

# **Quantum Computing and Quantum Bits in Mesoscopic Systems**



Edited by  
**Anthony Leggett, Berardo Ruggiero  
and Paolo Silvestrini**

# Quantum Computing And Quantum Bits In Mesoscopic Systems

**Claus F. Klingshirn**



## **Quantum Computing And Quantum Bits In Mesoscopic Systems:**

*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 *Quantum Computing in Solid State Systems* Berardo Ruggiero, Per Delsing, Carmine Granata, Yuri A. Pashkin, P. Silvestrini, 2006-05-30 Quantum Computation in Solid State Systems discusses experimental implementation of quantum computing for information processing devices in particular observations of quantum behavior in several solid state systems are presented The complementary theoretical contributions provide models of minimizing decoherence in the different systems Most recent theoretical and experimental results on macroscopic quantum coherence of mesoscopic systems as well as the realization of solid state qubits and quantum gates are discussed Particular attention is given to coherence effects in Josephson devices Other solid state systems including quantum dots optical ion and spin devices are also discussed **Quantum Computing: Physics, Blockchains, And Deep Learning Smart Networks** Melanie Swan, Renato P Dos Santos, Frank Witte, 2020-03-20 Quantum information and contemporary smart network domains are so large and complex as to be beyond the reach of current research approaches Hence new theories are needed for their understanding and control Physics is implicated as smart networks are physical systems comprised of particle many items interacting and reaching criticality and emergence across volumes of macroscopic and microscopic states Methods are integrated from statistical physics information theory and computer science Statistical neural field theory and the AdS CFT correspondence are employed to derive a smart network field theory SNFT and a smart network quantum field theory SNQFT for the orchestration of smart network systems Specifically a smart network field theory conventional or quantum is a field theory for the organization of particle many systems from a characterization control criticality and novelty emergence perspective This book provides insight as to how quantum information science as a paradigm shift in computing may influence other high impact digital transformation technologies such as blockchain and machine learning Smart networks refer to the idea that the internet is no longer simply a communications network but rather a computing platform The trajectory is that of communications networks becoming

computing networks with self executing code and perhaps ultimately quantum computing networks Smart network technologies are conceived as autonomous self operating computing networks This includes blockchain economies deep learning neural networks autonomous supply chains self piloting driving fleets unmanned aerial vehicles industrial robotics cloudminds real time bidding for advertising high frequency trading networks smart city IoT sensors and the quantum internet

**Quantum Spin Glasses, Annealing and Computation** Shu Tanaka,Ryo Tamura,Bikas K.

Chakrabarti,2017-05-04 Quantum annealing is a new generation tool of information technology which helps in solving combinatorial optimization problems with high precision based on the concepts of quantum statistical physics Detailed discussion on quantum spin glasses and its application in solving combinatorial optimization problems is required for better understanding of quantum annealing concepts Fulfilling this requirement the book highlights recent development in quantum spin glasses including Nishimori line replica method and quantum annealing methods along with the essential principles Separate chapters on simulated annealing quantum dynamics and classical spin models are provided for enhanced learning Important topics including adiabatic quantum computers and quenching dynamics are discussed in detail This text will be useful for students of quantum computation quantum information statistical physics and computer science

*Quantum Coherence in Solid State Systems* Benoît Deveaud,Antonio Quattropani,Paolo Schwendimann,2009 This volume gives an overview of the manifestations of quantum coherence in different solid state systems including semiconductor confined systems magnetic systems crystals and superconductors Besides being of paramount importance in fundamental physics the study of quantum coherence furnishes the starting point for important applications like quantum computing or secure data transmission The coherent effects discussed mainly involve elementary excitations in solids like polaritons excitons magnons macroscopic quantities like superconductor currents and electron spins Also several new aspects of the physics of quasi particles are understood and discussed in this context Due to the variety of systems in which quantum coherence may be observed solid state systems are the natural candidates for applications that rely on coherence for example quantum computer Book Jacket

Explorations in Quantum Computing Colin P. Williams,2010-12-07 By the year 2020 the basic memory components of a computer will be the size of individual atoms At such scales the current theory of computation will become invalid Quantum computing is reinventing the foundations of computer science and information theory in a way that is consistent with quantum physics the most accurate model of reality currently known Remarkably this theory predicts that quantum computers can perform certain tasks breathtakingly faster than classical computers and better yet can accomplish mind boggling feats such as teleporting information breaking supposedly unbreakable codes generating true random numbers and communicating with messages that betray the presence of eavesdropping This widely anticipated second edition of Explorations in Quantum Computing explains these burgeoning developments in simple terms and describes the key technological hurdles that must be overcome to make quantum computers a reality This easy to read time tested and

comprehensive textbook provides a fresh perspective on the capabilities of quantum computers and supplies readers with the tools necessary to make their own foray into this exciting field Topics and features concludes each chapter with exercises and a summary of the material covered provides an introduction to the basic mathematical formalism of quantum computing and the quantum effects that can be harnessed for non classical computation discusses the concepts of quantum gates entangling power quantum circuits quantum Fourier wavelet and cosine transforms and quantum universality computability and complexity examines the potential applications of quantum computers in areas such as search code breaking solving NP Complete problems quantum simulation quantum chemistry and mathematics investigates the uses of quantum information including quantum teleportation superdense coding quantum data compression quantum cloning quantum negation and quantum cryptography reviews the advancements made towards practical quantum computers covering developments in quantum error correction and avoidance and alternative models of quantum computation This text reference is ideal for anyone wishing to learn more about this incredible perhaps ultimate computer revolution Dr Colin P Williams is Program Manager for Advanced Computing Paradigms at the NASA Jet Propulsion Laboratory California Institute of Technology and CEO of Xtreme Energetics Inc an advanced solar energy company Dr Williams has taught quantum computing and quantum information theory as an acting Associate Professor of Computer Science at Stanford University He has spent over a decade inspiring and leading high technology teams and building business relationships with and Silicon Valley companies Today his interests include terrestrial and Space based power generation quantum computing cognitive computing computational material design visualization artificial intelligence evolutionary computing and remote olfaction He was formerly a Research Scientist at Xerox PARC and a Research Assistant to Prof Stephen W Hawking Cambridge University *Decoherence, Entanglement and Information Protection in Complex Quantum Systems* Vladimir M. Akulin,A. Sarfati,G. Kurizki,S. Pellegrin,2005-12-15 This book is a collection of articles on the contemporary status of quantum mechanics dedicated to the fundamental issues of entanglement decoherence irreversibility information processing and control of quantum evolution with a view of possible applications It has multidisciplinary character and is addressed at a broad readership in physics computer science chemistry and electrical engineering It is written by the world leading experts in pertinent fields such as quantum computing atomic molecular and optical physics condensed matter physics and statistical physics **Quantum Information** Gregg Jaeger,2007-04-03 In one word this is a responsible book the rest is commentary Around 1992 a few of us were led by Charles Bennett into a Garden of Eden of quantum information communication and computation No sooner had we started exploring our surroundings and naming the birds and the beasts than Peter Shor put an end to that apparent innocence by showing that factoring could be turned by means of quantum hardware into a polynomial task Fast factoring meant business everybody seemed to be awfully interested in factoring Not that anyone had any use for factoring per se but it seemed that all the world s secrets were protected by factor keyed padlocks Think of all the power and the glory and

something else that you might get by acting as a consultant to big businesses and government agencies helping them pick everyone else's locks and at the same time build unpickable ones well nearly unpickable for themselves And if one can get an exponential advantage in factoring wouldn't an exponential advantage be lying around the corner for practically any other computational task Quantum information and all that has indeed blossomed in a few years into a wonderful new chapter of physics comparable in flavor and scope to thermodynamics It has also turned into a veritable industry producing papers conferences experiments effects devices even proposals for quantum computer architectures

*Bio-Inspired and Nanoscale Integrated Computing* Mary Mehrnoosh Eshaghian-Wilner, 2009-09-22 Brings the latest advances in nanotechnology and biology to computing This pioneering book demonstrates how nanotechnology can create even faster denser computing architectures and algorithms Furthermore it draws from the latest advances in biology with a focus on bio inspired computing at the nanoscale bringing to light several new and innovative applications such as nanoscale implantable biomedical devices and neural networks Bio Inspired and Nanoscale Integrated Computing features an expert team of interdisciplinary authors who offer readers the benefit of their own breakthroughs in integrated computing as well as a thorough investigation and analyses of the literature Carefully edited the book begins with an introductory chapter providing a general overview of the field It ends with a chapter setting forth the common themes that tie the chapters together as well as a forecast of emerging avenues of research Among the important topics addressed in the book are modeling of nano devices quantum computing quantum dot cellular automata dielectrophoretic reconfigurable nano architectures multilevel and three dimensional nanomagnetic recording spin wave architectures and algorithms fault tolerant nanocomputing molecular computing self assembly of supramolecular nanostructures DNA nanotechnology and computing nanoscale DNA sequence matching medical nanorobotics heterogeneous nanostructures for biomedical diagnostics biomimetic cortical nanocircuits bio applications of carbon nanotubes and nanoscale image processing Readers in electrical engineering computer science and computational biology will gain new insights into how bio inspired and nanoscale devices can be used to design the next generation of enhanced integrated circuits

*Quantum Computers, Algorithms and Chaos* G. Casati, D.L. Shepelyansky, P. Zoller, 2006-12-19 During the last ten years Quantum Information Processing and Communication QIPC has established itself as one of the new hot topic fields in physics with the potential to revolutionize many areas of science and technology QIPC replaces the laws of classical physics applied to computation and communication with the more fundamental laws of quantum mechanics This becomes increasingly important due to technological progress going down to smaller and smaller scales where quantum effects start to be dominant In addition to its fundamental nature QIPC promises to advance computing power beyond the capabilities of any classical computer to guarantee secure communication and establish direct links to emerging quantum technologies such as for example quantum based sensors and clocks One of the outstanding feature of QIPC is its interdisciplinary character it brings together researchers from physics mathematics and

computer science In particular within physics we have seen the emergence of a new QIPC community which ranges from theoretical to experimental physics and crosses boundaries of traditionally separated disciplines such as atomic physics quantum optics statistical mechanics and solid state physics all working on different and complementary aspects of QIPC This publication covers the following topics Introduction to quantum computing Quantum logic information and entanglement Quantum algorithms Error correcting codes for quantum computations Quantum measurements and control Quantum communication Quantum optics and cold atoms for quantum information Quantum computing with solid state devices Theory and experiments for superconducting qubits Interactions in many body systems quantum chaos disorder and random matrices Decoherence effects for quantum computing and Future prospects of quantum information processing

Soft Computing in Chemical and Physical Sciences Kanchan Sarkar, Sankar Prasad Bhattacharyya, 2017-11-06 This book can be regarded as Soft computing for physicists and chemists self taught It prepares the readers with a solid background of soft computing and how to adapt soft computing techniques to problem solving in physical and chemical research Soft computing methods have been little explored by researchers in physical and chemical sciences primarily because of the absence of books that bridge the gap between the traditional computing paradigm pursued by researchers in science and the new soft computing paradigm that has emerged in computer science This book is the interface between these primary sources and researchers in physics and chemistry

**Nanotechnology Applications to Telecommunications and Networking** Daniel Minoli, 2005-10-24 Be a part of the nanotechnology revolution in telecommunications This book provides a unique and thought provoking perspective on how nanotechnology is poised to revolutionize the telecommunications computing and networking industries The author discusses emerging technologies as well as technologies under development that will lay the foundation for such innovations as Nanomaterials with novel optical electrical and magnetic properties Faster and smaller non silicon based chipsets memory and processors New science computers based on Quantum Computing Advanced microscopy and manufacturing systems Faster and smaller telecom switches including optical switches Higher speed transmission phenomena based on plasmonics and other quantum level phenomena Nanoscale MEMS micro electro mechanical systems The author of this cutting edge publication has played a role in the development of actual nanotechnology based communication systems In this book he examines a broad range of the science of nanotechnology and how this field will affect every facet of the telecommunications and computing industries in both the near and far term including Basic concepts of nanotechnology and its applications Essential physics and chemistry underlying nanotechnology science Nanotubes nanomaterials and nanomaterial processing Promising applications in nanophotonics including nanocrystals and nanocrystal fibers Nanoelectronics including metal nanoclusters semiconducting nanoclusters nanocrystals nanowires and quantum dots This book is written for telecommunications professionals researchers and students who need to discover and exploit emerging revenue generating opportunities to develop the next generation of nanoscale

telecommunications and network systems Non scientists will find the treatment completely accessible A detailed glossary clarifies unfamiliar terms and concepts Appendices are provided for readers who want to delve further into the hard core science including nanoinstrumentation and quantum computing Nanotechnology is the next industrial revolution and the telecommunications industry will be radically transformed by it in a few years This is the publication that readers need to understand how that transformation will happen the science behind it and how they can be a part of it **Brain**

**Informatics** Ning Zhong, Kuncheng Li, Shengfu Lu, Lin Chen, 2009-10-05 This volume contains the papers selected for presentation at The 2009 International Conference on Brain Informatics BI 2009 held at Beijing University of Technology China on October 22-24 2009 It was organized by the Web Intelligence Consortium WIC and IEEE Computational Intelligence Society Task Force on Brain Informatics IEEE TF BI The conference was held jointly with The 2009 International Conference on Active Media Technology AMT 2009 Brain informatics BI has emerged as an interdisciplinary research field that focuses on studying the mechanisms underlying the human information processing system HIPS It investigates the essential functions of the brain ranging from perception to thinking and encompassing such areas as multi perception attention memory language computation heuristic search reasoning planning decision making problem solving learning discovery and creativity The goal of BI is to develop and demonstrate a systematic approach to achieving an integrated understanding of both macroscopic and microscopic level working principles of the brain by means of experimental computational and cognitive neuroscience studies as well as utilizing advanced Web Intelligence WI centric information technologies BI represents a potentially revolutionary shift in the way that research is undertaken It attempts to capture new forms of collaborative and interdisciplinary work Following this vision new kinds of BI methods and global research communities will emerge through infrastructure on the wisdom Web and knowledge grids that enables high speed and distributed large scale analysis and computations and radically new ways of sharing data knowledge *Irreversible Quantum Dynamics* Fabio Benatti, Roberto Floreanini, 2008-01-11 The idea of editing the present volume in the Lecture Notes in Physics series arose while organizing the Conference on Irreversible Quantum Dynamics that took place at The Abdus Salam International Center for Theoretical Physics Trieste Italy from July 29 to August 2 2002 The aim of the Conference was to bring together different groups of researchers whose interests and pursuits involve irreversibility and time asymmetry in quantum mechanics The Conference promoted open and in depth exchanges of different points of view concerning both the content and character of quantum irreversibility and the methodologies used to study it The following main themes were addressed Theoretical Aspects of Quantum Irreversible Dynamics Open Quantum Systems and Applications Foundational Aspects of Irreversible Quantum Dynamics Asymmetric Time Evolution and Resonances Each theme was reviewed by an expert in the field accompanied by more specific research like shorter talks The whole topic of quantum irreversibility in all its manifold aspects has always raised a lot of interest starting with the description of unstable systems in quantum mechanics and the issue of quantum measurement



Further in cent years a boost of activity concerning noise dissipation and open systems has been prompted by the fast developing eld of quantum communication and information theory These considerations motivated the editors to put together a volume that tries to summarize the present day status of the research in the eld with the aim of providing the reader with an accessible and exhaustive introduction to it Integration of Constraint Programming, Artificial Intelligence, and Operations Research Emmanuel Hebrard,Nysret Musliu,2020-09-18 The volume LNCS 12296 constitutes the papers of the 17th International Conference on the Integration of Constraint Programming Artificial Intelligence and Operations Research which will be held online in September 2020 The 32 regular papers presented together with 4 abstracts of fast track papers were carefully reviewed and selected from a total of 72 submissions Additionally this volume includes the 4 abstracts and 2 invited papers by plenary speakers The conference program also included a Master Class on the topic Recent Advances in Optimization Paradigms and Solving Technology **Solid State Physics** Henry Ehrenreich,Frans Spaepen,2004-07-17 Solid state physics is the branch of physics that is primarily devoted to the study of matter in its solid phase especially at the atomic level This prestigious serial presents timely and state of the art reviews pertaining to all aspects of solid state physics

**Computational and Experimental Chemistry** Tanmoy Chakraborty,Michael J. Bucknum,Eduardo A. Castro,2013-09-24 This book covers a range of new research on computational quantum chemistry along with a special section devoted to exotic carbon allotropes and spiro quantum theory The section on spiro quantum theory covers the technical presentation of the ideas surrounding the emergence of a synthetic analytical and theoretical spiro quantum chemistry edifi **Semiconductor Optics** Claus F. Klingshirn,2006-01-02 The book on Semiconductor Optics has been favourably received by the s dents and the scienti c community worldwide After the rst edition which appeared in 1995 several reprints became necessary starting from 1997 one of them for the Chinese market They contained only rather limited updates of the material and corrections In the meantime scienti c progress brought a lot of new results which necessitate a new seriously revised edition This progress includes bulk se conductors but especially structures of reduced dimensionality These new trends and results are partly included in existing chapters e g for phonons or for time resolved spectroscopy partly new chapters have been introduced like the ones on cavity polaritons and photonic structures We based the description of the optical properties againon the simple and intuitively clear model ofthe Lorentz oscillatorsandthe concept of polaritons asthequantaoflightinmatter Butsince thereis presentlyatrend todescribe at least the optical properties of the electronic system of semiconductors by the optical or the semiconductor Bloch equations a chapter has been added on this topic written by Prof Dr R v Baltz Karlsruhe to familiarize the reader with this concept too which needs a bit more quantum mechanics compared the approach used here The chapter on group theory has been revised by Prof Dr K Hummer Karlsruhe Forchheim Karlsruhe C F Klingshirn September 2004 Preface to the First Edition One of the most prominent senses of many animals and of course of human beingsis sightorvision Recent Progress in Many-body Theories Joseph A. Carlson,Gerardo Ortiz,2006 Quantum many body

theory has greatly expanded its scope and depth over the past few years treating more deeply long standing issues like phase transitions and strongly correlated systems and simultaneously expanding into new areas such as cold atom physics and quantum information This collection of contributions highlights recent advances in all these areas by leaders in their respective fields Also included are some historic perspectives by L P Gor'kov and S T Belyaev Feenberg Medal Recipients at this conference and Nobel Laureate P W Anderson gives his unique outlook on the future of physics The volume covers the key topics in many body theory tied together through advances in theoretical tools and computational techniques and a unifying theme of fundamental approaches to quantum many body physics

*Fluctuations And Localization In Mesoscopic Electron Systems* Martin Janssen, 2001-06-15 The quantum phenomena of tunneling and interference show up not only in the microscopic world of atoms and molecules but also in cold materials of the real world such as metals and semiconductors Though not fully macroscopic such mesoscopic systems contain a huge number of particles and the holistic nature of quantum mechanics becomes evident already in simple electronic measurements The measured quantity fluctuates as a function of applied fields in an unpredictable yet reproducible way Despite this fingerprint character of fluctuations their statistical properties are universal i e they are the same for a large class of different mesoscopic systems having only very few parameters in common Localization of electrons is a dramatic effect of destructive interference As a consequence a metal can become an insulator while reaching mesoscopic scales Based on elementary quantum and statistical physics this text introduces the theory of mesoscopic electron systems It focuses on universal characteristics of fluctuations and on the localization mechanism General concepts and methods are stressed such as scaling laws for distribution functions Tools from condensed matter theory are used flexibly Involved technical details are skipped so as to present a broad overview of the field including topics like quantum dots the quantum Hall effect and a number of the most recent developments

## Whispering the Secrets of Language: An Emotional Quest through **Quantum Computing And Quantum Bits In Mesoscopic Systems**

In a digitally-driven earth wherever screens reign supreme and quick connection drowns out the subtleties of language, the profound secrets and mental nuances concealed within words frequently go unheard. Yet, located within the pages of **Quantum Computing And Quantum Bits In Mesoscopic Systems** a charming literary value sporting with organic thoughts, lies an exceptional quest waiting to be undertaken. Penned by a skilled wordsmith, that charming opus attracts readers on an introspective trip, delicately unraveling the veiled truths and profound influence resonating within ab muscles fabric of each word. Within the mental depths of the moving review, we shall embark upon a genuine exploration of the book is core themes, dissect its fascinating writing fashion, and yield to the strong resonance it evokes strong within the recesses of readers hearts.

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