Nonequilibrium Green Functions Approach To Inhomogeneous Systems

Equilibrium and nonequilibrium properties of correlated many-body systems are of growing interest in many fields of physics, including condensed matter, dense plasmas, nuclear matter and particles. The most powerful and general method which applies equally to all these areas is given by quantum field theory.Written by the leading experts and understandable to non-specialists, this book provides an overview on the basic ideas and concepts of the method of nonequilibrium Green's functions. It is complemented by modern applications of the method to a variety of topics, such as optics and transport in dense plasmas and semiconductors; correlations, bound states and coherence; strong field effects and short-pulse lasers; nuclear matter and QCD.Authors include: Gordon Bayan, Pawel Danielewicz, Don DuBois, Hartmut Haug, Klaus Henneberger, Antti-Pekka Jauho, J□rn Kuoll, Dietrich Kremp, Pavel Lipavsky and Paul C Martin.

The 2001 Spring Meeting of the 65th Deutsche Physikalische Gesellschaft was held together with the 65. Physikertagung, in Hamburg, during the pe riod March 26 30 2001. With more than 3500 conference attendees, a record has again been achieved after several years of stabilisation in participation. This proves the continuing and now even increasing, attraction of solid state physics, especially for young colleagues who often discuss for the first time their scientific results in public at this meeting. More than 2600 scientific pa pers were presented orally, as well as posters, among them about 120 invited lectures from Germany and from abroad. This Volume 41 of "Advances in Solid State Physics" contains the written versions of half of the latter. We nevertheless hope that the book truly reflects the current state of the field. Amazingly enough, the majority of the papers as well as the discussions at the meeting, concentrated on the nanostructured solid state. This re flects the currently extremely intensive quest for developing the electronic and magnetic device generations of the future, which stimulates science be sides the challenge of the unknown as has always been the case since the very beginning of Solid State Physics about 100 years ago.

Advances in Quantum Chemistry presents surveys of current topics in this rapidly developing field that has emerged at the cross section of the historically established areas of mathematics, physics, chemistry, and biology. It features detailed reviews written by leading international researchers. This series provides a one-stop resource for following progress in this interdisciplinary area. Publishes articles, invited reviews and proceedings of major international conferences and workshops Written by leading international researchers in quantum and theoretical chemistry Highlights important interdisciplinary developments

Recent years have witnessed a resurgence in the kinetic approach to dynamic many-body problems. Modern kinetic theory offers a unifying theoretical framework within which a great variety of seemingly unrelated systems can be explored in a coherent way. Kinetic methods are currently being applied in such areas as the dynamics of colloidal suspensions, granular material flow, electron transport in mesoscopic systems, the calculation of Lyapunov exponents and other properties of classical many-body systems characterised by chaotic behaviour. The present work focuses on Brownian motion, dynamical systems, granular flows, and quantum kinetic theory.

The Non-Equilibrium Green's Function Method for Nanoscale Device Simulation

Advances in Solid State Physics

Proceedings of the Conference "Kadanoff-Baym Equations: Progress and Perspectives for Many-body Physics", Rostock, Germany, 20-24 September 1999

Theory and Simulation Methods for Electronic and Phononic Transport in Thermoelectric Materials

Annotations to Quantum Statistical Mechanics

Advances in semiconductor technology have made possible the fabrication of structures whose dimensions are much smaller than the mean free path of an electron. This book gives a thorough account of the theory of electronic transport in such mesoscopic systems. After an initial chapter covering fundamental concepts, the transmission function formalism is presented, and used to describe three key topics in mesoscopic physics: the quantum Hall effect; localisation; and double-barrier tunnelling. Other sections include a discussion of optical analogies to mesoscopic phenomena, and the book concludes with a description of the non-equilibrium Green's function formalism and its relation to the transmission formalism. Complete with problems and solutions, the book will be of great interest to graduate students of mesoscopic physics and nanoelectronic device engineering, as well as to established researchers in these fields.

This book presents quantum kinetic theory in a comprehensive way. The focus is on density operator methods and on non-equilibrium Green functions. The theory allows to rigorously treat nonequilibrium dynamics in quantum many-body systems. Of particular interest are ultrafast processes in plasmas, condensed matter and trapped atoms that are stimulated by rapidly developing experiments with short pulse lasers and free electron lasers. To describe these experiments theoretically, the most powerful approach is given by non-Markovian quantum kinetic equations that are discussed in detail, including computational aspects.

A novel method of simulating edge-emitting semiconductor lasers in a non-equilibrium steady-state is developed. The simulation is based on a non-equilibrium Green's function (NEGF) method. The Dyson equation (central equation of this method) is derived and written in a basis suitable for numerical implementation. The electron-photon self-energy is derived form scratch for the case of the edge-emitting laser. Other interactions present in the simulation are phenomenological scattering and scattering due to longitudinal optical phonons. This microscopic approach significantly reduce the number of phenomenological parameters needed to simulate laser. As an example, the theory is applied to analyze quantum well laser with the effective mass Hamiltonian. The major laser characteristics such as modal gain, threshold gain, carrier and current densities are determined.

Calculations and Simulations of Low-Dimensional Materials A comprehensive guide to methods for calculating and simulating the properties of low-dimensional materials Two-dimensional materials are those, such as graphene and 2D oxides, whose thickness is so small as to approach the atomic scale. Potential applications for these materials exist in an enormous range of scientific and industrial fields. A previous era of low-dimensional materials focused on direct experimentation to demonstrate the properties, reactions, and potential applications of these materials; however, in recent years, calculation and simulation have been shown to have considerable predictive power, reducing the period between design and deployment of these potentially critical materials. Calculations and Simulations of Low-Dimensional Materials offers the first comprehensive survey of this exciting new approach to low-dimensional materials. It guides readers through the foundational physics and through a range of calculation and simulation methods, each with different predictive capacities. Mastery of these methods will enable readers to narrowly tailor the properties of particular materials towards real-world applications, providing confidence in the underlying mechanics and in the range of possible outcomes. Calculations and Simulations of Low-Dimensional Materials readers will also find: Broad coverage of material properties, including electronic, spin, magnetic, photonic, optical, electrochemical and transport properties Discussion of potential applications in areas such as electronics, spintronics, and valleytronics Examination of further potential applications regarding quantum Hall phase, photonics, optoelectronics, multiferroic, and photocatalysis Calculations and Simulations of Low-Dimensional Materials is a useful reference for materials scientists, electrochemists, inorganic chemists, physical chemists, photochemists, and the libraries that support these professions.

Green's Function Methods in Equilibrium and Nonequilibrium Problems

Atom to Transistor

Quantum Kinetic Theory

An Introduction to Schwinger's Variational Method with Green's Function Nanoapplications, Graphene and Superconductivity

Physics of Hot Electron Transport in Semiconductors

Quantum Transport in Mesoscopic Systems

Equilibrium and nonequilibrium properties of correlated many-body systems are of growing interest in many areas of physics, including condensed matter, dense plasmas, nuclear matter and particles. The most powerful and general method which is equally applied to all these areas is given by quantum field theory. This book provides an overview of the basic ideas and concepts of the method of nonequilibrium Green's functions, written by the leading experts and presented in a way accessible to non-specialists and graduate students. It is complemented by invited review papers on modern applications of the method to a variety of topics, such as optics and quantum transport in semiconductors; superconductivity; strong field effects, QCD, and state-of-the-art computational concepts — from Green's functions to quantum Monte Carlo and time-dependent density functional theory. The proceedings have been selected for coverage in: • Index to Scientific & Technical Proceedings (ISTP CDROM version / ISI Proceedings) Contents:Nonequilibrium Green's Functions: History, General Problems, Plasmas:Real-Time Nonequilibrium Green's Functions (L V Keldysh)Theory of High-Tc Superconductivity in Layered Cuprates (A A Abrikosov)Correlated Quantum Plasmas in Strong Laser Fields (M Schlanges et al.)Quantum Transport in Semiconductors:Non-Equilibrium Green's Functions in Semiconductor Device Modeling (R Lake et al.)Nonequilibrium Green Function Modelling of Transport in Mesoscopic Systems (A-P Jauho)Bohm Trajectories in Quantum Transport (J R Barker)Optical and Electronic Properties of Semiconductors:Coulomb Correlations in the Quantum Kinetics of Electron Phonon Systems (W Sch ä fer et al.)Excitonic Quantum Coherences and Correlations in Semiconductor Quantum Wells (R Binder et al.)Nuclear Matter and High Energy Physics:Renormalization of Self-Consistent Φ-Derivable Approximations (H van Hees & J Knoll)Crossover from Neutron-Proton Superfluidity to Bose – Einstein Condensation of Deuterons in Nuclear Matter (A A Isayev)Kinetics of Vacuum Pair Creation in Strong Electromagnetic Fields (A V Tarakanov et al.)Alternative Computational Methods:Time-Dependent Density Functional Theory from a Practitioners Perspective (K Andrae et al.)Combination of Quantum Kinetic Theory and First-Principle Simulations for Strongly Correlated Quantum Plasmas (M Bonitz et al.)Tunneling of Interacting Identical Particles (Yu E Lozovik et al.)and other papers Readership: Graduate students and researchers interested in many-body theory in all areas of physics. Keywords:Nonequilibrium Green's Functions;Real Time Green's Functions;Many-Body Theory;Quantum Kinetic Theory;Quantum Transport;Semiconductor Optics;Semiconductor Device Simulations

Starting with the simplest semiclassical approaches and ending with the description of complex fully quantum-mechanical methods for quantum transport analysis of state-of-the-art devices, Computational Electronics: Semiclassical and Quantum Device Modeling and Simulation provides a comprehensive overview of the essential techniques and methods for effectively analyzing transport in semiconductor devices. With the transistor reaching its limits and new device designs and paradigms of operation being explored, this timely resource delivers the simulation methods needed to properly model state-of-the-art nanoscale devices. The first part examines semiclassical transport methods, including drift-diffusion, hydrodynamic, and Monte Carlo methods for solving the Boltzmann transport equation. Details regarding numerical implementation and sample codes are provided as templates for sophisticated simulation software. The second part introduces the density gradient method, quantum hydrodynamics, and the concept of effective potentials used to account for quantum-mechanical space quantization effects in particle-based simulators. Highlighting the need for quantum transport approaches, it describes various quantum effects that appear in current and future devices being mass-produced or fabricated as a proof of concept. In this context, it introduces the concept of effective potential used to approximately include quantum-mechanical space-quantization effects within the semiclassical particle-based device simulation scheme. Addressing the practical aspects of computational electronics, this authoritative resource concludes by addressing some of the open questions related to quantum transport not covered in most books. Complete with self-study problems and numerous examples throughout, this book supplies readers with the practical understanding required to create their own simulators.

This review volume is based primarily on the balance equation approach developed since 1984. It provides a simple and analytical description about hot electron transport, particularly, in semiconductors with higher carrier density where the carrier-carrier collision is much stronger than the single particle scattering. The steady state and time-dependent hot electron transport, thermal noise, hot phonon effect, the memory effect, and other related subjects of charge carriers under strong electric fields are reviewed. The application of Zubarev's nonequilibrium statistical operator to hot electron transport and its equivalence to the balance equation method are also presented. For semiconductors with very low carrier density, the problem can be regarded as a single carrier transport which will be treated non-perturbatively by the nonequilibrium Green's function technique and the path integral theory. The last part of this book consists of a chapter on the dynamic conductivity and the shot noise suppression of a double-carrier resonant tunneling system. Contents:Balance-Equation Approach to Hot-Carrier Transport in Semiconductors (X L Lei & N J M Horing): Recent Developments in Magnetotransport Theory (N J M Horing et al.)Effect of Nonequilibrium Phonon on the Electron Relaxation and Transport (M Lax & W Cai)Nonlinear Transport of Electrons under a Strong High Frequency Electric Field in Semiconductors (W Cai & M Lax)Nonequilibrium Statistical Operator in Hot-Electron Transport Theory (D Y Xing & M Liu)Path Integral Study of Polaron Transport under High Electric Field (Z B Su): Impurity Resistivity under Thermalized Condition (C S Ting & L Y Chen)Nonequilibrium Green's Function Approach to Dynamic Properties of Resonant-Tunneling through Double Barrier Structures (L Y Chen & C S Ting) Readership: Physicists and electrical engineers. keywords:

This dissertation, "Nonequilibrium Green's Function-hierarchical Equation of Motion Method for Time-dependent Quantum Transport" by Shuguang, Chen, 陈曙光, was obtained from The University of Hong Kong (Pokfulam, Hong Kong) and is being sold pursuant to Creative Commons: Attribution 3.0 Hong Kong License. The content of this dissertation has not been altered in any way. We have altered the formatting in order to facilitate the ease of printing and reading of the dissertation. All rights not granted by the above license are retained by the author. Abstract: The nonequilibrium Green's function-hierarchical equation of motion (NEGFHEOM) method has been developed to simulate the time-dependent electron transport process. The real-time evolution of the reduced single-electron density matrix is solved through the Liouville-von-Neumann equation. The method is very efficient compared to conventional NEGF formulas which need to discretize the simulation time. The hierarchical equation of motion (HEOM) is closed at the second-tier in the time-dependent noninteracting Kohn-Sham framework. When combined with the wide band limit (WBL) approximation, the HEOM terminate at the first-tier. The resulting NEGF-HEOM-WBL method is particularly suitable for simulating the long time transient dynamics for large systems. The method developed is first applied to calculate the transient current through an array of as many as 1000 quantum dots. Upon switching on the bias voltage, the current increases linearly with respect to time before reaching its steady state value. And the time required for the current to reach its steady state value is exactly the time for a conducting electron to travel through the array at Fermi velocity. These phenomena can be understood by simple analysis on the energetics of the quantum dots or by classical electron gas model. Then the method is employed to investigate several simple molecular circuits, in which the para-linkage or meta-linkage benzene acts as the transmitting molecular entity. The simulation results shows that it takes a certain amount of time before the quantum interference manifests itself, and that the transmission through the meta case is hundreds of times smaller than that through the para case. To investigate the quantum interference process in molecular electronics, the concept of Buttiker probe is introduced. The Buttiker probe is an electrode that, when attached to electronic devices, causes the coherence passing through disappear. Simulation results show that the Buttiker probe can enhance the transmission of the meta benzene system through destroying the constructive interference. By turning the probe on and off, it can be observed that large strong correlations are indeed built up as electrons are transported through benzenoid structures - when the decoherence is turned off, the current rises, and when the decoherence is turned back on, the current falls. Finally, TDDFT(B)-NEGF-HEOM-WBL method is implemented to solve realistic systems in the formalism of time-dependent density functional theory (tightbinding). Ab initio calculations are carried out to simulate the time-dependent electron transport through a CNT-based device. The simulation results show that when the input bias voltage is in low frequency, both the conventional adiabatic approximation method and the NEGF-HEOM-WBL methods are good enough. However, when high frequency dynamic responses are need to be captured, the NEGF-HEOM-WBL method is more suitable. DOI: 10.5353/th_b5312338 Subjects: Quantum theory - Mathematics Green's functions Transport theory

A Pathway from Elementary Physics to Nonequilibrium Green Functions

An Introduction

Advances in Quantum Chemistry

Time-Dependent Density-Functional Theory

Nonequilibrium Green's Functions Approach to Inhomogeneous Systems

Quantum Statistical Field Theory

This book presents the conceptual framework underlying the atomistic theory of matter, emphasizing those aspects that relate to current flow. This includes some of the most advanced concepts of non-equilibrium quantum statistical mechanics. No prior acquaintance with quantum mechanics is assumed. Chapter 1 provides a description of quantum transport in elementary terms accessible to a beginner. The book then works its way from hydrogen to nanostructures, with extensive coverage of current flow. The final chapter summarizes the equations for quantum transport with illustrative examples showing how conductors evolve from the atomic to the ohmic regime as they get larger. Many numerical examples are used to provide concrete illustrations and the corresponding Matlab codes can be downloaded from the web. Videostreamed lectures, keyed to specific sections of the book, are also available through the web. This book is primarily aimed at senior and graduate students.

Annotation Proceedings of the conference Progress in Nonequilibrium Green's Functions, held in Dresden, Germany, from August 19-23, 2002.

This book examines some of the charge carrier transport issues encountered in the field of modern semiconductor devices and novel materials. Theoretical approaches to the understanding and modeling of the relevant physical phenomena, seen in devices that have very small spatial dimensions and that operate under high electric field strength, are described in papers written by leading experts and pioneers in this field. In addition, the book examines the transport physics encountered in novel materials such as wide band gap semiconductors (GaN, SiC, etc.) as well as organic semiconductors. Topics in High Field Transport in Semiconductors provides a comprehensive overview that will be beneficial to newcomers as well as engineers and researchers engaged in this exciting field.

Nonequilibrium Green's Functions Approach to Inhomogeneous SystemsSpringer

Non-Equilibrium Nano-Physics

A Modern Introduction

Electronic Transport in Mesoscopic Systems
Nanoscale Transistors
Quantum Statistical Mechanics
Theory of Quantum Transport at Nanoscale

This book offers a self-contained introduction to non-equilibrium quantum particle dynamics for inhomogeneous systems, including a survey of recent breakthroughs pioneered by the authors and others. The approach is based on real-time Green ' s functions.

This book is an introduction to a rapidly developing field of modern theoretical physics – the theory of quantum transport at nanoscale. The theoretical methods considered in the book are in the basis of our understanding of charge, spin and heat transport in nanostructures and nanostructured materials and are widely used in nanoelectronics, molecular electronics, spin-dependent electronics (spintronics) and bio-electronics. The book is based on lectures for graduate and post-graduate students at the University of Regensburg and the Technische Universit ä t Dresden (TU Dresden). The first part is devoted to the basic concepts of quantum transport: Landauer-B ü ttiker method and matrix Green function formalism for coherent transport, Tunneling (Transfer) Hamiltonian and master equation methods for tunneling, Coulomb blockade, vibrons and polarons. The results in this part are obtained as possible without sophisticated techniques, such as nonequilibrium Green functions, which are considered in detail in the second part. A general introduction into the nonequilibrium Green function theory is given. The approach based on the equation-of-motion technique, as well as more sophisticated one based on the Dyson-Keldysh diagrammatic technique are presented. The main attention is paid to the theoretical methods able to describe the nonequilibrium (at finite voltage) electron transport through interacting nanosystems, specifically the correlation effects due to electron-electron and electron-vibron interactions.

The physics of non-equilibrium many-body systems is one of the most rapidly expanding areas of theoretical physics. Traditionally used in the study of laser physics and superconducting kinetics, these techniques have more recently found applications in the study of dynamics of cold atomic gases, mesoscopic and nano-mechanical systems. The book gives a self-contained presentation of the modern functional approach to non-equilibrium field-theoretical methods. They are applied to examples ranging from biophysics to the kinetics of superfluids and superconductors. Its step-by-step treatment gives particular emphasis to the pedagogical aspects, making it ideal as a reference for advanced graduate students and researchers in condensed matter physics.

For modeling the transport of carriers in nanoscale devices, a Green-function formalism is the most accurate approach. Due to the complexity of the formalism, one should have a deep understanding of the underlying principles and use smart approximations and numerical methods for solving the kinetic equations at a reasonable computational time. In this book the required concepts from quantum and statistical mechanics and numerical methods for calculating Green functions are presented. The Green function is studied in detail for systems both under equilibrium and under nonequilibrium conditions. Because the formalism enables rigorous modeling of different scattering mechanisms in terms of self-energies, but an exact evaluation of self-energies for realistic systems is not possible, their approximation and inclusion in the quantum kinetic equations of the Green functions are elaborated. All the elements of the kinetic equations, which are the device Hamiltonian, contact self-energies and scattering self-energies, are examined and efficient methods for their evaluation are explained. Finally, the application of these methods to study novel electronic devices such as nanotubes, graphene, Si-nanowires and low-dimensional thermoelectric devices and photodetectors are discussed.

Dynamics: Models and Kinetic Methods for Non-equilibrium Many Body Systems
Nonequilibrium Green Functions Approach to Ionization Processes
Progress in Nonequilibrium Green's Functions
Nonequilibrium Green's Function-Hierarchical Equation of Motion Method for Time-Dependent Quantum Transport
Electrical Transport in Nanoscale Systems
Calculations and Simulations of Low-Dimensional Materials

This book originated out of a desire to provide students with an instrument which might lead them from knowledge of elementary classical and quantum physics to moderntheoreticaltechniques for the analysisof electrontransport in semiconductors. The book is basically a textbook for students of physics, material science, and electronics. Rather than a monograph on detailed advanced research in a speci?c area, it intends to introduce the reader to the fascinating ?eld of electron dynamics in semiconductors, a ?eld that, through its applications to electronics, greatly contributed to the transformationof all our lives in the second half of the twentieth century, and continues to provide surprises and new challenges. The ?eld is so extensive that it has been necessary to leave aside many subjects, while others could be dealt with only in terms of their basic principles. The book is divided into ?ve major parts. Part I moves from a survey of the fundamentals of classical and quantum physics to a brief review of basic semiconductor physics. Its purpose is to establish a common platform of language and symbols, and to make the entire treatment, as far as pos- ble, self-contained. Parts II and III, respectively, develop transport theory in bulk semiconductors in semiclassical and quantum frames. Part IV is devoted to semiconductor structures, including devices and mesoscopic coherent s- tems. Finally, Part V develops the basic theoretical tools of transport theory within the modern nonequilibrium Green-function formulation, starting from an introduction to second-quantization formalism.

Mesoscopic physics deals with systems larger than single atoms but small enough to retain their quantum properties. The possibility to create and manipulate conductors of the nanometer scale has given birth to a set of phenomena that have revolutionized physics: quantum Hall effects, persistent currents, weak localization, Coulomb blockade, etc. This Special Issue tackles the latest developments in the field. Contributors discuss time-dependent transport, quantum pumping, nanoscale heat engines and motors, molecular junctions, electron–electron correlations in confined systems, quantum thermo-electrics and current fluctuations. The works included herein represent an up-to-date account of exciting research with a broad impact in both fundamental and applied topics.

This book provides an introduction to the methods of coupled quantum statistical field theory and Green's functions. The methods of coupled quantum field theory have played a major role in the extensive development of nonrelativistic quantum many-particle theory and condensed matter physics. This introduction to the subject is intended to facilitate delivery of the material in an easily digestible form to advanced undergraduate physics majors at a relatively early stage of their scientific development. The main mechanism to accomplish this is the early introduction of variational calculus and the Schwinger Action Principle, accompanied by Green's functions. Important achievements of the theory in condensed matter and quantum statistical physics are reviewed in detail to help develop research capability. These include the derivation of coupled field Green's function equations-of-motion for a model electron-hole-phonon system, extensive discussions of retarded, thermodynamic and nonequilibrium Green's functions and their associated spectral representations and approximation procedures. Phenomenology emerging in these discussions include quantum plasma dynamic-nonlocal-screening, plasmons, polaritons, linear electromagnetic response, excitons, polarons, phonons, magnetic Landau quantization, van der Waals interactions, chemisorption, etc. Considerable attention is also given to low dimensional and nanostructured systems, including quantum wells, wires, dots and superlattices, as well as materials having exceptional conduction properties such as Superconductors, Superfluids and Graphene.

The aim of this book is to present a formulation of the non-equilibrium physics in nanoscale systems in terms of many-body states and operators and, in addition, discuss a diagrammatic approach to Green functions expressed by many-body states. The intention is not to give an account of strongly correlated systems as such. Thus, the focus of this book ensues from the typical questions that arise when addressing nanoscale systems from a practical point of view, e.g. current-voltage asymmetries, negative differential conductance, spin-dependent tunneling. The focus is on nanoscale systems constituted of complexes of subsystems interacting with one another, under non-equilibrium conditions, in which the local properties of the subsystems are preferably being described in terms of its (many-body) eigenstates.

Theory of Electron Transport in Semiconductors
Semiclassical and Quantum Device Modeling and Simulation
Topics in High Field Transport in Semiconductors
Simulations of Semiconductor Laser Using Non-equilibrium Green's Functions Method
Nonequilibrium Green's Function Approach to Artificial Atoms
Nonequilibrium Green's Function Approach Compared to Semiclassical Methods

Time-dependent density-functional theory (TDDFT) is a quantum mechanical approach for the dynamical properties of electrons in matter. It's widely used in (bio)chemistry and physics to calculate molecular excitation energies and optical properties of materials. This is the first graduate-level text on the formal framework and applications of TDDFT.

The Green's function method is one of the most powerful and versatile formalisms in physics, and its nonequilibrium version has proved invaluable in many research fields. This book provides a unique, self-contained introduction to nonequilibrium many-body theory. Starting with basic quantum mechanics, the authors introduce the equilibrium and nonequilibrium Green's function formalisms within a unified framework called the contour formalism. The physical content of the contour Green's functions and the diagrammatic expansions are explained with a focus on the time-dependent aspect. Every result is derived step-by-step, critically discussed and then applied to different physical systems, ranging from molecules and nanostructures to metals and insulators. With an abundance of illustrative examples, this accessible book is ideal for graduate students and researchers who are interested in excited state properties of matter and nonequilibrium physics.

To push MOSFETs to their scaling limits and to explore devices that may complement or even replace them at molecular scale, a clear understanding of device physics at nanometer scale is necessary. Nanoscale Transistors provides a description on the recent development of theory, modeling, and simulation of nanotransistors for electrical engineers, physicists, and chemists working on nanoscale devices. Simple physical pictures and semi-analytical models, which were validated by detailed numerical simulations, are provided for both evolutionary and revolutionary nanotransistors. After basic concepts are reviewed, the text summarizes the essentials of traditional semiconductor devices, digital circuits, and systems to supply a baseline against which new devices can be assessed. A nontraditional view of the MOSFET using concepts that are valid at nanoscale is developed and then applied to nanotube FET as an example of how to extend the concepts to revolutionary nanotransistors. This practical guide then explore the limits of devices by discussing conduction in single molecules

The discovery of Bose–Einstein condensation (BEC) in trapped ultracold atomic gases in 1995 has led to an explosion of theoretical and experimental research on the properties of Bose-condensed dilute gases. The first treatment of BEC at finite temperatures, this book presents a thorough account of the theory of two-component dynamics and nonequilibrium behaviour in superfluid Bose gases. It uses a simplified microscopic model to give a clear, explicit account of collective modes in both the collisionless and collision-dominated regions. Major topics such as kinetic equations, local equilibrium and two-fluid hydrodynamics are introduced at an elementary level. Explicit predictions are worked out and linked to experiments. Providing a platform for future experimental and theoretical studies on the finite temperature dynamics of trapped Bose gases, this book is ideal for researchers and graduate students in ultracold atom physics, atomic, molecular and optical physics and condensed matter physics.

A Many-Body Approach
An Efficient Ab-initio Non-equilibrium Green's Function Approach to Carriers Dynamics in Many-body Interacting Systems
Nonequilibrium Many-Body Theory of Quantum Systems
Non-Equilibrium Green's Function Approach to Dielectric Response: De-Screening of the Coulomb Interaction at High Electric Fields
Quantum Foundations And Open Quantum Systems: Lecture Notes Of The Advanced School
Bose-Condensed Gases at Finite Temperatures

This book introduces readers to state-of-the-art theoretical and simulation techniques for determining transport in complex band structure materials and nanostructured-geometry materials, linking the techniques developed by the electronic transport community to the materials science community. Starting from the semi-classical Boltzmann Transport Equation method for complex band structure materials, then moving on to Monte Carlo and fully quantum mechanical models for nanostructured materials, the book addresses the theory and computational complexities of each method, as well as their advantages and capabilities. Presented in language that is accessible to junior computational scientists, while including enough detail and depth with regards to numerical implementation to tackle modern research problems, it offers a valuable resource for computational scientists and postgraduate researchers whose work involves the theory and simulation of electro-thermal transport in advanced materials.

Equilibrium and nonequilibrium properties of correlated many-body systems are of growing interest in many fields of physics, including condensed matter, dense plasmas, nuclear matter and particles. The most powerful and general method which applies equally to all these areas is given by quantum field theory. Written by the leading experts and understandable to non-specialists, this book provides an overview on the basic ideas and concepts of the method of nonequilibrium Green's functions. It is complemented by modern applications of the method to a variety of topics, such as optics and transport in dense plasmas and semiconductors; correlations, bound states and coherence; strong field effects and short-pulse lasers; nuclear matter and QCD. Authors include: Gordon Bayan, Pawel Danielewicz, Don DuBois, Hartmut Haug, Klaus Henneberger, Antti-Pekka Jauho, Jörn Kuoll, Dietrich Kremp, Pavel Lipavsky and Paul C Martin.

Contents:Kadanoff–Baym Equations: History and PerspectivesGeneral Problems of Quantum Kinetic TheoryPlasmasSemiconductors. OpticsQuantum Transport in Coulomb SystemsNuclear Matter, Correlations. Bound States. Bose CondensationNumerical Concepts Readership: Graduate students and researchers interested in the theoretical description of quantum many-body systems in nonequilibrium. Keywords:Equilibrium;Nonequilibrium;Many-Body Systems;Optics;Quantum Field Theory;Nonequilibrium Green's Functions;Kadanoff-Baym Equations;Quantum Kinetic Theory;Plasmas;Semiconductors;Quantum Transport;Nuclear Matter

This graduate textbook provides an in-depth description of the transport phenomena relevant to systems of nanoscale dimensions. The different theoretical approaches are critically discussed, with emphasis on their basic assumptions and approximations. The book also covers information content in the measurement of currents, the role of initial conditions in establishing a steady state, and the modern use of density-functional theory. Topics are introduced by simple physical arguments, with particular attention to the non-equilibrium statistical nature of electrical conduction, and followed by a detailed formal derivation. This textbook is ideal for graduate students in physics, chemistry, and electrical engineering.

The Advanced School on Quantum Foundations and Open Quantum Systems was an exceptional combination of lectures. These comprise lectures in standard physics and investigations on the foundations of quantum physics.On the one hand it included lectures on quantum information, quantum open systems, quantum transport and quantum solid state. On the other hand it included lectures on quantum measurement, models for elementary particles, sub-quantum structures and aspects on the philosophy and principles of quantum physics.The special program of this school offered a broad outlook on the current and near future fundamental research in theoretical physics.The lectures are at the level of PhD students.

Computational Electronics
Quantum Transport
Progress in Nonequilibrium Green's Functions II
Field Theory of Non-Equilibrium Systems
Concepts and Applications
Predicting Phonon Thermal Conductance at Atomic Junctions

High-field dielectric response is investigated using the technique of non-equilibrium Green's functions based on an Airy-coordinate formulation. The field-dependent polarization function of the system is derived. De-screening of the Coulomb interaction due to collisional broadening and high electric field is examined.

This book is a rewritten and annotated version of Leo P. Kadanoff and Gordon Baym's lectures that were presented in the book Quantum Statistical Mechanics: Green's Function Methods in Equilibrium and Nonequilibrium Problems. The lectures were devoted to a discussion on the use of thermodynamic Green's functions in describing the properties of many-particle systems. The functions provided a method for discussing finite-temperature problems with no more conceptual difficulty than ground-state problems, and the method was equally applicable to boson and fermion systems and equilibrium and nonequilibrium problems. The lectures also explained nonequilibrium statistical physics in a systematic way and contained essential concepts on statistical physics in terms of Green's functions with sufficient and rigorous details. In-Gee Kim thoroughly studied the lectures during one of his research projects but found that the unspecialized method used to present them in the form of a book reduced their readability. He started the tedious work of rewriting and annotating them to fully understand the formalism of nonequilibrium quantum statistical mechanics. While doing so, he realized they can be a useful resource for students of modern physics but will have to be upgraded to match pace with the evolved curricula. Being aware that besides completing the course work and passing the relevant examinations, it is necessary for graduate students of modern physics to make the knowledge of a topic concrete in their minds. This book is a systematically prepared summary of those lectures and will be extremely useful for graduate students as well as senior researchers to settle down the key knowledge of the subject.

Tailoring Properties for Applications
Nonequilibrium Green's Function-hierarchical Equation of Motion Method for Time-dependent Quantum Transport
Device Physics, Modeling and Simulation