Quantum Nanoelectronics An Introduction To Electr

An Introduction to Nanoscience and Nanotechnology
Quantum Computing
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Nonequilibrium Quantum Transport Physics In Nanosystems: Foundation Of Computational Nonequilibrium Physics In Nanoscience And Nanotechnology
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Quantum Mechanics for Scientists and Engineers

NEAL KARTER

An Introduction to Nanoscience and Nanotechnology Cambridge University Press
The author presents all aspects, in theory and experiments, of nanoelectronic devices starting from field-effect transistors and leading to alternative device concepts such as Schottky-barrier MOSFETs and band-to-band tunnel FETs. Latest advances in Nanoelectronics, as ultralow power nanoscale devices and the realization of silicon MOS spin qubits, are discussed and finally a brief introduction into device simulations is given as well.
Quantum Computing John Wiley & Sons
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 Universität Dresden (TU Dresden). The first part is devoted to the basic concepts of quantum transport: Landauer-Büttiker 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.
Graphene Nanoelectronics Springer Science & Business Media
This introductory text develops the reader’s fundamental understanding of core principles and experimental aspects underlying the operation of nanoelectronic devices. The author makes a thorough and systematic presentation of electron transport in quantum-confined systems such as quantum dots, quantum wires, and quantum wells together with Landauer-Büttiker formalism and non-equilibrium Green’s function approach. The coverage encompasses nanofabrication techniques and characterization tools followed by a comprehensive exposition of nanoelectronic devices including resonant tunneling diodes, nanoscale MOSFETs, carbon nanotube FETs, high-electron-mobility transistors, single-electron transistors, and heterostructure optoelectronic devices. The writing throughout is simple and straightforward, with clearly drawn illustrations and extensive self-study exercises for each chapter. Introduces the basic concepts underlying the operation of nanoelectronic devices. Offers a broad overview of the field, including state-of-the-art developments. Covers the relevant quantum and solid-state physics and nanoelectronic device principles. Written in lucid language with accessible mathematical treatment. Includes extensive end-of-chapter exercises and many insightful diagrams.
Fundamentals of Nanoelectronics Springer Science & Business Media
This book presents the first comprehensive treatment of discrete phase-space quantum mechanics and the lattice Weyl-Wigner formulation of energy band dynamics, by the originator of these theoretical techniques. The author's quantum superfield theoretical formulation of nonequilibrium quantum physics is given in real time, without the awkward use of artificial time contour employed in previous formulations. These two main quantum theoretical techniques combine to yield general (including quasiparticle-pairing dynamics) and exact quantum transport equations in phase-space, appropriate for nanodevices. The derivation of transport formulas in mesoscopic physics from the general quantum transport equations is also treated. Pioneering nanodevices are discussed in the light of the quantum-transport physics equations, and an in-depth treatment of the physics of resonant tunneling devices is given. Operator Hilbert-space methods and quantum tomography are discussed. Discrete phase-space quantum mechanics on finite fields is treated for completeness and by virtue of its relevance to quantum computing. The phenomenological treatment of evolution superoperator and measurements is given to help clarify the general quantum transport theory. Quantum computing and information theory is covered to demonstrate the foundational aspects of discrete quantum dynamics, particularly in deriving a complete set of multiparticle entangled basis states.
The Physics of Nanoelectronics Oxford University Press
A comprehensive textbook on nanoelectronics covering the underlying physics, nanostructures, nanomaterials and nanodevices.
Nanoelectronics Fundamentals CRC Press
Quantum Heterostructures provides a detailed description of the key physical and engineering principles of quantum semiconductor heterostructures. Blending important concepts from physics, materials science, and electrical engineering, it also explains clearly the behavior and operating features of modern microelectronic and optoelectronic devices. The authors begin by outlining the trends that have driven development in this field, most importantly the need for high-performance devices in computer, information, and communications technologies. They then describe the basics of quantum nanoelectronics, including various transport mechanisms. In the latter part of the book, they cover novel microelectronic devices, and optical devices based on quantum heterostructures. The book contains many homework problems and is suitable as a textbook for undergraduate and graduate courses in electrical engineering, physics, or materials science. It will also be of great interest to those involved in research or development in microelectronic or optoelectronic devices.
Introduction to Nano Walter de Gruyter GmbH & Co KG
Long awaited new edition of this highly successful textbook, provides once more a unique introduction to the concepts, techniques and applications of nanoscale systems by covering its entire spectrum up to recent findings on graphene.
Quantum Transport World Scientific

A tutorial coverage of electronic technology, starting from the basics of condensed matter and quantum physics. Experienced author Ed Wolf presents established and novel devices like Field Effect and Single Electron Transistors, and leads the reader up to applications in data storage, quantum computing, and energy harvesting. Intended to be self-contained for students with two years of calculus-based college physics, with corresponding fundamental knowledge in mathematics, computing and chemistry.

Nonequilibrium Quantum Transport Physics In Nanosystems: Foundation Of Computational Nonequilibrium Physics In Nanoscience And Nanotechnology Cambridge University Press

As electric devices become smaller and smaller, transport simulations based on the quantum mechanics become more and more important. There are currently numerous textbooks on the basic concepts of quantum transport, but few present calculation methods in detail. This book provides various quantum transport simulation methods and shows applications

Nanoelectronics and Information Technology Wiley-VCH

Advances in nanotechnology have allowed physicists and engineers to miniaturize electronic structures to the limit where finite-size related phenomena start to impact their properties. This book discusses such phenomena and models made for their description. The book starts from the semiclassical description of nonequilibrium effects, details the scattering theory used for quantum transport calculations, and explains the main interference effects. It also describes how to treat fluctuations and correlations, how interactions affect transport through small islands, and how superconductivity modifies these effects. The last two chapters describe new emerging fields related with graphene and nanoelectromechanics. The focus of the book is on the phenomena rather than formalism, but the book still explains in detail the main models constructed for these phenomena. It also introduces a number of electronic devices, including the single-electron transistor, the superconducting tunnel junction refrigerator, and the superconducting quantum bit.

Granular Nanoelectronics CRC Press

This book covers the state of the art in the theoretical framework, computational modeling, and the fabrication and characterization of nanoelectronics devices. It addresses material properties, device physics, circuit analysis, system design, and a range of applications. A discussion on the nanoscale fabrication, characterization and metrology is also included. The book offers a valuable resource for researchers, graduate students, and senior undergraduate students in engineering and natural sciences, who are interested in exploring nanoelectronics from materials, devices, systems, and applications perspectives.

Introduction to the Physics of Nanoelectronics World Scientific

Today, the concepts of single-electron tunneling (SET) are used to understand and model single-atom and single-molecule nanoelectronics. The characteristics of nanoelectronic devices, especially SET transistors, can be understood on the basis of the physics of nanoelectronic devices and circuit models. A circuit theory approach is necessary for considering possible integration with current microelectronic circuitry. To explain the properties and possibilities of SET devices, this book follows an approach to modeling these devices using electronic circuit theory. All models and equivalent circuits are derived from the first principles of circuit theory. Based on energy conservation, the circuit model of SET is an impulsive current source, and modeling distinguishes between bounded and unbounded currents. The Coulomb blockade is explained as a property of a single junction. In addition, this edition differs from the previous one by elaborating on the section on spice simulations and providing a spice simulation on the SET electron box circuit, including the spice netlist. Also, a complete, new proof of the two-capacitor problem in circuit theory is presented; the importance of this proof in understanding energy conservation in SET circuits cannot be underestimated. This book will be very useful for advanced undergraduate- and graduate-level students of electrical engineering and nanoelectronics and researchers in nanotechnology, nanoelectronic device physics, and computer science. Only book modeling both single-electron tunneling and many electron tunneling from the points of view of electronics; starting from experiments, via a physics description, working towards a circuit description; and based on energy conservation, in electrical circuits, developing the impulse circuit model for single-electron tunneling.

Introduction to Quantum Nanotechnology Cambridge University Press

The technological means now exists for approaching the fundamentallimiting scales of solid state electronics in which a single carrier can, in principle, represent a single bit in an information flow. In this light, the prospect of chemically, or biologically, engineered molccular-scale structures which might support information processing functions has enticed workers for many years. The one common factor in all suggested molecular switches, ranging from the experimentally feasible proton-tunneling structure, to natural systems such as the micro-tubule, is that each proposed structure deals with individual information carrying entities. Whereas this future molecular electronics faces enormous technical challenges, the same limit is already appearing in existing semiconducting quantum wires and small tunneling structures, both superconducting and normal meta! devices, in which the motion of a single eh arge through the tunneling barrier can produce a sufficient voltage change to cut-off further tunneling current. We may compare the above situation with today's Si microelectronics, where each bit is encoded as a very !arge number, not necessarily fixed, of electrons within acharge pulse. The associated reservoirs and sinks of charge carriers may be profitably tapped and manipulated to proviele macro-currents which can be readily amplified or curtailed. On the other band, modern semiconductor ULSI has progressed by adopting a linear scaling principle to the down-sizing of individual semiconductor devices.

Introduction to Nanotechnology Springer

This book presents synthesis techniques for the preparation of low-dimensional nanomaterials including 0D (quantum dots), 1D (nanowires, nanotubes) and 2D (thin films, few layers), as well as their potential applications in nanoelectronic systems. It focuses on the size effects involved in the transition from bulk materials to nanomaterials; the electronic properties of nanoscale devices; and different classes of nanomaterials from microelectronics to nanoelectronics, to molecular electronics. Furthermore, it demonstrates the structural stability, physical, chemical, magnetic, optical, electrical, thermal, electronic and mechanical properties of the nanomaterials. Subsequent chapters address their characterization, fabrication techniques from lab-scale to mass production, and functionality. In turn, the book considers the environmental impact of nanotechnology and novel applications in the mechanical industries, energy harvesting, clean energy, manufacturing materials, electronics, transistors, health and medical therapy. In closing, it addresses the combination of

biological systems with nanoelectronics and highlights examples of nanoelectronic–cell interfaces and other advanced medical applications. The book answers the following questions: • What is different at the nanoscale? • What is new about nanoscience? • What are nanomaterials (NMs)? • What are the fundamental issues in nanomaterials? • Where are nanomaterials found? • What nanomaterials exist in nature? • What is the importance of NMs in our lives? • Why so much interest in nanomaterials? • What is at nanoscale in nanomaterials? • What is graphene? • Are pure low-dimensional systems interesting and worth pursuing? • Are nanotechnology products currently available? • What are sensors? • How can Artificial Intelligence (AI) and nanotechnology work together? • What are the recent advances in nanoelectronic materials? • What are the latest applications of NMs?

Quantum Nanoelectronics Springer

This self-contained text describes the underlying theory and approximate quantum models of real nanodevices for nanotechnology applications.

Theoretical Foundations of Nanoscale Quantum Devices Elsevier

A detailed primer describing the most effective theoretical and computational methods and tools for simulating graphene-based systems.

Quantum Mechanics with Applications to Nanotechnology and Information Science World Scientific Publishing Company

This book provides a comprehensive overview of the rapidly developing field of molecular electronics. It focuses on our present understanding of the electrical conduction in single-molecule circuits and provides a thorough introduction to the experimental techniques and theoretical concepts. It will also constitute as the first textbook-like introduction to both the experiment and theory of electronic transport through single atoms and molecules. In this sense, this publication will prove invaluable to both researchers and students interested in the field of nanoelectronics and nanoscience in general. Molecular Electronics is self-contained and unified in its presentation. It may be used as a textbook on nanoelectronics by graduate students and advanced undergraduates studying physics and chemistry. In addition, included are previously unpublished material that will help researchers gain a deeper understanding into the basic concepts involved in the field of molecular electronics.

Nanoelectronic Materials Springer Science & Business Media

This book provides an introduction to the physics of nanoelectronics, with a focus on the theoretical aspects of nanoscale devices. The book begins with an overview of the mathematics and quantum mechanics pertaining to nanoscale electronics, to facilitate the understanding of subsequent chapters. It goes on to encompass quantum electronics, spintronics, Hall effects, carbon and graphene electronics, and topological physics in nanoscale devices. Theoretical methodology is developed using quantum mechanical and non-equilibrium Green s function (NEGF) techniques to calculate electronic currents and elucidate their transport properties at the atomic scale. The spin Hall effect is explained and its application to the emerging field of spintronics where an electron s spin as well as its charge is utilised is discussed. Topological dynamics and gauge potential are introduced with the relevant mathematics, and their application in nanoelectronic systems is explained. Graphene, one of the most promising carbon-based nanostructures for nanoelectronics, is also explored. Begins with an overview of the mathematics and quantum mechanics pertaining to nanoscale electronicsEncompasses quantum electronics, spintronics, Hall effects, carbon and graphene electronics, and topological physics in nanoscale devicesComprehensively introduces topological dynamics and gauge potential with the relevant mathematics, and extensively discusses their application in nanoelectronic systems"

Quantum Heterostructures MIT Press

This introductory text develops the reader’s fundamental understanding of core principles and experimental aspects underlying the operation of nanoelectronic devices. The author makes a thorough and systematic presentation of electron transport in quantum-confined systems such as quantum dots, quantum wires, and quantum wells together with Landauer-Büttiker formalism and non-equilibrium Green’s function approach. The coverage encompasses nanofabrication techniques and characterization tools followed by a comprehensive exposition of nanoelectronic devices including resonant tunneling diodes, nanoscale MOSFETs, carbon nanotube FETs, high-electron-mobility transistors, single-electron transistors, and heterostructure optoelectronic devices. The writing throughout is simple and straightforward, with clearly drawn illustrations and extensive self-study exercises for each chapter. Introduces the basic concepts underlying the operation of nanoelectronic devices. Offers a broad overview of the field, including state-of-the-art developments. Covers the relevant quantum and solid-state physics and nanoelectronic device principles. Written in lucid language with accessible mathematical treatment. Includes extensive end-of-chapter exercises and many insightful diagrams.

Introduction to Graphene-Based Nanomaterials Gilad James Mystery School

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.