

Mathematics and Its Applications

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Norman E. Hurt

# Mathematical Physics of Quantum Wires and Devices

From Spectral Resonances  
to Anderson Localization



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# Mathematical Physics Of Quantum Wire And Devices From Spectral Resonances To Anderson Localization

**Gregory Berkolaiko, Peter Kuchment**



## **Mathematical Physics Of Quantum Wire And Devices From Spectral Resonances To Anderson Localization:**

**Mathematical Physics of Quantum Wires and Devices** N.E. Hurt, 2013-03-14 This monograph on quantum wires and quantum devices is a companion volume to the author's Quantum Chaos and Mesoscopic Systems Kluwer Dordrecht 1997 The goal of this work is to present to the reader the mathematical physics which has arisen in the study of these systems The course which I have taken in this volume is to juxtapose the current work on the mathematical physics of quantum devices and the details behind the work so that the reader can gain an understanding of the physics and where possible the open problems which remain in the development of a complete mathematical description of the devices I have attempted to include sufficient background and references so that the reader can understand the limitations of the current methods and have direction to the original material for the research on the physics of these devices As in the earlier volume the monograph is a panoramic survey of the mathematical physics of quantum wires and devices Detailed proofs are kept to a minimum with outlines of the principal steps and references to the primary sources as required The survey is very broad to give a general development to a variety of problems in quantum devices not a specialty volume

**Introduction to Quantum Graphs** Gregory Berkolaiko, Peter Kuchment, 2013 A quantum graph is a graph considered as a one dimensional complex and equipped with a differential operator Hamiltonian Quantum graphs arise naturally as simplified models in mathematics physics chemistry and engineering when one considers propagation of waves of various nature through a quasi one dimensional e.g. meso or nano scale system that looks like a thin neighborhood of a graph Works that currently would be classified as discussing quantum graphs have been appearing since at least the 1930s and since then quantum graphs techniques have been applied successfully in various areas of mathematical physics mathematics in general and its applications One can mention for instance dynamical systems theory control theory quantum chaos Anderson localization microelectronics photonic crystals physical chemistry nano sciences superconductivity theory etc Quantum graphs present many non trivial mathematical challenges which makes them dear to a mathematician's heart Work on quantum graphs has brought together tools and intuition coming from graph theory combinatorics mathematical physics PDEs and spectral theory This book provides a comprehensive introduction to the topic collecting the main notions and techniques It also contains a survey of the current state of the quantum graph research and applications

**Semiconductor Physics** Karl W. Böer, Udo W. Pohl, 2023-02-02 This handbook gives a complete and detailed survey of the field of semiconductor physics It addresses every fundamental principle the most important research topics and results as well as conventional and emerging new areas of application Additionally it provides all essential reference material on crystalline bulk low dimensional and amorphous semiconductors including valuable data on their optical transport and dynamic properties This updated and extended second edition includes essential coverage of rapidly advancing areas in semiconductor physics such as topological insulators quantum optics magnetic nanostructures and spintronic systems Richly illustrated and authored by a duo of internationally

acclaimed experts in solar energy and semiconductor physics this handbook delivers in depth treatment of the field reflecting a combined experience spanning several decades as both researchers and educators Offering a unique perspective on many issues Semiconductor Physics is an invaluable reference for physicists materials scientists and engineers throughout academia and industry **Frontiers in Physics** Swee-Ping Chia,Kurunathan Ratnavelu,Muhamad Rasat

Muhamad,2009-07-20 This volume covers a range of exciting frontier issues in physics It involves new development within the broad spectrum of physics and the associated technical application The collection of papers in this volume allows the readers to explore and review the scientific status of developments at the frontiers of the various fields of physics **The**

**British National Bibliography** Arthur James Wells,2000 **American Book Publishing Record** ,2000-07 *Applied*

*Mathematics in Tunisia* Aref Jeribi,Mohamed Ali Hammami,Afif Masmoudi,2015-10-05 This contributed volume presents some recent theoretical advances in mathematics and its applications in various areas of science and technology Written by internationally recognized scientists and researchers the chapters in this book are based on talks given at the International Conference on Advances in Applied Mathematics ICAAM which took place December 16 19 2013 in Hammamet Tunisia Topics discussed at the conference included spectral theory operator theory optimization numerical analysis ordinary and partial differential equations dynamical systems control theory probability and statistics These proceedings aim to foster and develop further growth in all areas of applied mathematics **Forthcoming Books** Rose Arny,2000 *Physics Briefs*

,1994 *Science Abstracts* ,1992 **Index to Theses with Abstracts Accepted for Higher Degrees by the Universities of Great Britain and Ireland and the Council for National Academic Awards** ,2004 **Resonant**

**Tunneling** Lev Baskin,Pekka Neittaanmäki,Boris Plamenevskii,Oleg Sarafanov,2015-05-07 This volume studies electron resonant tunneling in two and three dimensional quantum waveguides of variable cross sections in the time independent approach Mathematical models are suggested for the resonant tunneling and develop asymptotic and numerical approaches for investigating the models Also schemes are presented for several electronics devices based on the phenomenon of resonant tunneling Devices based on the phenomenon of electron resonant tunneling are widely used in electronics Efforts are directed towards refining properties of resonance structures There are prospects for building new nano size electronics elements based on quantum dot systems However the role of resonance structure can also be given to a quantum wire of variable cross section Instead of an electrode quantum dot electrode system one can use a quantum wire with two narrows A waveguide narrow is an effective potential barrier for longitudinal electron motion along a waveguide The part of the waveguide between two narrows becomes a resonator where electron resonant tunneling can occur This phenomenon consists in the fact that for an electron with energy  $E$  the probability  $T(E)$  to pass from one part of the waveguide to the other part through the resonator has a sharp peak at  $E = E_{\text{res}}$  where  $E_{\text{res}}$  denotes a resonant energy Such quantum resonators can find applications as elements of nano electronics devices and provide some advantages in regard to operation properties and

production technology The book is addressed to mathematicians physicists and engineers interested in waveguide theory and its applications in electronics

**Quantum Wells, Wires and Dots** Paul Harrison, 2011-09-26 Quantum Wells Wires and Dots 3rd Edition is aimed at providing all the essential information both theoretical and computational in order that the reader can starting from essentially nothing understand how the electronic optical and transport properties of semiconductor heterostructures are calculated Completely revised and updated this text is designed to lead the reader through a series of simple theoretical and computational implementations and slowly build from solid foundations to a level where the reader can begin to initiate theoretical investigations or explanations of their own

**Intersubband Transitions in Quantum Wells: Physics and Device Applications**, 1999-10-28 Since its inception in 1966 the series of numbered volumes known as Semiconductors and Semimetals has distinguished itself through the careful selection of well known authors editors and contributors The Willardson and Beer series as it is widely known has succeeded in producing numerous landmark volumes and chapters Not only did many of these volumes make an impact at the time of their publication but they continue to be well cited years after their original release Recently Professor Eicke R Weber of the University of California at Berkeley joined as a co editor of the series Professor Weber a well known expert in the field of semiconductor materials will further contribute to continuing the series tradition of publishing timely highly relevant and long impacting volumes Some of the recent volumes such as Hydrogen in Semiconductors Imperfections in III V Materials Epitaxial Microstructures High Speed Heterostructure Devices Oxygen in Silicon and others promise that this tradition will be maintained and even expanded Reflecting the truly interdisciplinary nature of the field that the series covers the volumes in Semiconductors and Semimetals have been and will continue to be of great interest to physicists chemists materials scientists and device engineers in modern industry

Quantized Detector Networks George Jaroszkiewicz, 2023-07-27 Explores how the contextual nature of empirical truth and the laws of observation affect our understanding of quantum physics

**An Introduction to Quantum Transport in Semiconductors** David K. Ferry, 2017-12-14 Throughout their college career most engineering students have done problems and studies that are basically situated in the classical world Some may have taken quantum mechanics as their chosen field of study This book moves beyond the basics to highlight the full quantum mechanical nature of the transport of carriers through nanoelectronic structures The book is unique in that addresses quantum transport only in the materials that are of interest to microelectronics semiconductors with their variable densities and effective masses The author develops Green s functions starting from equilibrium Green s functions and going through modern time dependent approaches to non equilibrium Green s functions introduces relativistic bands for graphene and topological insulators and discusses the quantum transport changes that these bands induce and discusses applications such as weak localization and phase breaking processes resonant tunneling diodes single electron tunneling and entanglement Furthermore he also explains modern ensemble Monte Carlo approaches to simulation of various approaches to quantum transport and the

hydrodynamic approaches to quantum transport All in all the book describes all approaches to quantum transport in semiconductors thus becoming an essential textbook for advanced graduate students in electrical engineering or physics

**Electronic Quantum Transport in Mesoscopic Semiconductor Structures** Thomas Ihn, 2004-09-09 The physics of semiconductors has seen an enormous evolution within the last fifty years Countless achievements have been made in scientific research and device applications have revolutionized everyday life We have learned how to customize materials in order to tailor their optical as well as electronic properties The ongoing trend toward device miniaturization has been the driving force on the application side and it has fertilized fundamental research Nowadays advanced processing techniques allow the fabrication of sub micron semiconductor structures in many university research laboratories At the same time experiments down to millikelvin temperatures allow researchers to anticipate the observation of quantum phenomena so far hidden at room temperature by the large thermal energy and strong dephasing The field of mesoscopic physics deals with systems under experimental conditions where several quantum length scales for electrons such as system size and phase coherence length or phase coherence length and elastic mean free path are comparable Intense research over the last twenty years has revealed an enormous richness of quantum effects in mesoscopic semiconductor physics which is typically characterized by an interplay of quantum interference and many body interactions The most famous phenomena are probably the integer and fractional quantum Hall effects the quantization of conductance through a quantum point contact the Aharonov Bohm effect and single electron charging of quantum dots

**Quantum Electrodynamics and Quantum Optics** A. O. Barut, 1984 The borderline of quantum electrodynamics and quantum optics offer spectacular results and problems concerning the foundations of radiation theory Perhaps the major new viewpoint that has emerged from recent investigations is that one can now work inside a time dependent quantum process whereas up to now all elementary quantum processes were either stationary or one worked with asymptotic in and out states i.e. an S matrix approach In the first part of this volume the Quantum Electrodynamics the present status of the main approaches to this most accurate of all physical theories are discussed the Hamiltonian approach the Green's function approach with particular emphasis to bound state problems and the newer nonperturbative approach The latest numerical results on radiative corrections Lamb shifts and anomalous magnetic moments are reviewed with new results for high Z atoms Also discussed are different theoretical interpretations of the radiative phenomena as due to quantized field vacuum fluctuations or due to self energy A small group of contributions are devoted to the physics and mathematical description of decaying or unstable states in quantum theory This remarkable phenomenon of quantum theory still needs complete clarification it is a time dependent phenomenon which can be described also by asymptotic S matrix methods but with complex energies

**Intense Resonant Interactions in Quantum Electronics** V.M. Akulin, N.V. Karlov, 1992-01-02 This book is a course of lectures given for senior students at the Moscow Institute of Physics and Technology For those who have graduated in the USSR this information should be sufficient to give

an idea of the level and the manner in which the subject matter is presented On the other hand readers outside of this country may never have heard about this well known Soviet institution and so we would like to say few words about it now The Moscow Institute of Physics and Technology MFTI or Fiztekh was founded in 1947 as the result of a special directive of Stalin in order to supply the space and nuclear program with highly educated experts The best scientists in the country were involved in the foundation process They invented an effective and flexible educational system that includes basic education according to an university program followed by specialization at leading scientific centers Being organized initially as a department of Moscow State University MFTI recently separated into an independent institution In the sixties it lost its mainly top secret and military character and became the most prestigious place in the country for an education in physics The political changes of the last few years have opened it to contacts with other countries The course of lectures comprising this book is dedicated to the subject of the intense resonant interaction of laser radiation with matter and contains a significant part of the Ph D

**Intersubband Transitions in Quantum Wells: Physics and Device Applications II**

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## Introduction

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