



Quantum Mesoscopic Phenomena and Mesoscopic Devices in Microelectronics

Edited by

Igor O. Kulik and Recai Ellialtıoğlu

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Quantum Mesoscopic Phenomena And Mesoscopic Devices In Microelectronics

Amit K. Jaiswal, Shiv Shankar



Quantum Mesoscopic Phenomena And Mesoscopic Devices In Microelectronics:

Quantum Mesoscopic Phenomena and Mesoscopic Devices in Microelectronics Igor O. Kulik, Recai Ellialtıoğlu, 2000
Quantum mechanical laws are well documented at the level of a single or a few atoms and are here extended to systems containing 10² to 10¹⁰ electrons still much smaller than the usual macroscopic objects but behaving in a manner similar to a single atom Besides the purely theoretical interest such systems pose a challenge to the achievement of the ultimate microelectronic applications The present volume presents an up to date account of the physics technology and expected applications of quantum effects in solid state mesoscopic structures Physical phenomena include the Aharonov Bohm effect persistent currents Coulomb blockade and Coulomb oscillations in single electron devices Andreev reflections and the Josephson effect in superconductor normal superconductor systems shot noise suppression in microcontacts and contact resistance quantisation and overall quantum coherence in mesoscopic and nanoscopic structures related to the emerging physics of quantum computation in the solid state environment

Quantum Mesoscopic Phenomena and Mesoscopic Devices in Microelectronics Igor O. Kulik, Recai Ellialtıogammalu, 2012-12-06 Quantum mechanical laws are well documented at the level of a single or a few atoms and are here extended to systems containing 10² to 10¹⁰ electrons still much smaller than the usual macroscopic objects but behaving in a manner similar to a single atom Besides the purely theoretical interest such systems pose a challenge to the achievement of the ultimate microelectronic applications The present volume presents an up to date account of the physics technology and expected applications of quantum effects in solid state mesoscopic structures Physical phenomena include the Aharonov Bohm effect persistent currents Coulomb blockade and Coulomb oscillations in single electron devices Andreev reflections and the Josephson effect in superconductor normal superconductor systems shot noise suppression in microcontacts and contact resistance quantisation and overall quantum coherence in mesoscopic and nanoscopic structures related to the emerging physics of quantum computation in the solid state environment

Program and Abstracts Igor O. Kulik, NATO Advanced Study Institute, 1999

Quantum Phenomena in Mesoscopic Systems B. Altshuler, A. Tagliacozzo, V. Tognetti, 2004-01-28 This book is a snapshot of the vision shared by outstanding scientists on the key theoretical and experimental issues in Mesoscopic Physics Quantum properties of electrons in solid state devices and transport in semiconducting and superconducting low dimensional systems are discussed as well as the basis of quantum computing entanglement noise decoherence and read out Each chapter collects the material presented at a Varenna School course of last year by leading experts in the field The reader gets a flavor how theorists and experimentalists are paving the way to the physical realization of solid state qubits the basic units of the new logic and memory elements for quantum processing He will be surprised in finding that mesoscopic solid state devices which were invented just yesterday think of the Single Electron Transistor or the Cooper Pair Box are currently used as charge sensing applications in the equipment of frontier research laboratories These devices contribute as probing systems to

produce evidence on still unsettled questions in topics like the metal insulator transition in disordered two dimensional systems quantum Hall conductance in heterostructures or Kondo conductance in quantum dots

Fundamentals of Quantum Information Dieter Heiss, 2008-01-11 Quantum information science is a rapidly developing field that not only promises a revolution in computer sciences but also touches deeply the very foundations of quantum physics This book consists of a set of lectures by leading experts in the field that bridges the gap between standard textbook material and the research literature thus providing the necessary background for postgraduate students and non specialist researchers wishing to familiarize themselves with the subject thoroughly and at a high level This volume is ideally suited as a course book for postgraduate students and lecturers will find in it a large choice of material for bringing their courses up to date

Towards the Controllable Quantum States Hideaki Takayanagi, Junsaku Nitta, 2003 The realizations of physical systems whose quantum states can be directly manipulated have been pursued for experiments on fundamental problems in quantum mechanics and implementations of quantum information devices Micro fabricated superconducting systems and electronic spins are among the most promising candidates This book contains the newest and most advanced research reports on such materials called Mesoscopic Superconductivity and Spintronics The former includes superconductor semiconductor hybrid systems very small Josephson junctions and micron size SQUIDS The latter includes the control of spin transports in semiconductor heterostructures nano scale quantum dots and spin injections Superconductor ferromagnetic metal hybrid structures are covered by both of the topics The proceedings have been selected for coverage in Index to Scientific Technical Proceedings ISTP CDRom version ISI Proceedings

Physics of Quantum Rings Vladimir M. Fomin, 2018-09-01 This book now in its second edition introduces readers to quantum rings as a special class of modern high tech material structures at the nanoscale It deals in particular with their formation by means of molecular beam epitaxy and droplet epitaxy of semiconductors and their topology driven electronic optical and magnetic properties A highly complex theoretical model is developed to adequately represent the specific features of quantum rings The results presented here are intended to facilitate the development of low cost high performance electronic spintronic optoelectronic and information processing devices based on quantum rings This second edition includes both new and significantly revised chapters It provides extensive information on recent advances in the physics of quantum rings related to the spin orbit interaction and spin dynamics spin interference in Rashba rings tunable exciton topology on type II InAs GaAsSb quantum nanostructures the electron phonon interaction in ring like structures quantum interference manifestations in novel materials graphene nanoribbons MoS₂ and the effects of electrical field and THz radiation on the optical properties of quantum rings The new edition also shares insights into the properties of various novel architectures including coupled quantum ring quantum dot chains and concentric quantum rings topologic states of light in self assembled ring like cavities and optical and plasmon modes in M bius shaped resonators

Mesoscopic Systems Yoshimasa Murayama, 2008-09-26 Future high tech applications

such as nanotechnology require a deep understanding of the physics of mesoscopic systems These systems form a bridge between macroscopic systems governed by classical physics and microscopic systems governed by quantum physics This introduction discusses a variety of typical surface optical transport and magnetic properties of mesoscopic systems with reference to many experimental observations It is written for physicists materials scientists and engineers who want to stay abreast of current research or high tech development

Future Trends in Microelectronics S. Luryi, Jimmy Xu, Alex Zaslavsky, 2012-12-06 Silicon technology has developed along virtually one single line reducing the minimal size of lithographic features But has this taken us to the point of diminishing returns Are we now at a turning point in the logical evolution of microelectronics Some believe that the semiconductor microelectronics industry has matured the research game is over comparisons with the steel industry are being made Others believe that qualitative progress in hardware technology will come roaring back based on innovative research This debate spirited as it is is reflected in the pages of Future Trends in Microelectronics where such questions are discussed What kind of research does the silicon industry need to continue its expansion What is the technical limit to shrinking Si devices Is there any economic sense in pursuing this limit What are the most attractive applications of optoelectronic hybrid systems Are there any green pastures beyond the traditional semiconductor technologies Identifying the scenario for the future evolution of microelectronics will present a tremendous opportunity for constructive action today

Complexity from Microscopic to Macroscopic Scales: Coherence and Large Deviations A.T. Skjeltorp, Tamas Vicsek, 2012-12-06 Many mesoscopic systems display adaptive behaviour changes in some physical property that results from a small change in an internal or external driving force There is a kind of progression in adaptive phenomena from quantum mesoscopics to complex evolved cooperative systems and large scale events like turbulence The field of mesoscopic magnetism especially quantum coherence and quantum tunnelling in spin systems and the coupling between mesoscopic magnetism and mesoscopic transport is currently a very active area of solid state physics Dephasing is an important concept in mesoscopic systems like these A basic question is the limit at which quantum mechanics breaks down and what it can be replaced with Another interesting crossover is that between complexity and large excursions or events with turbulence as a prototype example The book also contains a discussion of finance Qualitatively speaking turbulence and financial markets are apparently similar so our understanding of turbulence may be relevant to understanding price fluctuations

Energy Localisation and Transfer Thierry Dauxois, 2004 This book provides an introduction to localised excitations in spatially discrete systems from the experimental numerical and mathematical points of view Also known as discrete breathers nonlinear lattice excitations and intrinsic localised modes these are spatially localised time periodic motions in networks of dynamical units Examples of such networks are molecular crystals biomolecules and arrays of Josephson superconducting junctions The book also addresses the formation of discrete breathers and their potential role in energy transfer in such systems

21st Century Nanoscience Klaus D. Sattler, 2022-01-18 This 21st

Century Nanoscience Handbook will be the most comprehensive up to date large reference work for the field of nanoscience Handbook of Nanophysics by the same editor published in the fall of 2010 was embraced as the first comprehensive reference to consider both fundamental and applied aspects of nanophysics This follow up project has been conceived as a necessary expansion and full update that considers the significant advances made in the field since 2010 It goes well beyond the physics as warranted by recent developments in the field Key Features Provides the most comprehensive up to date large reference work for the field Chapters written by international experts in the field Emphasises presentation and real results and applications This handbook distinguishes itself from other works by its breadth of coverage readability and timely topics The intended readership is very broad from students and instructors to engineers physicists chemists biologists biomedical researchers industry professionals governmental scientists and others whose work is impacted by nanotechnology It will be an indispensable resource in academic government and industry libraries worldwide The fields impacted by nanoscience extend from materials science and engineering to biotechnology biomedical engineering medicine electrical engineering pharmaceutical science computer technology aerospace engineering mechanical engineering food science and beyond

21st Century Nanoscience - A Handbook Klaus D. Sattler, 2020-04-22 This 21st Century Nanoscience Handbook will be the most comprehensive up to date large reference work for the field of nanoscience Handbook of Nanophysics by the same editor published in the fall of 2010 and was embraced as the first comprehensive reference to consider both fundamental and applied aspects of nanophysics This follow up project has been conceived as a necessary expansion and full update that considers the significant advances made in the field since 2010 It goes well beyond the physics as warranted by recent developments in the field This ninth volume in a ten volume set covers industrial applications Key Features Provides the most comprehensive up to date large reference work for the field Chapters written by international experts in the field Emphasises presentation and real results and applications This handbook distinguishes itself from other works by its breadth of coverage readability and timely topics The intended readership is very broad from students and instructors to engineers physicists chemists biologists biomedical researchers industry professionals governmental scientists and others whose work is impacted by nanotechnology It will be an indispensable resource in academic government and industry libraries worldwide The fields impacted by nanophysics extend from materials science and engineering to biotechnology biomedical engineering medicine electrical engineering pharmaceutical science computer technology aerospace engineering mechanical engineering food science and beyond *Bose-Einstein Condensates and Atom Lasers* S. Martellucci, Arthur N. Chester, Alain

Aspect, Massimo Inguscio, 2007-05-08 Proceedings of the International School of Quantum Electronics 27th course on Bose Einstein Condensates and Atom Lasers October 19 24 1999 Erice Italy Since the experimental demonstration of Bose Einstein Condensation in dilute atomic gases there has been an explosion of interest in the properties of this novel macroscopic quantum system The book covers the methods used to produce these new samples of coherent atoms their

manipulation and the study of their properties Emphasis is given to the anticipated development of new types of sources which more and more resemble traditional types of lasers Because of recent new applications and increasing demand for lasers sensors and associated instrumentation the chapters also cover current developments in the basic techniques materials and applications in the field of the generation of coherent atoms

Spintronics Tomasz Blachowicz, Andrea Ehrmann, 2024-10-07 Spintronics being a part of electronics is under intense development for about forty years and mainly concerns transport of electronics spin in low dimensional structures This field based on often difficult theoretical concepts of quantum physics has surprisingly strong and real technological and application consequences Thus spintronic solutions concern memory systems information processing devices and are used as sensors to detect variety of physical fields The early development of this field can be associated with the names of such scientists as E I Rashba A Fert P Gr nberg J Barna B Hillebrands G G ntherodt I K Schuller M Grimsditch A Hoffman P Vavassori and S Datta This list is absolutely not closed and might be easily extended however it results rather from scientific history and contacts with people who influenced the research carriers of the authors The authors give in this up dated 2nd edition an insight into this emerging field providing theoretical and experimental aspects of spintronics and guide readers from a basic understanding of fundamental processes to recent applications and future possibilities opened by ongoing research The textbook is suited for students and for interested scientists who were discouraged by the theoretical formalism only

Quantum Computing and Quantum Bits in Mesoscopic Systems Anthony Leggett, Berardo Ruggiero, Paolo Silvestrini, 2012-12-06 Quantum information science is a new field of science and technology which requires the collaboration of researchers coming from different fields of physics mathematics and engineering both theoretical and applied Quantum Computing and Quantum Bits in Mesoscopic Systems addresses fundamental aspects of quantum physics enhancing the connection between the quantum behavior of macroscopic systems and information theory In addition to theoretical quantum physics the book comprehensively explores practical implementation of quantum computing and information processing devices On the experimental side this book reports on recent and previous observations of quantum behavior in several physical systems coherently coupled Bose Einstein condensates quantum dots superconducting quantum interference devices Cooper pair boxes and electron pumps in the context of the Josephson effect In these systems the book discusses all required steps from fabrication through characterization to the final basic implementation for quantum computing

Trends in Boson Research A. V. Ling, 2006 Bosons are particles which form totally symmetric composite quantum states As a result they obey Bose Einstein statistics The spin statistics theorem states that bosons have integer spin Bosons are also the only particles which can occupy the same state as another All elementary particles are either bosons or fermions Gauge bosons are elementary particles which act as the carriers of the fundamental forces such as the W vector bosons of the weak force the gluons of the strong force the photons of the electromagnetic force and the graviton of the gravitational force Particles composed of a number of other

particles such as protons or nuclei can be either fermions or bosons depending on their total spin. Hence many nuclei are in fact bosons. While fermions obey the Pauli exclusion principle no more than one fermion can occupy a single quantum state, there is no exclusion property for bosons which are free to and indeed other things being equal tend to crowd into the same quantum state. This explains the spectrum of black body radiation and the operation of lasers, the properties of superfluid helium 4 and the possibility of bosons to form Bose-Einstein condensates, a particular state of matter. It is important to note that Bose-Einstein condensation occurs only at ultralow temperature. There is nothing exotic about bosons otherwise. At any reasonable temperatures both the boson and fermion particles behave as classical particles, i.e. particles in a box and follow the Maxwell-Boltzmann Statistics. This new book includes leading research from around the world. *New Challenges in Superconductivity: Experimental Advances and Emerging Theories* J. Ashkenazi, Mikhail V. Eremin, Joshua L. Cohn, Ilya Eremin, Dirk Manske, Davor Pavuna, Fuliln Zuo, 2006-01-24. This volume contains the proceedings of the 2004 University of Miami Workshop on Unconventional Superconductivity. The workshop was the fourth in a series of successful meetings on High T Superconductivity and C related topics which took place at the James L Knight Physics Building on the University of Miami campus in Coral Gables Florida in January 1991 1995 1999 and 2004. The workshop consisted of two consecutive events: 1. NATO Advanced Research Workshop ARW on New Challenges in Superconductivity: Experimental Advances and Emerging Theories held on January 11-14 2004; 2. Symposium on Emerging Mechanisms for High Temperature Superconductivity SEMHTS held on January 15-16 2004. It is hard to write a balanced preface to a volume like this one yet at least we try to offer the reader a taste of what was happening in this workshop. There were close to a hundred scientists from around the world, albeit fewer Russians than we had originally hoped for. Nevertheless the workshop was very lively and we trust that this is demonstrated in this volume. The workshop included high quality presentations on state-of-the-art works yet a key issue discussed by many was how homogeneous the cuprates are. STM data as well as other reports showed that the cuprate superconductors SCs studied were inhomogeneous, especially in the underdoped regime, while experiments like ARPES and magnetoresistance have established the existence of a Fermi Surface FS at least above some doping level in the cuprates. *Food Packaging and Preservation* Amit K. Jaiswal, Shiv Shankar, 2023-11-16. *Food Packaging and Preservation: Antimicrobial Materials and Technologies* provides a scaffolded introduction to principles of biological science, food contamination and their effect on human health as well as nanomaterials, natural antimicrobials and emerging non-thermal processing methods. The book's goal is to help users develop sustainable usage of these materials and technologies. It is designed to help researchers in food technology, materials science, nanoscience and polymer science but it will also be ideal for researchers and developers who develop antimicrobial technologies for food industry applications, in particular food packaging and the preservation of food products. Thoroughly explores the application of nanomaterials, nanocomposites, antimicrobial materials from natural sources and emerging non-thermal processing technologies. Covers nanomaterials

natural extracts and their usage in micro and nanoemulsion form Examines non thermal processing methods and their combinations for food packaging and food preservation **Supermaterials** Rudi Cloots,M. Ausloos,Marek Pekala,Alan J. Hurd,Gilbert Vacquier,2012-12-06 What is a supermaterial A concise definition is by no means obvious but a clue can be obtained from the topics discussed here In addition to superconductors the reader will encounter magnetic effects of many kinds including giant and even colossal ones organic conductors photoconductors and even 400 year old Japanese ceramics Processing is a prominent pursuit in supermaterials research especially but not exclusively of the superconductors The papers on characterisation and theory break new ground particularly in pursuit of new optoelectronic phenomena The parade of new materials recently synthesised often containing four or more elements is surprising But it is in its reporting of new applications that the book stands out from circuits to sensors supermaterials are making their impact on society

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