novel Superconductors

Nonequilibrium Superconductivity

Stellar Magnetism

Bose-Einstein Condensation

Relaxation Processes in Micromagnetics

Selected Topics in Superconductivity, reflects the high level of activity in the discovery of high-Tc superconductivity. Out of the 19 articles that it has, a fairly good number of them discuss several important and fundamental aspects of the high-Tc superconductivity. Some of the issues related to the phenomenon of superconductivity in general are discussed in a few of the manuscripts. The remaining articles deal with superconductivity in unconventional and highly correlated metals

This book presents in a pedagogical yet complete way correlated systems in one dimension. Recent progress in nanotechnology and material research have made one dimensional systems a crucial part of today's physics. After an introduction to the basic concepts of correlated systems, the book gives a step by step description of the techniques needed to treat one dimension, and discusses the resulting physics. Then specific experimental realizations of one dimensional systems such as spin chains, quantum wires, nanotubes, organic superconductors etc. are examined. Given its progressive and pedagogical approach, this book should satisfy both graduate students who want to learn the tools of the trade and become professionals in the field as well as more advanced researchers who want to know more about the physics of a specific one dimensional system without unnecessary technicalities.

This book provides the reader with a detailed theoretical treatment of the key mechanisms of superconductivity, up to the current state of the art (phonons, magnons, plasmons). In addition, the book describes the properties of key superconducting compounds that are of most interest for science and its applications today. For many years there has been a search for new materials with higher values of the main parameters, such as the critical temperature and the critical current. At present, the possibility to observe superconductivity at room temperature has become perfectly realistic. The book is especially concerned with high Tc systems, such as the high Tc oxides, hydrides with record values of the critical temperature under high pressure, nanoclusters, etc. A number of interesting novel superconducting systems have been discovered recently. Among them: topological materials, interface systems, intercalated graphene. The book contains rigorous derivations, based on statistical mechanics and many-body theory. The book is also providing qualitative explanations of the main concepts and results, which makes it accessible and interesting for a broader readership.

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.

Theory of Nonequilibrium Superconductivity Near Spin-active Interfaces

Advanced General Relativity

Quantum Gravity

Superconductivity

Volume 1

This book provides a comparison of the different chemical structures, normal state properties, and simplest superconducting properties of all known classes of layered superconductors. It introduces the three phenomenological models used to describe such systems, and will guide young researchers hoping to produce a room-temperature superconductor.

Volume 2 of Novel Superfluids continues the presentation of recent results on superfluids, including novel metallic systems, superfluid liquids, and atomic/molecular gases of bosons and fermions. The phenomenon of superfluidity remains one of the most important topics in physics. Again and again, novel superfluids yield surprising and interesting behaviors. The many classes of metallic superconductors continue to offer challenges. The technicalapplications grow steadily. What the temperature and field limits are remains illusive. Atomic nuclei, neutron stars and the Universe itself all involve various aspects of superfluidity, and the lessons learned have hada broad impact on physics as a whole.

The search for a quantum theory of the gravitational field is one of the great open problems in theoretical physics. This book presents a self-contained discussion of the concepts, methods and applications that can be expected in such a theory. The two main approaches to its construction – the direct quantisation of Einstein's general theory of relativity and string theory – are covered. Whereas the first attempts to construct a viable theory for the gravitational field alone, string theory assumes that a quantum theory of gravity will be achieved only through a unification of all the interactions. However, both employ the general method of quantization of constrained systems, which is described together with illustrative examples relevant for quantum gravity. There is a detailed presentation of the main approaches employed in quantum general relativity: path-integral quantization, the background-field method and canonical quantum gravity in the metric, connection and loop formulations. The discussion of string theory centres around its quantum-gravitational aspects and the comparison with quantum general relativity. Physical applications discussed at length include the quantization of black holes, quantum cosmology, the indications of a discrete structure of spacetime, and the origin of irreversibility. This third edition contains new chapters or sections on quantum gravity phenomenology, Horava-Lifshitz quantum gravity, analogue gravity, the holographic principle, and affine quantum gravity. It will present updates on loop quantum cosmology, the LTB model, asymptotic safety, and various discrete approaches. The third edition also contains pedagogical extensions throughout the text. This book will be of interest to researchers and students working in relativity and gravitation, cosmology, quantum field theory and related topics. It will also be of interest to mathematicians and philosophers of science.

This book presents cutting-edge topics in modern theoretical physics - quantum Hall systems - the subject of two Nobel Prizes in 1985 and 1998.

Electronic and Optical Properties of Conjugated Polymers

Nuclear Science Abstracts

Energy Research Abstracts

Proceedings of a summer course held August 13-26, 1971, at Georgetown University, Washington, D. C. Volume 1

Radiation and Climate

We conclude that the Riccati formalism can serve as a powerful framework to compute the nonequilibrium properties of mesoscopic heterostructures consisting of superconductors, normal metal, and magnetic materials.

The book includes a thorough description of a wide range of physical properties of organic superconductors of reduced dimensionality. The authors start with an overview of the field followed by a background discussion and selected experimental topics. A critical discussion of theoretical proposals is presented under the constraints of experimental observations and exciting possibilities for the symmetry of the order parameter are presented, including the cases of inhomogeneous superconducting states and triplet superconductivity. The possible origins of Cooper pairing are explored and tests to detect experimentally the pairing symmetry are described in detail. The book ends with a discussion of important open questions, where the search for their answers will keep the field alive for the next decade.

This is the first text on the modern theory of superconductivity. It deals with the behaviour of superconductors in external fields varying in time, and with transport phenomena in superconductors. The book starts with the fundamentals of the first-principle, microscopic theory of superconductivity, and guides the reader through the modern theoretical analysis directly to applications of the theory to practical problems. The reader of this book will learn about the methods of quantum field theory applied to nonstationary superconductivity in their most advanced formulation, namely about the so-called semi-classical version of the real-time Green's function technique applied to the celebrated Bardeen, Cooper, and Schrieffer model of superconductivity. A considerable part of the book is devoted to vortex dynamics, dealing with the behaviour of superconductors in the most practical situation when they carry electric currents in the presence of a magnetic field.

The importance of phonons has long been recognized by research ers in nonequilibrium superconductivity. Similarly, experimentalists studying phonons at low temperatures have relied heavily on supercon ductors as sources and detectors. To a large extent this symbiotic relationship has developed with a general mutual awareness; however, to our knowledge these subjects have never been treated together in conferences or study institutes. It was with the hope of further contributing to the awareness and communication between workers in these areas that this NATO Advanced Study Institute (ASI) has been conceived. A second, but equally important, reason for holding this ASI is to fill a void by providing the first general textbook in this important area of physics. Therefore, there was an emphasis on the tutorial nature of the lectures and written contributions to this textbook. It should not go unnoticed that the experimental and theoretical concepts covered in this textbook are of paramount importance to the various applications of superconductors. Almost by definition, the use of a superconductor implies a nonequilibrium state! For example, phonon conduction to the helium bath is important in devices ranging from microscopic Josephson junctions to large scale magnets and transmission lines. Knowledge of the more fundamental nonequilibrium effects can aid in our understanding of devices as well as provide the potential for entirely new applications.

An Introduction

Novel Superfluids

Brownian Motion

Advanced Ferroelectricity

Physics of Strongly Coupled Plasma

Electrons in solids behave like microscopic bar magnets, and in certain solids these align to produce macroscopic magnetizations. This book deals with the dynamics of this magnetization field. It addresses questions of microscopic mechanism only to the extent that residual interactions of the magnetic moments with other degrees of freedom of the host solid affect the dynamics, particularly the dissipative aspects. Several of these damping mechanisms are evaluated here for their effect on the equations of the magnetization dynamics. This dynamics is intrinsically nonlinear. This is important in the applications, particularly magnetic recording, which involves very large motion of the magnetization, well beyond the validity of linearized (small motion) approximations or limited extensions thereof. Therefore nonlinear solution methods are emphasized, but with only minimal use of numerical simulation. The book should be useful to practitioners of magnetic recording, and to physicists studying magnetic phenomena.

Bose-Einstein condensation represents a new state of matter and is one of the cornerstones of quantum physics, resulting in the 2001 Nobel Prize. Providing a useful introduction to one of the most exciting fields of physics today, this text will be of interest to a growing community of physicists, and is easily accessible to non-specialists alike.

This book presents a unified and comprehensive theoretical treatment of electromagnetic, thermal and mechanical phenomena in superconductors. Introduces basic concepts and principles with particular emphasis on general methodology. Introduces phenomenological London theory, Ginzburg-Landau theory, electrodynamic models for superconducting thin films, AC losses and Josephson junctions, and BCS microscopic theory of superconductivity.

Starting from the early experiments, this detailed presentation, containing more than 500 references, provides a comprehensive review on current-induced nonequilibrium phenomena in quasi-one-dimensional superconductors, leading the reader from the fundamentals to the most recent research results. Experiments on monocrystalline filaments (whiskers) - including those obtained by the author - are compared with results on long thin film microbridges and related species and interpreted within the theoretical framework. Instructions on experimental techniques are given and yet unresolved problems are discussed. The book is well suited as an introduction for the novice and as a handbook for the active researcher.

Principles of Electron Tunneling Spectroscopy
Theory of Nonequilibrium Superconductivity
Classical Analogies in the Solution of Quantum Many-Body Problems
Gravity Waves, Spinning Particles, and Black Holes
Quasi-One-Dimensional Organic Superconductors

This book introduces the main concepts of nonequilibrium phenomena in superconductors. The authors cover both experimentally well-understood topics and problems which physicists could challenge more in view of current theoretical understanding. Some of these topics include thermoelectric phenomena, influence of laser radiation as well as fluctuations in superconductors.

This book reports on the latest developments in the field of Superfluidity. The phenomenon has had a tremendous impact on the fundamental sciences as well as a host of technologies. It began with the discovery of superconductivity in mercury in 1911, which was ultimately described theoretically by the theory of Bardeen Cooper and Schriever (BCS) in 1957. The analogous phenomena, superfluidity, was discovered in helium in 1938 and tentatively explained shortly thereafter as arising from a Bose-Einstein Condensation (BEC) by London. But the importance of superfluidity, and the range of systems in which it occurs, has grown enormously. In addition to metals and the helium liquids the phenomena has now been observed for photons in cavities, excitons in semiconductors, magnons in certain materials, and cold gasses trapped in high vacuum. It very likely exist for neutrons in a neutron star and, possibly, in a conjectured quark state at their center. Even the Universe itself can be regarded as being in a kind of superfluid state. All these topics are discussed by experts in the respective subfields.

This accessible textbook offers a novel, concept-led approach to superconducting electronics, using the COMSOL Multiphysics software to help describe fundamental principles in an intuitive manner. Based on a course taught by the author and aimed primarily at engineering students, the book explains concepts effectively and efficiently, uncovering the “shortcut” to understanding each topic, enabling readers to quickly grasp the underlying essence. The book is divided into two main parts; the first part provides a general introduction to key topics encountered in superconductivity, illustrated using COMSOL simulations based on time-dependent Ginzburg-Landau equations and avoiding any deeply mathematical derivations. It includes numerous worked examples and problem sets with tips and solutions. The second part of the book is more conventional in nature, providing detailed derivations of the basic equations from first principles. This part covers more advanced topics, including the BCS-Gor'kov-Eliashberg approach to equilibrium properties of superconductors, the derivation of kinetic equations for nonequilibrium superconductors, and the derivation of time-dependent Ginzburg–Landau equations, used as the basis for COMSOL modeling in the first part. Supported throughout by an extensive library of COMSOL Multiphysics animations, the book serves as a uniquely accessible introduction to the field for engineers and others with a less rigorous background in physics and mathematics. However, it also features more detailed mathematical background for those wishing to delve further into the subject.

Brownian motion - the incessant motion of small particles suspended in a fluid - is an important topic in statistical physics and physical chemistry. This book studies its origin in molecular scale fluctuations, its description in terms of random process theory and also in terms of statistical mechanics. A number of new applications of these descriptions to physical and chemical processes, as well as statistical mechanical derivations and the mathematical background are discussed in detail. Graduate students, lecturers, and researchers in statistical physics and physical chemistry will find this an interesting and useful reference work.

Shortcut to Superconductivity
Introduction to Superconductivity
Quantum Hall Systems
Fluctuations, Dynamics, and Applications
Braid Groups, Composite Fermions, and Fractional Charge

Conjugated polymers have important technological applications including solar cells and light emitting devices. They are active components in many important biological processes. This book describes and explains the electronic and optical properties of conjugated polymers by developing theoretical models to understand the key electronic states.

Nonequilibrium Superconductivity, Phonons, and Kapitza Boundaries
Vortices in Unconventional Superconductors and Superfluids
Current-Induced Nonequilibrium Phenomena in Quasi-One-Dimensional Superconductors
Quantum Physics in One Dimension
The Science and Technology of Superconductivity