Open Problems In Strongly Correlated Electron Systems

#Strongly Correlated Electron Systems #Condensed Matter Physics #Quantum Materials #Electron Correlation #Research Challenges

Explore the most significant open problems and unresolved questions within strongly correlated electron systems, a frontier area of condensed matter physics. These complex quantum materials exhibit fascinating phenomena, from high-temperature superconductivity to exotic magnetic states, posing immense challenges and opportunities for groundbreaking discoveries that could redefine our understanding of matter and lead to next-generation technologies.

Open Problems in Strongly Correlated Electron Systems

Proceedings of the NATO Advanced Research Workshop, Bled, Slovenia, 26-30 April 2000

Strongly Correlated Electron Systems Ii - Proceedings Of The Adriatico Conference And Miniwork-shop

This is the second in a series of miniworkshops and Adriatico conferences devoted to the exciting field of strongly correlated electron systems including quantum Hall effect, metal insulator transition, heavy fermions and high Tc superconductivity. In spite of enormous efforts made by physicists worldwide to solve these difficult problems, many important issues are still widely open and this topic remains the most active field in condensed matter physics. The review talks and reports on original research given by the experts in the field represent a state-of-the-art summary of this fast-moving field.

Exactly Solvable Models of Strongly Correlated Electrons

Systems of strongly correlated electrons are at the heart of recent developments in condensed matter theory. They have applications to phenomena like high-c superconductivity and the fractional quantum hall effect. Analytical solutions to such models, though mainly limited to one spatial dimension, provide a complete and unambiguous picture of the dynamics involved. This volume is devoted to such solutions obtained using the Bethe Ansatz, and concentrates on the most important of such models, the Hubbard model. The reprints are complemented by reviews at the start of each chapter and an extensive bibliography.

Proceedings of the Adriatico Research Conference and Miniworkshop Strongly Correlated Electron System III

Focusing on the purely theoretical aspects of strongly correlated electrons, this volume brings together a variety of approaches to models of the Hubbard type - i.e., problems where both localized and delocalized elements are present in low dimensions. The chapters are arranged in three parts. The first part deals with two of the most widely used numerical methods in strongly correlated electrons, the density matrix renormalization group and the quantum Monte Carlo method. The second part covers Lagrangian, Functional Integral, Renormalization Group, Conformal, and Bosonization methods

that can be applied to one-dimensional or weakly coupled chains. The third part considers functional derivatives, mean-field, self-consistent methods, slave-bosons, and extensions.

Theoretical Methods for Strongly Correlated Electrons

This book provides the first systematic discourse on a very peculiarapproach to the theory of strongly correlated systems. HubbardX-operators have been known for a long time but have not been widelyused because of their awkward algebra. The book shows that it ispossible to deal with X-operators even in the general multilevel localeigenstate system, and not just in the case of the nondegenerateHubbard model. X-operators provide the natural language for describingquasiparticles in the Hubbard subbands with unusual doping andtemperature-dependent band structures.

Strongly Correlated Electron Systems Iii - Proceedings Of The Adriatico Research Conference And Miniworkshop

This book contains lectures on strongly correlated electron systems presented by eminent physicists. These lectures are up-to-date summaries of relevant subjects in the field of condensed matter physics. Contributions include: BCS theory of nodal superconductors; strongly correlated particle systems and composite operator methods; diagonalization- and numerical renormalization-group-based methods for interacting quantum systems; as well as phenomenological aspects of unconventional superconductivity.

Strongly Correlated Electron Systems - Proceedings Of The Anniversary Adriatico Research Conference And Workshop

An understanding of the effects of electronic correlations in quantum systems is one of the most challenging problems in physics, partly due to the relevance in modern high technology. Yet there exist hardly any books on the subject which try to give a comprehensive overview on the field covering insulators, semiconductors, as well as metals. The present book tries to fill that gap. It intends to provide graduate students and researchers a comprehensive survey of electron correlations, weak and strong, in insulators, semiconductors and metals. This topic is a central one in condensed matter and beyond that in theoretical physics. The reader will have a better understanding of the great progress which has been made in the field over the past few decades. Contents:IntroductionIndependent ElectronsHomogeneous Electron GasDensity Functional Theory-Wavefunction-Based MethodsCorrelated Ground-State WavefunctionsQuasiparticle ExcitationsIncoherent ExcitationsCoherent-Potential ApproximationsStrongly Correlated ElectronsTransition MetalsTransition-Metal OxidesHeavy QuasiparticlesExcitations with Fractional ChargesSuperconductivity Readership: Graduate students and researchers in condensed matter physics. Keywords:Electron Correlations;Many-body Theory;Quasi-Particles;Fractional Charges;Superconductivity;Many-Body WavefunctionsKey Features:Besides approaches based on Density Functional Theory, the importance of many-body wavefunction and projection methods is emphasizedConsiderable space is devoted to systems with strong electron correlations evident in high-Tc superconducting cuprates Transition metals and their oxides are discussed as well as compounds with heavy quasiparticlesDifferent competing methods for describing correlation effects are presentedAt various places a connection to relevant experiments is madeReviews: “Peter Fulde's book is well suited as an introduction to the general field of correlated electron systems… For this purpose some elementary chapters are included. Finally, the book is hard work but also fun to read because of its personal style.” Prof. Dr. Joachim Keller Institut für Theoretische Physik Universität Regensburg “Written with great pedagogical skill, it will be of interest to both experts in the field and graduate students. The book presents a consistent description of a new branch of solid state physics — the theory of strongly correlated systems which cannot be treated by conventional approaches as the density functional theory being successful for many years in describing band structure of solids. In this respect it can be used as a textbook for a university course on this new and fascinating branch of solid state physics.” Professor Nikolay Pladika Joint Institute for Nuclear Research “Peter Fulde provides an excellent introduction to this field. This book provides a very careful treatment of an extraordinarily wide range of topics, and is particularly strong on transition-metal oxides and heavy fermion systems. This carefully written book can be recommended to a very wide readership.” Contemporary Physics

Strongly Correlated Electron Systems

This volume contains invited and contributed papers of eminent scientists who are deeply involved in the field of strongly correlated electron systems and high-Tc superconductivity. The topics of the papers include the Hubbard model, the t-J model, the polaronic model for high-Tc superconductivity, Fermi liquid and non-Fermi liquid theory, and heavy fermion systems.

Hubbard Operators in the Theory of Strongly Correlated Electrons

This book contains lectures on strongly correlated electron systems presented by eminent physicists. These lectures are up-to-date summaries of relevant subjects in the field of condensed matter physics intended to train students. Contributions include: Strongly correlated electron behaviors and heavy Fermions in anomalous rare-earth and actinide systems; strong correlations in low dimensional systems; functional renormalization group approach to correlated electron systems; and numerical approaches to coupled quantum systems.

Lectures on the Physics of Highly Correlated Electron Systems IX

The volume contains the lectures delivered at the XIII Training Course in the Physics of Strongly Correlated Systems, held in Vietri sul Mare (Salerno) Italy, in October 2008. The project of the meeting was to promote the formation of young scientists by means of training through research. These features are reflected in the book: the lectures are up-to-date monographies of relevant subjects in the field of Condensed Matter Physics. Contributions include: Quantum Magnetism in insulators (Single impurities in semiconductors and insulators; One- Two- and Three-dimensional magnets and quantum phase transitions; Undoped and doped Kondo insulators); Novel quantum condensates in excitonic matter (The physical systems: excitonic insulators, the Dicke model, exciton and polariton BEC; Second quantization, coherent states and path integral; exciton and polariton condensates in mean field theory; Open systems and Keldysh formulation; Phase-breaking and open system dynamics); Introduction to unconventional superconductivity (Generalized BCS theory; Phenomenological approach and symmetry aspects; Generalized Ginzburg-Landau theory; Josephson and tunneling effects); Quantum Monte-Carlo simulations (Classical and quantum cluster algorithms; The worm algorithm; Optimized ensembles for classical and quantum Monte-Carlo simulations; Continuous time QMC solvers for quantum impurity problems and DMFT).

Correlated Electrons in Quantum Matter

This book is a wide-ranging survey of the physics of out-of-equilibrium systems of correlated electrons, ranging from the theoretical, to the numerical, computational and experimental aspects. It starts from basic approaches to non-equilibrium physics, such as the mean-field approach, then proceeds to more advanced methods, such as dynamical mean-field theory and master equation approaches. Lastly, it offers a comprehensive overview of the latest advances in experimental investigations of complex quantum materials by means of ultrafast spectroscopy.

Emergent phenomena in strongly correlated electron systems

This book provides a broad description of the development and (computational) application of many-electron approaches from a multidisciplinary perspective. In the context of studying many-electron systems Computer Science, Chemistry, Mathematics and Physics are all intimately interconnected. However, beyond a handful of communities working at the interface between these disciplines, there is still a marked separation of subjects. This book seeks to offer a common platform for possible exchanges between the various fields and to introduce the reader to perspectives for potential further developments across the disciplines. The rapid advances of modern technology will inevitably require substantial improvements in the approaches currently used, which will in turn make exchanges between disciplines indispensable. In essence this book is one of the very first attempts at an interdisciplinary approach to the many-electron problem.

Superconductivity And Strongly Correlated Electron Systems

Focusing on the purely theoretical aspects of strongly correlated electrons, this volume brings together a variety of approaches to models of the Hubbard type - i.e., problems where both localized and delocalized elements are present in low dimensions. The chapters are arranged in three parts. The first part deals with two of the most widely used numerical methods in strongly correlated electrons, the density matrix renormalization group and the quantum Monte Carlo method. The second part

covers Lagrangian, Functional Integral, Renormalization Group, Conformal, and Bosonization methods that can be applied to one-dimensional or weakly coupled chains. The third part considers functional derivatives, mean-field, self-consistent methods, slave-bosons, and extensions.

Lectures on the Physics of Highly Correlated Electron Systems X

Contains the lectures and participant contributions delivered at the Sixth Training Course in the Physics of Correlated Electron Systems and High-Tc Superconductors.

Lectures on the Physics of Strongly Correlated Systems XIII

The book presents exact results for one-dimensional models (including quantum spin models) of strongly correlated electrons in a comprehensive and concise manner. It incorporates important results related to magnetic and hybridization impurities in electron hosts and contains exact original results for disordered ensembles of impurities in interacting systems. These models describe a number of real low-dimensional electron systems that are widely used in nanophysics and microelectronics.An important method of modern theoretical and mathematical physics — the Bethe's Ansatz (BA) — is introduced to readers. This book presents different forms of the BA for periodic and open quantum chains. Other forms dealt with are the co-ordinate BA, thermodynamic BA, nested BA, algebraic BA, and thermal BA. The book also contains a compact description of other theoretical methods such as scaling, conformal field theory, Abelian and non-Abelian bosonizations.The book is suitable for use as a textbook by graduate students in non-perturbative methods of low-dimensional quantum many-body theory. It will also be a useful source of reference for qualified physicists, as well as non-experts in low-dimensional physics, as it explores material necessary for further studies in the fields of exactly solvable quantum models and low-dimensional correlated electron systems.

Strongly Correlated Electron Systems

The papers were peer reviewed by a local panel. The objective of the meeting was to promote the progress of young scientists by means of training through research. The lectures are up-to-date monographs of relevant subjects in the field of condensed matter physics. Contributions include the following lectures: Electron-Phonon Interaction and Strong Correlations in High-Temperature Superconductors: One cannot avoid the unavoidable (The properties of the normal state and pairing mechanism in high-Tc superconductors, Forward scattering peak in the EPI, The FSP theory, The ARPES non-shift puzzle, Interesting predictions of the FSP theory); Strongly Correlated Electron Materials: Dynamical Mean-Field Theory and Electronic Structure (The basic principles of dynamical mean-field theory (DMFT), application of DMFT to the Mott transition, compare to recent spectroscopy, transport experiments; the key role of the quasiparticle coherence scale, transfers of spectral weight between low- and intermediate or high energies is emphasized); Monte Carlo Simulations of Quantum Systems with Global Updates (a model for doped antiferromagnets, first application of the hybrid loop algorithm, namely the t-Jmodel with 1/r2 interaction).

Out-of-Equilibrium Physics of Correlated Electron Systems

Novel Electronic Structure Theory: General Innovations and Strongly Correlated Systems, Volume 76, the latest release in the Advances in Quantum Chemistry series presents work and reviews of current work in quantum chemistry (molecules), but also includes scattering from atoms and solid state work of interest in physics. Topics covered in this release include the Present Status of Selected Configuration Interaction with Truncation Energy Error, Recent Developments in Asymptotic Expansions from Numerical Analysis and Approximation Theory, The kinetic energy Pauli enhancement factor and its role in determining the shell structure of atoms and molecules, Numerical Hartree-Fock and Many-Body Calculations for Diatomic Molecules, and more. Provides reports on current work in molecular and atomic quantum mechanics Contains work reported by many of the best scientists in the field Presents the latest release in the Advances in Quantum Chemistry series

Non Perturbative Aspects of Strongly Correlated Electron Systems

Focuses on fundamental mathematical and computational methods underpinning physics. Relevant to statistical physics, chaotic and complex systems, classical and quantum mechanics, classical and quantum integrable systems and classical and quantum field theory.

Many-Electron Approaches in Physics, Chemistry and Mathematics

This volume attempts to fill the gap between standard introductions to solid state physics, and textbooks which give a sophisticated treatment of strongly correlated systems. Starting with the basics of the microscopic theory of magnetism, one proceeds with relatively elementary arguments to such topics of current interest as the Mott transition, heavy fermions, and quantum magnetism. The basic approach is that magnetism is one of the manifestations of electronOCoelectron interaction, and its treatment should be part of a general discussion of electron correlation effects. Though the text is primarily theoretical, a large number of illustrative examples are brought from the experimental literature. There are many problems, with detailed solutions. The book is based on the material of lectures given at the Diploma Course of the International Center for Theoretical Physics, Trieste, and later at the Technical University and the R. EAtvAs University of Budapest, Hungary. Sample Chapter(s). Chapter 1.1: Magnetism and Other Effects of Electron-Electron Interaction (483 KB). Chapter 1.2: Sources of Magnetic Fields (311 KB). Chapter 1.3: Getting Acquainted: Magnetite (692 KB). Chapter 1.4: Variety of Correlated Systems: An Outline of the Course (307 KB). Contents: Atoms, Ions, and Molecules; Crystal Field Theory; Mott Transition and Hubbard Model; Mott Insulators; Heinsenberg Magnets; Itinerant Electron Magnetism; Ferromagnetism in Hubbard Models; The Gutzwiller Variational Method; The Correlated Metallic State; Mixed Valence and Heavy Fermions; Quantum Hall Effect; Hydrogen Atom; Single-Spin-Flip Ansatz; Gutzwiller Approximation; SchriefferOCoWolff Transformation. Readership: Graduate students and researchers in condensed matter physics."

Physics of Strongly Correlated Electron Systems

This volume contains the lectures delivered at the Fourth Training Course in the Physics of Correlated Electron Systems and High-Tc Superconductors. In contrast to usual workshops, this course was designed to promote active participation of senior and young researchers and to introduce them to some specific problems. Three of the four lectures held are included in this book.

Theoretical Methods for Strongly Correlated Electrons

A Study of Rigorous Techniques in Strongly Correlated Electron Systems