

Lecture Notes in Physics

Tobias Brandes (Ed.)

Low-Dimensional Systems

Interactions
and Transport Properties

Workshop,
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Lowdimensional Systems Interactions And Transport Properties

Eckehard Schöll



Low-dimensional Systems Interactions And Transport Properties:

Low-Dimensional Systems Tobias Brandes, 2014-03-12 Experimental progress over the past few years has made it possible to test a number of fundamental physical concepts related to the motion of electrons in low dimensions The production and experimental control of novel structures with typical sizes in the sub micrometer regime has now become possible In particular semiconductors are widely used in order to confine the motion of electrons in two dimensional heterostructures The quantum Hall effect was one of the first highlights of the new physics that is revealed by this confinement In a further step of the technological development in semiconductor heterostructures other artificial devices such as quasi one dimensional quantum wires and quantum dots artificial atoms have also been produced These structures again differ very markedly from three and two dimensional systems especially in relation to the transport of electrons and the interaction with light Although the technological advances and the experimental skills connected with these new structures are progressing extremely fast our theoretical understanding of the physical effects such as the quantum Hall effect is still at a very rudimentary level In low dimensional structures the interaction of electrons with one another and with other degrees of freedoms such as lattice vibrations or light gives rise to new phenomena that are very different from those familiar in the bulk material The theoretical formulation of the electronic transport properties of small devices may be considered well established provided interaction processes are neglected

Low-Dimensional Systems Tobias Brandes, 2008-01-11 Experimental progress over the past few years has made it possible to test a number of fundamental physical concepts related to the motion of electrons in low dimensions The production and experimental control of novel structures with typical sizes in the sub micrometer regime has now become possible In particular semiconductors are widely used in order to confine the motion of electrons in two dimensional heterostructures The quantum Hall effect was one of the first highlights of the new physics that is revealed by this confinement In a further step of the technological development in semiconductor heterostructures other artificial devices such as quasi one dimensional quantum wires and quantum dots artificial atoms have also been produced These structures again differ very markedly from three and two dimensional systems especially in relation to the transport of electrons and the interaction with light Although the technological advances and the experimental skills connected with these new structures are progressing extremely fast our theoretical understanding of the physical effects such as the quantum Hall effect is still at a very rudimentary level In low dimensional structures the interaction of electrons with one another and with other degrees of freedoms such as lattice vibrations or light gives rise to new phenomena that are very different from those familiar in the bulk material The theoretical formulation of the electronic transport properties of small devices may be considered well established provided interaction processes are neglected

Handbook of Nanophysics Klaus D. Sattler, 2010-09-17 Intensive research on fullerenes nanoparticles and quantum dots in the 1990s led to interest in nanotubes and nanowires in subsequent years Handbook of Nanophysics Nanotubes and Nanowires focuses on the fundamental physics and latest applications of these

important nanoscale materials and structures Each peer reviewed chapter contains a broad **Theory of Transport Properties of Semiconductor Nanostructures** Eckehard Schöll,2013-11-27 Recent advances in the fabrication of semiconductors have created almost unlimited possibilities to design structures on a nanometre scale with extraordinary electronic and optoelectronic properties The theoretical understanding of electrical transport in such nanostructures is of utmost importance for future device applications This represents a challenging issue of today's basic research since it requires advanced theoretical techniques to cope with the quantum limit of charge transport ultrafast carrier dynamics and strongly nonlinear high field effects This book which appears in the electronic materials series presents an overview of the theoretical background and recent developments in the theory of electrical transport in semiconductor nanostructures It contains 11 chapters which are written by experts in their fields Starting with a tutorial introduction to the subject in Chapter 1 it proceeds to present different approaches to transport theory The semiclassical Boltzmann transport equation is in the centre of the next three chapters Hydrodynamic moment equations Chapter 2 Monte Carlo techniques Chapter 3 and the cellular automaton approach Chapter 4 are introduced and illustrated with applications to nanometre structures and device simulation A full quantum transport theory covering the Kubo formalism and nonequilibrium Green's functions Chapter 5 as well as the density matrix theory Chapter 6 is then presented *An Introduction to Condensed Matter Physics for the Nanosciences* Arthur McGurn,2023-04-13 The book provides an accessible introduction to the principles of condensed matter physics with a focus on the nanosciences and device technologies The basics of electronic phononic photonic superconducting optics quantum optics and magnetic properties are explored and nanoscience and device materials are incorporated throughout the chapters Many examples of the fundamental principles of condensed matter physics are taken directly from nanoscience and device applications This book requires a background in electrodynamics quantum mechanics and statistical mechanics at the undergraduate level It will be a valuable reference for advanced undergraduates and graduate students of physics engineering and applied mathematics Features Contains discussions of the basic principles of quantum optics and its importance to lasers quantum information and quantum computation Provides references and a further reading list to additional scientific literature so that readers can use the book as a starting point to then follow up with a more advanced treatment of the topics covered Requires only a basic background in undergraduate electrodynamics quantum mechanics and statistical mechanics **Low-Dimensional Materials** Hui-Ming Cheng,Dai-Ming Tang,Xiaolong Zou,Lili Zhang,2024-10-05 *Low Dimensional Materials Bridging the Fundamental Principles to Practice Applications* provides an overview of research on low dimensional materials devices and their applications There are seven chapters in the book starting from the basic quantum theory in chapter one to the control and characterization of the unique structures chapters two and four to the relation of the physical and chemical properties with structures chapter five and to the practical and promising applications in energy information and health chapter six before conclusions and future outlook in chapter seven

Discusses the whole field of low dimensional materials from quantum mechanics and low dimensional effects to structure property relations various methods of fabrication and assembly techniques and a characterization of atomic and interface structures Covers a wide range of topics making it a map for readers to understand the fundamentals of low dimensional materials Written with a bottom up approach with a solid foundation of quantum mechanics thermodynamics and energy transport in low dimensional systems

Strong Interactions in Low Dimensions D. Baeriswyl, L. Degiorgi, 2007-09-29 This book provides an attempt to convey the colorful facets of condensed matter systems with reduced dimensionality Some of the specific features predicted for interacting one dimensional electron systems such as charge and spin density waves have been observed in many quasi one dimensional materials The two dimensional world is even richer besides d wave superconductivity and the Quantum Hall Effect perhaps the most spectacular phases explored during the last two decades many collective charge and spin states have captured the interest of researchers such as charge stripes or spontaneously generated circulating currents Recent years have witnessed important progress in material preparation measurement techniques and theoretical methods Today larger and better samples higher flux for neutron beams advanced light sources better resolution in electron spectroscopy new computational algorithms and the development of field theoretical approaches allow an in depth analysis of the complex many body behaviour of low dimensional materials The epoch when simple mean field arguments were sufficient for describing the gross features observed experimentally is definitely over The Editors aim is to thoroughly explain a number of selected topics the application of dynamical probes such as neutron scattering optical absorption and photoemission as well as transport studies both electrical and thermal Some of the more theoretical chapters are directly relevant for experiments such as optical spectroscopy transport in one dimensional models and the phenomenology of charge inhomogeneities in layered materials while others discuss more general topics and methods for example the concept of a Luttinger liquid and bosonization or duality transformations both promising tools for treating strongly interacting many body systems

Physics and Chemistry of Nano-structured Materials Shihe Yang, 2003-09-02 The development of nanostructured materials represents a new and fast evolving application of recent research in physics and chemistry Novel experimental tools coupled with new theory have made this possible Topics covered in this book include nanocrystals semiconductor heterostructures nanotubes nanowires and manipulation and fabrication techniques The core of the book consists of ten lectures by five distinguished researchers Paul Alivisatos D D Awschalom Sumio Iijima Charles Lieber and Phaedon Avouris presented at an Advanced Study Institute in Hong Kong in January 1999 It should interest materials physicists and chemists as well as materials scientists with an interest in the growth and characterisation of sophisticated materials

Handbook on the Physics and Chemistry of Rare Earths Vitalij K. Pecharsky, Jean-Claude G. Bunzli, 2020-11-11 Handbook on the Physics and Chemistry of Rare Earths Including Actinides Volume 58 the latest release in this continuous series that covers all aspects of rare earth science including chemistry life

sciences materials science and physics presents interesting chapters on Forensic applications of rare earth materials and Rare earths the seventeen position nob Presents up to date overviews and new developments in the field of rare earths covering both their physics and chemistry Contains individual chapters that are comprehensive and broad along with critical reviews Provides contributions from highly experienced invited experts Physical Properties of Ceramic and Carbon Nanoscale Structures Stefano Bellucci, 2011-02-28 This is the second volume in a series of books on selected topics in Nanoscale Science and Technology based on lectures given at the well known INFN schools of the same name The aim of this collection is to provide a reference corpus of suitable introductory material to relevant subfields as they mature over time by gathering the significantly expanded and edited versions of tutorial lectures given over the years by internationally known experts The present set of notes stems in particular from the participation and dedication of prestigious lecturers such as Andrzej Huczko Nicola Pugno Alexander Malesevich Pasquale Onorato and Stefano Bellucci All lectures were subsequently carefully edited and reworked taking into account the extensive follow up discussions A tutorial lecture by Huczko et al shows how a variety of carbon and ceramic nanostructures nanotubes nanowires nanofibres nanorods and nanoencapsulates have in particular great potential for improving our understanding of the fundamental concepts of the roles of both dimensionality and size on physical material properties Bellucci and Onorato provide an extensive and tutorial review of the quantum transport properties in carbon nanotubes encompassing a description of the electronic structure from graphene to single wall nanotubes as well as a discussion of experimental evidence of superconductivity in carbon nanotubes and the corresponding theoretical interpretation In the first contribution by Pugno new ideas on how to design futuristic self cleaning super adhesive and releasable hierarchical smart materials are presented He also reviews the mechanical strength of such nanotubes and megacables with an eye to the visionary project of a carbon nanotube based space elevator megacable In his second contribution Pugno outlines in detail the role on the fracture strength of thermodynamically unavoidable atomistic defects with different size and shape both numerically and theoretically for nanotubes and nanotube bundles Focusing on graphitic allotropes the chapter by Bellucci and Malesevich aims to give a taste of the widespread implications carbon nanostructures have on research and applications starting from an historical overview followed by a discussion of the structure and physical properties of carbon nanotubes and graphene in particular in the context of the several different synthesis techniques presently available

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