

W.C.J. Magnus  
W.J. Schoenmaker

# Quantum Transport in Sub-Micron Devices

A Theoretical  
Introduction



Springer

# Quantum Transport In Submicron Devices A Theoretical Introduction

**Peter Mohn**



## **Quantum Transport In Submicron Devices A Theoretical Introduction:**

**Quantum Transport in Submicron Devices** Wim Magnus,Wim Schoenmaker,2002-06-12 The aim of this book is to resolve the problem of electron and hole transport with a coherent and consistent theory that is relevant to the understanding of transport phenomena in submicron devices Along the road readers encounter landmarks in theoretical physics as the authors guide them through the strong and weak aspects of various hypotheses

**Quantum Transport in Submicron Devices** Wim Magnus,Wim Schoenmaker,2012-12-06 In this book the problem of electron and hole transport is approached from the point of view that a coherent and consistent physical theory can be constructed for transport phenomena Along the road readers will visit some exciting citadels in theoretical physics as the authors guide them through the strong and weak aspects of the various theoretical constructions Our goal is to make clear the mutual coherence and to put each theoretical model in an appropriate perspective The mere fact that so many partial solutions have been proposed to describe transport be it in condensed matter fluids or gases illustrates that we are entering a world of physics with a rich variety of phenomena Theoretical physics always seeks to provide a unifying picture By presenting this tour of many very inventive attempts to build such a picture it is hoped that the reader will be inspired and encouraged to help find the unifying principle behind the many faces of transport

**Theory of Semiconductor Quantum Devices** Fausto Rossi,2011-01-13 Primary goal of this book is to provide a cohesive description of the vast field of semiconductor quantum devices with special emphasis on basic quantum mechanical phenomena governing the electro optical response of new generation nanomaterials The book will cover within a common language different types of optoelectronic nanodevices including quantum cascade laser sources and detectors few electron exciton quantum devices and semiconductor based quantum logic gates The distinguishing feature of the present volume is a unified microscopic treatment of quantum transport and coherent optics phenomena on ultrasmall space and time scales as well as of their semiclassical counterparts

**Quantum Kinetics in Transport and Optics of Semiconductors** Hartmut Haug,Antti-Pekka Jauho,2007-12-10 Nanoscale miniaturization and femtosecond laser pulse spectroscopy require a quantum mechanical description of the carrier kinetics that goes beyond the conventional Boltzmann theory On these extremely short length and time scales the electrons behave as do partially coherent waves This monograph deals with quantum kinetics for transport in low dimensional microstructures and for ultra short laser pulse spectroscopy The nonequilibrium Green function theory is described and used for the derivation of the quantum kinetic equations Numerical methods for the solution of the retarded quantum kinetic equations are discussed and results are presented for high field transport and for mesoscopic transport phenomena Quantum beats polarization decay and non Markovian behaviour are treated for femtosecond spectroscopy on a microscopic basis Since the publishing of the first edition in 1996 the nonequilibrium Green function technique has been applied to a large number of new research topics and the revised edition introduces the reader to many of these areas such as molecular electronics noise calculations build up of

screening and polaron correlations and non Markovian relaxation among others Connection to recent experiments is made and it is emphasized how the quantum kinetic theory is essential in their interpretation **Green's Functions in Quantum Physics** Eleftherios N. Economou, 2006-08-02 Of interest to advanced students this book focuses on Green's functions for obtaining simple and general solutions to basic problems in quantum physics It demonstrates the unifying formalism of Green's functions across many applications including transport properties carbon nanotubes and photonics and photonic crystals

**Electrodynamics of Magnetoactive Media** Israel D. Vagner, B.I. Lembrikov, Peter Rudolf Wyder, 2013-03-09 Our objective was primarily to consider in a separate treatise from the general point of view a theory of as many electrodynamic phenomena in a magnetic field as possible The choice of material was determined by both the absence of such a book and the scientific interests of the authors From the very beginning however we felt it necessary to include the fundamentals of electrodynamics that are required for the thorough analysis of particular processes We believe that it is convenient for a reader to find in the same book a consistent review of some special fields in physics and a complete set of theoretical instruments that are necessary for the clear understanding of more advanced parts of the book There exists a number of excellent textbooks and monographs describing the problems of classical electrodynamics in general and its applications to continuous media We have to acknowledge for example the following fundamental books Electrodynamics by A Sommerfeld 1 The Classical Theory of Fields by L D Landau and E M Lifshitz 2 Electromagnetic Theory by J A Stratton 3 and Electrodynamics of Continuous Media by L D Landau and E M Lifshitz 4 This list is certainly not exhaustive However to our knowledge a book specifically covering the theory of electrodynamic phenomena in a magnetic field has not yet been written

Quantum Theory of Magnetism Robert M. White, 2007-01-23 Quantum Theory of Magnetism is the only book that deals with the phenomenon of magnetism from the point of view of linear response That is how does a magnetic material respond when excited by a magnetic field That field may be uniform or spatially varying static or time dependent Previous editions have dealt primarily with the magnetic response This edition incorporates the resistive response of magnetic materials as well It also includes problems to test the reader's or student's comprehension The rationale for a book on magnetism is as valid today as it was when the first two editions of Quantum Theory of Magnetism were published Magnetic phenomena continue to be discovered with deep scientific implications and novel applications Since the Second Edition for example Giant Magneto Resistance GMR was discovered and the new field of spintronics is currently expanding Not only do these phenomena rely on the concepts presented in this book but magnetic properties are often an important clue to our understanding of new materials e.g. high temperature superconductors Their magnetic properties studied by susceptibility measurements nuclear magnetic resonance neutron scattering etc have provided insight to the superconductivity state This updated edition offers revised emphasis on some material as a result of recent developments and includes new material such as an entire chapter on thin film magnetic multilayers Researchers and students once again have access to an up to date

classic reference on magnetism the key characteristic of many modern materials      **Magnetism in the Solid State** Peter Mohn, 2006-06-09 This book presents a phenomenological approach to the field of solid state magnetism Beginning with basic concepts in statistical thermodynamics and electronic structure theory the text discusses models for localized moments Weiss Heisenberg and delocalized moments Stoner This is followed by a chapter about exchange and correlation in metals again considering the results for the localized and delocalized limit The book ends with a chapter about spin fluctuations which are introduced as an alternative to the finite temperature Stoner theory The book will be a useful reference for researchers and a valuable accompaniment to graduate courses on magnetism and magnetic materials      **Physics of Transition Metal**

**Oxides** Sadamichi Maekawa, Takami Tohyama, Stewart Edward Barnes, Sumio Ishihara, Wataru Koshibae, Giniyat Khaliullin, 2013-03-09 The fact that magnetite  $\text{Fe}_3\text{O}_4$  was already known in the Greek era as a peculiar mineral is indicative of the long history of transition metal oxides as useful materials The discovery of high temperature superconductivity in 1986 has renewed interest in transition metal oxides High temperature superconductors are all cuprates Why is it To answer to this question we must understand the electronic states in the cuprates Transition metal oxides are also familiar as magnets They might be found stuck on the door of your kitchen refrigerator Magnetic materials are valuable not only as magnets but as electronics materials Manganites have received special attention recently because of their extremely large magnetoresistance an effect so large that it is called colossal magnetoresistance CMR What is the difference between high temperature superconducting cuprates and CMR manganites Elements with incomplete d shells in the periodic table are called transition elements Among them the following eight elements with the atomic numbers from 22 to 29 i.e. Ti V Cr Mn Fe Co Ni and Cu are the most important These elements make compounds with oxygen and present a variety of properties High temperature superconductivity and CMR are examples Most of the textbooks on magnetism discuss the magnetic properties of transition metal oxides However when one studies magnetism using traditional textbooks one finds that the transport properties are not introduced in the initial stages      **Positron Annihilation in Semiconductors** Reinhard

Krause-Rehberg, Hartmut S. Leipner, 1999-01-21 This comprehensive book reports on recent investigations of lattice imperfections in semiconductors by means of positron annihilation It reviews positron techniques and describes the application of these techniques to various kinds of defects such as vacancies impurity vacancy complexes and dislocations

**Solid State Theory** Ulrich Rössler, 2013-06-29 Solid State Theory An Introduction is a textbook for graduate students of physics and material sciences Whilst covering the traditional topics of older textbooks it also takes up new developments in theoretical concepts and materials that are connected with such breakthroughs as the quantum Hall effects the high  $T_c$  superconductors and the low dimensional systems realized in solids Thus besides providing the fundamental concepts to describe the physics of the electrons and ions comprising the solid including their interactions the book casts a bridge to the experimental facts and gives the reader an excellent insight into current research fields A compilation of problems makes the

book especially valuable to both students and teachers      *Optics of Semiconductors and Their Nanostructures* Heinz Kalt, Michael Hetterich, 2013-04-09 In recent years the field of semiconductor optics has been pushed to several extremes The size of semiconductor structures has shrunk to dimensions of a few nanometers the semiconductor light interaction is studied on timescales as fast as a few femtoseconds and transport properties on a length scale far below the wavelength of light have been revealed These advances were driven by rapid improvements in both semiconductor and optical technologies and were further facilitated by progress in the theoretical description of optical excitations in semiconductors This book written by leading experts in the field provides an up to date introduction to the optics of semiconductors and their nanostructures so as to help the reader understand these exciting new developments It also discusses recently established applications such as blue light emitters as well as the quest for future applications in areas such as spintronics quantum information processing and third generation solar cells      Magnetism Joachim Stöhr, Hans Christoph Siegmann, 2007-01-19 This text book gives a comprehensive account of magnetism one of the oldest yet most vibrant fields of physics It spans the historical development the physical foundations and the continuing research underlying the subject The book covers both the classical and quantum mechanical aspects of magnetism and novel experimental techniques Perhaps uniquely it discusses spin transport and magnetization dynamics phenomena associated with atomically and spin engineered nano structures against the backdrop of spintronics and magnetic storage and memory applications The book is for students and serves as a reference for scientists in academia and research laboratories      Excitons in Low-Dimensional Semiconductors Stephan Glutsch, 2013-04-17 Low dimensional semiconductors have become a vital part of today's semiconductor physics and excitons in these systems are ideal objects that bring textbook quantum mechanics to life Furthermore their theoretical understanding is important for experiments and optoelectronic devices The author develops the effective mass theory of excitons in low dimensional semiconductors and describes numerical methods for calculating the optical absorption including Coulomb interaction geometry and external fields The theory is applied to Fano resonances in low dimensional semiconductors and the Zener breakdown in superlattices Comparing theoretical results with experiments the book is essentially self contained it is a hands on approach with detailed derivations worked examples illustrative figures and computer programs The book is clearly structured and will be valuable as an advanced level self study or course book for graduate students lecturers and researchers      **Physical Acoustics in the Solid State** Bruno Lüthi, 2006-01-15 Physical Acoustics in the Solid State reviews the modern aspects in the field including many experimental results especially those involving ultrasonics It covers practically all fields of solid state physics After a review of the relevant experimental techniques and an introduction to the theory of elasticity the book details applications in the various fields of condensed matter physics      **Two-Dimensional Coulomb Liquids and Solids** Yuriy Monarkha, Kimitoshi Kono, 2013-03-09 This book is about quantum phenomena in two dimensional 2D electron systems with extremely strong internal interactions The central objects of interest are Coulomb

liquids in which the average Coulomb interaction energy per electron is much higher than the mean kinetic energy and Wigner solids. The main themes are quantum transport in two dimensions and the dynamics of highly correlated electrons in the regime of strong coupling with medium excitations. In typical solids the mutual interaction energy of charge carriers is of the same order of magnitude as their kinetic energy and the Fermi liquid approach appears to be quite satisfactory. However, in 1970 a broad research began to investigate a remarkable model 2D electron system formed on the free surface of superfluid helium. In this system complementary to the 2D electronic systems formed in semiconductor interface structures the ratio of the mean Coulomb energy of electrons to their kinetic energy can reach approximately a hundred before it undergoes the Wigner solid WS transition. Under such conditions the Fermi liquid description is doubtful and one needs to introduce alternative treatments. Similar interface electron systems form on other cryogenic substrates like neon and solid hydrogen.

Fractal Concepts in Condensed Matter Physics Tsuneyoshi Nakayama, Kousuke Yakubo, 2013-06-29 Concisely and clearly written this book provides a self contained introduction to the basic concepts of fractals and demonstrates their use in a range of topics in condensed matter physics and statistical mechanics. The first part outlines different fractal structures observed in condensed matter. The main part of the book is dedicated to the dynamical behaviour of fractal structures including anomalous and percolating systems. The concept of multifractals is illustrated for the metal insulator quantum phase transition. The authors emphasize the unified description of these different dynamic problems thus making the book accessible to readers who are new to the field.

**X-Ray Multiple-Wave Diffraction** Shih-Lin Chang, 2013-04-17 X ray multiple wave diffraction sometimes called multiple diffraction or N beam diffraction results from the scattering of X rays from periodic two or higher dimensional structures like 2 d and 3 d crystals and even quasi crystals. The interaction of the X rays with the periodic arrangement of atoms usually provides structural information about the scatterer. Unlike the usual Bragg reflection the so called two wave diffraction the multiply diffracted intensities are sensitive to the phases of the structure factors involved. This gives X ray multiple wave diffraction the chance to solve the X ray phase problem. On the other hand the condition for generating an X ray multiple wave diffraction is much more strict than in two wave cases. This makes X ray multiple wave diffraction a useful technique for precise measurements of crystal lattice constants and the wavelength of radiation sources. Recent progress in the application of this particular diffraction technique to surfaces thin films and less ordered systems has demonstrated the diversity and practicability of the technique for structural research in condensed matter physics materials sciences crystallography and X ray optics. The first book on this subject *Multiple Diffraction of X Rays in Crystals* was published in 1984 and intended to give a contemporary review on the fundamental and application aspects of this diffraction.

Electron Scattering in Solid Matter Jan Zablouil, Robert Hammerling, László Szunyogh, Peter Weinberger, 2005-12-12 Addressing graduate students and researchers this book gives a very detailed theoretical and computational description of multiple scattering in solid matter. Particular emphasis is placed on solids with

reduced dimensions on full potential approaches and on relativistic treatments For the first time approaches such as the screened Korringa Kohn Rostoker method are reviewed considering all formal steps such as single site scattering structure constants and screening transformations and also the numerical point of view Furthermore a very general approach is presented for solving the Poisson equation needed within density functional theory in order to achieve self consistency Special chapters are devoted to the Coherent Potential Approximation and to the Embedded Cluster Method used for example for describing nanostructured matter in real space In a final chapter physical properties related to the single particle Green s function such as magnetic anisotropies interlayer exchange coupling electric and magneto optical transport and spin waves serve to illustrate the usefulness of the methods described

**Monte Carlo Simulation in Statistical Physics** Kurt Binder, Dieter W. Heermann, 2013-03-14 Monte Carlo Simulation in Statistical Physics deals with the computer simulation of many body systems in condensed matter physics and related fields of physics chemistry and beyond to traffic flows stock market fluctuations etc Using random numbers generated by a computer probability distributions are calculated allowing the estimation of the thermodynamic properties of various systems This book describes the theoretical background to several variants of these Monte Carlo methods and gives a systematic presentation from which newcomers can learn to perform such simulations and to analyze their results This fourth edition has been updated and a new chapter on Monte Carlo simulation of quantum mechanical problems has been added To help students in their work a special web server has been installed to host programs and discussion groups <http://www.cp.tphys.uni-heidelberg.de> Prof Binder was the winner of the Berni J Alder CECAM Award for Computational Physics 2001

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