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An Introduction to Quantum Computing - Phillip Kaye 2007 This concise, accessible text provides a thorough introduction to quantum computing - an exciting emergent field at the interface of the computer, engineering, mathematical and physical sciences. Aimed at advanced undergraduate and beginning graduate students in these disciplines, the text is technically detailed and is clearly illustrated throughout with diagrams and exercises. Some prior knowledge of linear algebra is assumed, including vector spaces and inner products. However, prior familiarity with topics such as tensor products and spectral decomposition is not required, as the necessary material is reviewed in the text.

An Introduction to Quantum Computing - Phillip Kaye 2007 The authors provide an introduction to quantum computing. Aimed at advanced undergraduate and beginning graduate students in these disciplines, this text is illustrated with diagrams and exercises.

Quantum Computing - Eleanor Rieffel 2014-05-09 "The text covers the basic building blocks of quantum information processing, quantum bits and quantum gates, showing their relationship to the key quantum concepts of quantum measurement, quantum state transformation, and entanglement between quantum subsystems; it treats quantum algorithms, discussing notions of complexity and describing a number of simple algorithms as well as the most significant algorithms to date; and it explores entanglement and robust quantum computation, investigating such topics as quantifying entanglement, decoherence, quantum error correction, and fault tolerance."--Back cover.

An Introduction to Quantum Computing Algorithms - Arthur O. Pittenger 2012-12-06 In 1994 Peter Shor [65] published a factoring algorithm for a quantum computer that finds the prime factors of a composite integer N more efficiently than is possible with the known algorithms for a classical computer. Since the difficulty of the factoring problem is crucial for the security of a public key encryption system, interest (and funding) in quantum computing and quantum computation suddenly blossomed. Quantum computing had arrived. The study of the role of quantum mechanics in the theory of computation seems to have begun in the early 1980s with the publications of Paul Benioff [6] [7] who considered a quantum mechanical model of computers and the computation process. A related question was discussed shortly thereafter by Richard Feynman [35] who began from a different perspective by asking what kind of computer should be used to simulate physics. His analysis led him to the belief that with a suitable class of "quantum machines" one could imitate any quantum system.
Quantum Computing for Everyone-Chris Bernhardt 2019-03-19 An accessible introduction to an exciting new area in computation, explaining such topics as qubits, entanglement, and quantum teleportation for the general reader. Quantum computing is a beautiful fusion of quantum physics and computer science, incorporating some of the most stunning ideas from twentieth-century physics into an entirely new way of thinking about computation. In this book, Chris Bernhardt offers an introduction to quantum computing that is accessible to anyone who is comfortable with high school mathematics. He explains qubits, entanglement, quantum teleportation, quantum algorithms, and other quantum-related topics as clearly as possible for the general reader. Bernhardt, a mathematician himself, simplifies the mathematics as much as he can and provides elementary examples that illustrate both how the math works and what it means. Bernhardt introduces the basic unit of quantum computing, the qubit, and explains how the qubit can be measured; discusses entanglement—which, he says, is easier to describe mathematically than verbally—and what it means when two qubits are entangled (citing Einstein's characterization of what happens when the measurement of one entangled qubit affects the second as "spooky action at a distance"); and introduces quantum cryptography. He recaps standard topics in classical computing—bits, gates, and logic—and describes Edward Fredkin's ingenious billiard ball computer. He defines quantum gates, considers the speed of quantum algorithms, and describes the building of quantum computers. By the end of the book, readers understand that quantum computing and classical computing are not two distinct disciplines, and that quantum computing is the fundamental form of computing. The basic unit of computation is the qubit, not the bit.

Introduction to Quantum Computation-Ioan Burda 2005 "Introduction to Quantum Computation" is an introduction to a new rapidly developing theory of quantum computing. The book is a comprehensive introduction to the main ideas and techniques of quantum computation. It begins with the basics of classical theory of computation: NP-complete problems, Boolean circuits, Finite state machine, Turing machine and the idea of complexity of an algorithm. The general quantum formalism (pure states, qubit, superposition, evolution of quantum system, entanglement, multi-qubit system ...) and complex algorithm examples are also presented. Matlab is a well known in engineer academia as matrix computing environment, which makes it well suited for simulating quantum algorithms. The (Quantum Computer Toolbox) QCT is written entirely in the Matlab and m-files are listed in book’s sections. There are certain data types that are implicitly defined by the QCT, including data types for qubit registers and transformations. The QCT contains many functions designed to mimic the actions of a quantum computer. In addition, the QCT contains several convenience functions designed to aid in the creation and modification of the data types used in algorithms. The main purposes of the QCT are for research involving Quantum Computation and as a teaching tool to aid in learning about Quantum Computing systems. The readers will learn to implement complex quantum algorithm (quantum teleportation and Deutsch, Grover, Shor algorithm) under Matlab environment (complete Matlab code examples).

Mathematics of Quantum Computing-Wolfgang Scherer 2019-11-13 This textbook presents the elementary aspects of quantum computing in a mathematical form. It is intended as core or supplementary reading for physicists, mathematicians, and computer scientists taking a first course on quantum computing. It starts by introducing the basic mathematics required for quantum mechanics, and then goes on to present, in detail, the notions of quantum mechanics, entanglement, quantum gates, and quantum algorithms, of which Shor's factorisation and Grover's search algorithm are discussed extensively. In addition, the algorithms for the Abelian Hidden Subgroup and Discrete Logarithm problems are presented and the latter is used to show how the Bitcoin digital signature may be compromised. It also addresses the problem of error correction as well as giving a detailed exposition of adiabatic quantum computing. The book contains around 140 exercises for the student, covering all of the topics treated, together with an appendix of solutions.

Introduction to Topological Quantum Computation-Jiannis K. Pachos 2012-04-12 Combining physics, mathematics and computer science, topological quantum computation is a rapidly expanding research area
focused on the exploration of quantum evolutions that are immune to errors. In this book, the author presents a variety of different topics developed together for the first time, forming an excellent introduction to topological quantum computation. The makings of anyonic systems, their properties and their computational power are presented in a pedagogical way. Relevant calculations are fully explained, and numerous worked examples and exercises support and aid understanding. Special emphasis is given to the motivation and physical intuition behind every mathematical concept. Demystifying difficult topics by using accessible language, this book has broad appeal and is ideal for graduate students and researchers from various disciplines who want to get into this new and exciting research field.

**Quantum Computing for Computer Scientists** - Noson S. Yanofsky 2008-08-11 The multidisciplinary field of quantum computing strives to exploit some of the uncanny aspects of quantum mechanics to expand our computational horizons. Quantum Computing for Computer Scientists takes readers on a tour of this fascinating area of cutting-edge research. Written in an accessible yet rigorous fashion, this book employs ideas and techniques familiar to every student of computer science. The reader is not expected to have any advanced mathematics or physics background. After presenting the necessary prerequisites, the material is organized to look at different aspects of quantum computing from the specific standpoint of computer science. There are chapters on computer architecture, algorithms, programming languages, theoretical computer science, cryptography, information theory, and hardware. The text has step-by-step examples, more than two hundred exercises with solutions, and programming drills that bring the ideas of quantum computing alive for today's computer science students and researchers.

**Quantum Computer Science** - N. David Mermin 2007-08-30 In the 1990's it was realized that quantum physics has some spectacular applications in computer science. This book is a concise introduction to quantum computation, developing the basic elements of this new branch of computational theory without assuming any background in physics. It begins with an introduction to the quantum theory from a computer-science perspective. It illustrates the quantum-computational approach with several elementary examples of quantum speed-up, before moving to the major applications: Shor's factoring algorithm, Grover's search algorithm, and quantum error correction. The book is intended primarily for computer scientists who know nothing about quantum theory, but will also be of interest to physicists who want to learn the theory of quantum computation, and philosophers of science interested in quantum foundational issues. It evolved during six years of teaching the subject to undergraduates and graduate students in computer science, mathematics, engineering, and physics, at Cornell University.

**Introduction to Quantum Computers** - Gennady P. Berman 1998 Quantum computing promises to solve problems which are intractable on digital computers. Highly parallel quantum algorithms can decrease the computational time for some problems by many orders of magnitude. This important book explains how quantum computers can do these amazing things. Several algorithms are illustrated: the discrete Fourier transform, Shor's algorithm for prime factorization; algorithms for quantum logic gates; physical implementations of quantum logic gates in ion traps and in spin chains; the simplest schemes for quantum error correction; correction of errors caused by imperfect resonant pulses; correction of errors caused by the nonresonant actions of a pulse; and numerical simulations of dynamical behavior of the quantum Control-Not gate. An overview of some basic elements of computer science is presented, including the Turing machine, Boolean algebra, and logic gates. The required quantum ideas are explained.

**Introduction to Quantum Computation and Information** - Hoi-Kwong Lo 1998-10-15 This book aims to provide a pedagogical introduction to the subjects of quantum information and quantum computation. Topics include non-locality of quantum mechanics, quantum computation, quantum cryptography, quantum error correction, fault-tolerant quantum computation as well as some experimental aspects of quantum computation and quantum cryptography. Only knowledge of basic quantum mechanics is assumed. Whenever more advanced concepts and techniques are used, they are introduced carefully. This book is meant to be a self-contained overview. While basic concepts are discussed in detail, unnecessary technical details
are excluded. It is well-suited for a wide audience ranging from physics
graduate students to advanced researchers. This book is based on a lecture
series held at Hewlett-Packard Labs, Basic Research Institute in the
Mathematical Sciences (BRIMS), Bristol from November 1996 to April 1997,
and also includes other contributions. Contents:Basic Elements of Quantum
Information Technology (T P Spiller)The Joy of Entanglement (S Popescu &
D Rohrlich)Quantum Information and Its Properties (R Jozsa)Quantum
Cryptography (H-K Lo)Experimental Quantum Cryptography (H
Zbinden)Quantum Computation: An Introduction (A Barenco)Quantum Error
Correction (A M Steane)Fault-Tolerant Quantum Computation (J
Preskill)Quantum Computers, Error-Correction and Networking: Quantum
Optical Approaches (T Pellizzari)Quantum Computation with Nuclear
Magnetic Resonance (I L Chuang)Future Directions for Quantum
Information Theory (C H Bennett)Readership: Graduate students and
advanced researchers in quantum/classical mechanics, quantum information
& computation, theoretical foundations of computer science and information
science. Keywords:Quantum Computation;Quantum Cryptography;Quantum
Information;Quantum Teleportation;Quantum Error-Correction;Quantum
Algorithm;Entanglement;Qubit;DecoherenceReviews: "The book fills a gap
between the turgid prose of the burgeoning research literature and the
superficial accounts in the popular press." Nature "The concepts introduced
in this book and the forecast of future directions provided should continue
to provide a good primer for the exciting breakthrough anticipated in this
field." Mathematics Abstracts “Despite its age, this book remains an
excellent way to learn the basics of quantum information.” Quantum
Information and Computation “… the expositions are generally very
beautiful, and the drawing together of many fundamental issues in one
place is something that is extremely useful, given the wide background of
ideas that go into the field … this is an excellent book for anyone who is
starting out in the field and would like to have an overview of what the key
issues are, and which directions of research are important, without being
bogged down by heavy detail.” Contemporary Physics

Quantum Computing Explained - David McMahon 2007-12-14 A self-
contained treatment of the fundamentals of quantum computing. This clear,
practical book takes quantum computing out of the realm of theoretical
physics and teaches the fundamentals of the field to students and
professionals who have not had training in quantum computing or quantum
information theory, including computer scientists, programmers, electrical
engineers, mathematicians, physics students, and chemists. The author cuts
through the conventions of typical jargon-laden physics books and instead
presents the material through his unique "how-to" approach and friendly,
conversational style. Readers will learn how to carry out calculations with
explicit details and will gain a fundamental grasp of: * Quantum mechanics
* Quantum computation * Teleportation * Quantum cryptography *
Entanglement * Quantum algorithms * Error correction A number of worked
examples are included so readers can see how quantum computing is done
with their own eyes, while answers to similar end-of-chapter problems are
provided for readers to check their own work as they learn to master the
information. Ideal for professionals and graduate-level students alike,
Quantum Computing Explained delivers the fundamentals of quantum
computing readers need to be able to understand current research papers
and go on to study more advanced quantum texts.

A First Introduction to Quantum Computing and Information-Bernard
Zygelman 2018-10-04 This book addresses and introduces new
developments in the field of Quantum Information and Computing (QIC) for
a primary audience of undergraduate students. Developments over the past
few decades have spurred the need for QIC courseware at major research
institutions. This book broadens the exposure of QIC science to the
undergraduate market. The subject matter is introduced in such a way so
that it is accessible to students with only a first-year calculus background.
Greater accessibility allows a broader range of academic offerings. Courses,
based on this book, could be offered in the Physics, Engineering, Math and
Computer Science departments. This textbook incorporates Mathematica-
based examples into the book. In this way students are allowed a hands-on
experience in which difficult abstract concepts are actualized by
simulations. The students can "turn knobs" in parameter space and explore
how the system under study responds. The incorporation of symbolic
manipulation software into course-ware allows a more holistic approach to
the teaching of difficult concepts. Mathematica software is used here
because it is easy to use and allows a fast learning curve for students who
have limited experience with scientific programming.
Quantum Computation and Quantum Information - Michael A. Nielsen
2000-10-23 First-ever comprehensive introduction to the major new subject of quantum computing and quantum information.

A First Introduction to Quantum Computing and Information - Bernard Zygelman 2018-09-21 This book addresses and introduces new developments in the field of Quantum Information and Computing (QIC) for a primary audience of undergraduate students. Developments over the past few decades have spurred the need for QIC courseware at major research institutions. This book broadens the exposure of QIC science to the undergraduate market. The subject matter is introduced in such a way so that it is accessible to students with only a first-year calculus background. Greater accessibility allows a broader range of academic offerings. Courses, based on this book, could be offered in the Physics, Engineering, Math and Computer Science departments. This textbook incorporates Mathematica-based examples into the book. In this way students are allowed a hands-on experience in which difficult abstract concepts are actualized by simulations. The students can “turn knobs” in parameter space and explore how the system under study responds. The incorporation of symbolic manipulation software into course-ware allows a more holistic approach to the teaching of difficult concepts. Mathematica software is used here because it is easy to use and allows a fast learning curve for students who have limited experience with scientific programming.

Programming Quantum Computers - Eric R. Johnston 2019-07-03
Quantum computers are set to kick-start a second computing revolution in an exciting and intriguing way. Learning to program a Quantum Processing Unit (QPU) is not only fun and exciting, but it’s a way to get your foot in the door. Like learning any kind of programming, the best way to proceed is by getting your hands dirty and diving into code. This practical book uses publicly available quantum computing engines, clever notation, and a programmer’s mindset to get you started. You’ll be able to build up the intuition, skills, and tools needed to start writing quantum programs and solve problems that you care about.

Introduction to Quantum Information Science - Masahito Hayashi
2014-08-22 This book presents the basics of quantum information, e.g., foundation of quantum theory, quantum algorithms, quantum entanglement, quantum entropies, quantum coding, quantum error correction and quantum cryptography. The required knowledge is only elementary calculus and linear algebra. This way the book can be understood by undergraduate students. In order to study quantum information, one usually has to study the foundation of quantum theory. This book describes it from more an operational viewpoint which is suitable for quantum information while traditional textbooks of quantum theory lack this viewpoint. The current book bases on Shor's algorithm, Grover's algorithm, Deutsch-Jozsa's algorithm as basic algorithms. To treat several topics in quantum information, this book covers several kinds of information quantities in quantum systems including von Neumann entropy. The limits of several kinds of quantum information processing are given. As important quantum protocols, this book contains quantum teleportation, quantum dense coding, quantum data compression. In particular conversion theory of entanglement via local operation and classical communication are treated too. This theory provides the quantification of entanglement, which coincides with von Neumann entropy. The next part treats the quantum hypothesis testing. The decision problem of two candidates of the unknown state are given. The asymptotic performance of this problem is characterized by information quantities. Using this result, the optimal performance of classical information transmission via noisy quantum channel is derived. Quantum information transmission via noisy quantum channel by quantum error correction are discussed too. Based on this topic, the secure quantum communication is explained. In particular, the quantification of quantum security which has not been treated in existing book is explained. This book treats quantum cryptography from a more practical viewpoint.

Quantum Computing - National Academies of Sciences, Engineering, and Medicine 2019-04-27 Quantum mechanics, the subfield of physics that describes the behavior of very small (quantum) particles, provides the basis for a new paradigm of computing. First proposed in the 1980s as a way to improve computational modeling of quantum systems, the field of quantum
computing has recently garnered significant attention due to progress in building small-scale devices. However, significant technical advances will be required before a large-scale, practical quantum computer can be achieved. Quantum Computing: Progress and Prospects provides an introduction to the field, including the unique characteristics and constraints of the technology, and assesses the feasibility and implications of creating a functional quantum computer capable of addressing real-world problems. This report considers hardware and software requirements, quantum algorithms, drivers of advances in quantum computing and quantum devices, benchmarks associated with relevant use cases, the time and resources required, and how to assess the probability of success.

**Quantum Algorithms Via Linear Algebra** - Richard J. Lipton 2014-12-15
Quantum computing explained in terms of elementary linear algebra, emphasizing computation and algorithms and requiring no background in physics.

**An Introduction to the Formalism of Quantum Information with Continuous Variables** - Carlos Navarrete-Benlloch 2016-01-01
Quantum information is an emerging field which has attracted a lot of attention in the last couple of decades. It is a broad subject which extends from the most applied questions (e.g. how to build quantum computers or secure cryptographic systems) to the most theoretical problems concerning the formalism and interpretation of quantum mechanics, its complexity, and its potential to go beyond classical physics. This book is an introduction to quantum information with special emphasis on continuous-variable systems (such as light) which can be described as collections of harmonic oscillators. It covers a selection of basic concepts, focusing on their physical meaning and mathematical treatment. It starts from the very first principles of quantum mechanics, and builds up the concepts and techniques following a logical progression. This is an excellent reference for students with a full semester of standard quantum mechanics and researchers in closely related fields.

**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.

Quantum Computing for Computer Architects-Tzvetan S. Metodi
2011-03-01 Quantum computers can (in theory) solve certain problems far faster than a classical computer running any known classical algorithm. While existing technologies for building quantum computers are in their infancy, it is not too early to consider their scalability and reliability in the context of the design of large-scale quantum computers. To architect such systems, one must understand what it takes to design and model a balanced, fault-tolerant quantum computer architecture. The goal of this lecture is to provide architectural abstractions for the design of a quantum computer and to explore the systems-level challenges in achieving scalable, fault-tolerant quantum computation. In this lecture, we provide an engineering-oriented introduction to quantum computation with an overview of the theory behind key quantum algorithms. Next, we look at architectural case studies based upon experimental data and future projections for quantum computation implemented using trapped ions. While we focus here on architectures targeted for realization using trapped ions, the techniques for quantum computer architecture design, quantum fault-tolerance, and compilation described in this lecture are applicable to many other physical technologies that may be viable candidates for building a large-scale quantum computing system. We also discuss general issues involved with programming a quantum computer as well as a discussion of work on quantum architectures based on quantum teleportation. Finally, we consider some of the open issues remaining in the design of quantum computers. Table of Contents: Introduction / Basic Elements for Quantum Computation / Key Quantum Algorithms / Building Reliable and Scalable Quantum Architectures / Simulation of Quantum Computation / Architectural Elements / Case Study: The Quantum Logic Array Architecture / Programming the Quantum Architecture / Using the QLA for Quantum Simulation: The Transverse Ising Model / Teleportation-Based Quantum Architectures / Concluding Remarks

Approaching Quantum Computing-Marinescu 2008-09

A Short Introduction to Quantum Information and Quantum Computation-Michel Le Bellac 2006-06-15 Quantum information and computation is a rapidly expanding and cross-disciplinary subject. This book, first published in 2006, gives a self-contained introduction to the field for physicists, mathematicians and computer scientists who want to know more about this exciting subject. After a step-by-step introduction to the quantum bit (qubit) and its main properties, the author presents the necessary background in quantum mechanics. The core of the subject, quantum computation, is illustrated by a detailed treatment of three quantum algorithms: Deutsch, Grover and Shor. The final chapters are devoted to the physical implementation of quantum computers, including the most recent aspects, such as superconducting qubits and quantum dots, and to a short account of quantum information. Written at a level suitable for undergraduates in physical sciences, no previous knowledge of quantum mechanics is assumed, and only elementary notions of physics are required. The book includes many short exercises, with solutions available to instructors through solutions@cambridge.org.

Quantum Computing-Mikio Nakahara 2008-03-11 Covering both theory and progressive experiments, Quantum Computing: From Linear Algebra to Physical Realizations explains how and why superposition and entanglement provide the enormous computational power in quantum computing. This self-contained, classroom-tested book is divided into two sections, with the first devoted to the theoretical aspects of quantum computing and the second focused on several candidates of a working quantum computer, evaluating them according to the DiVincenzo criteria. Topics in Part I Linear algebra Principles of quantum mechanics Qubit and the first application of quantum information processing—quantum key distribution Quantum gates Simple yet elucidating examples of quantum algorithms Quantum circuits
that implement integral transforms Practical quantum algorithms, including Grover’s database search algorithm and Shor’s factorization algorithm The disturbing issue of decoherence Important examples of quantum error-correcting codes (QECC) Topics in Part II DiVincenzo criteria, which are the standards a physical system must satisfy to be a candidate as a working quantum computer Liquid state NMR, one of the well-understood physical systems Ionic and atomic qubits Several types of Josephson junction qubits The quantum dots realization of qubits Looking at the ways in which quantum computing can become reality, this book delves into enough theoretical background and experimental research to support a thorough understanding of this promising field.

**Elements of Quantum Computation and Quantum Communication**

Anirban Pathak 2013-06-20 While there are many available textbooks on quantum information theory, most are either too technical for beginners or not complete enough. Filling this gap, Elements of Quantum Computation and Quantum Communication gives a clear, self-contained introduction to quantum computation and communication. Written primarily for undergraduate students in p

**Quantum Thermodynamics**

Sebastian Deffner 2019-07-02 This book provides an introduction to the emerging field of quantum thermodynamics, with particular focus on its relation to quantum information and its implications for quantum computers and next generation quantum technologies. The text, aimed at graduate level physics students with a working knowledge of quantum mechanics and statistical physics, provides a brief overview of the development of classical thermodynamics and its quantum formulation in Chapter 1. Chapter 2 then explores typical thermodynamic settings, such as cycles and work extraction protocols, when the working material is genuinely quantum. Finally, Chapter 3 explores the thermodynamics of quantum information processing and introduces the reader to some more state-of-the-art topics in this exciting and rapidly developing research field.

**Quantum Computing for Developers**

Johan Vos 2020-05-12 Quantum computing is on the horizon, ready to impact everything from scientific research to encryption and security. But you don’t need a physics degree to get started in quantum computing. Quantum Computing for Developers shows you how to leverage your existing Java skills into writing your first quantum software so you’re ready for the revolution. Rather than a hardware manual or academic theory guide, this book is focused on practical implementations of quantum computing algorithms. Using Strange, a Java-based quantum computer simulator, you’ll go hands-on with quantum computing’s core components including qubits and quantum gates as you write your very first quantum code. Purchase of the print book includes a free eBook in PDF, Kindle, and ePub formats from Manning Publications.

**Quantum Computing**

Jack D. Hidary 2020-03-29 This book integrates the foundations of quantum computing with a hands-on coding approach to this emerging field; it is the first work to bring these strands together in an updated manner. This work is suitable for both academic coursework and corporate technical training. This volume comprises three books under one cover: Part I outlines the necessary foundations of quantum computing and quantum circuits. Part II walks through the canon of quantum computing algorithms and provides code on a range of quantum computing methods in current use. Part III covers the mathematical toolkit required to master quantum computing. Additional resources include a table of operators and circuit elements and a companion GitHub site providing code and updates. Jack D. Hidary is a research scientist in quantum computing and AI at Alphabet X, formerly Google X. “Quantum Computing will change our world in unexpected ways. Everything technology leaders, engineers and graduate students need is in this book including the methods and hands-on code to program on this novel platform.”—Eric Schmidt, PhD, Former Chairman and CEO of Google; Founder, Innovation Endeavors.

**Quantum Computing**

Parag Lala 2019-02-01 A self-contained, reader-friendly introduction to the principles and applications of quantum computing Especially valuable to those without a prior knowledge of
quantum mechanics, this electrical engineering text presents the concepts and workings of quantum information processing systems in a clear, straightforward, and practical manner. The book is written in a style that helps readers who are not familiar with non-classical information processing more easily grasp the essential concepts; only prior exposure to classical physics, basic digital design, and introductory linear algebra is assumed. Quantum Computing: A Beginner’s Introduction presents each topic in a tutorial style with examples, illustrations, and diagrams to clarify the material. Written by an experienced electrical engineering educator and author, this is a self-contained resource, with all the necessary pre-requisite material included within the text. Coverage includes: •Complex Numbers, Vector Space, and Dirac Notation •Basics of Quantum Mechanics •Matrices and Operators •Boolean Algebra, Logic Gates and Quantum Information Processing •Quantum Gates and Circuit •Tensor Products, Superposition and Quantum Entanglement •Teleportation and Superdense Coding •Quantum Error Correction •Quantum Algorithms •Quantum Cryptography

Learn Quantum Computing with Python and Q#-Sarah C. Kaiser 2020-10-27 Learn Quantum Computing with Python and Q# demystifies quantum computing. Using Python and the new quantum programming language Q#, you’ll learn QC fundamentals as you apply quantum programming techniques to real-world examples including cryptography and chemical analysis. Learn Quantum Computing with Python and Q# builds your understanding of quantum computers, using Microsoft’s Quantum Development Kit to abstract away the mathematical complexities. You’ll learn QC basics as you create your own quantum simulator in Python, then move on to using the QDK and the new Q# language for writing and running algorithms very different to those found in classical computing. Purchase of the print book includes a free eBook in PDF, Kindle, and ePub formats from Manning Publications.

Principles of Quantum Computation and Information-Giuliano Benenti 2004-04-16 ' Quantum computation and information is a new, rapidly developing interdisciplinary field. Therefore, it is not easy to understand its fundamental concepts and central results without facing numerous technical details. This book provides the reader a useful and not-too-heavy guide. It offers a simple and self-contained introduction; no previous knowledge of quantum mechanics or classical computation is required. Volume I may be used as a textbook for a one-semester introductory course in quantum information and computation, both for upper-level undergraduate students and for graduate students. It contains a large number of solved exercises, which are an essential complement to the text, as they will help the student to become familiar with the subject. The book may also be useful as general education for readers who want to know the fundamental principles of quantum information and computation and who have the basic background acquired from their undergraduate course in physics, mathematics, or computer science. Contents:Introduction to Classical ComputationIntroduction to Quantum MechanicsQuantum ComputationQuantum Communication Readership: Upper-level undergraduates and graduate students in physics, mathematics and computer science. Keywords:Quantum Computation;Quantum Information;Quantum Algorithms;Quantum Communication;Quantum Cryptography;Complex Systems;Dynamical Systems;Quantum Chaos;Nanoscience;Quantum OpticsReviews: “The book by Benenti, Casati and Strini is an excellent introduction to the fascinating field of quantum computation and information. The reader is gently introduced to this field starting from the basics in computation and quantum mechanics to the more advanced topics of quantum computation of dynamical systems. The book is written in a very clear way, accessible both to undergraduate and graduate students in physics, computer science and engineering.” Rosario Fazio Scuola Normale Superiore Pisa, Italy “The first volume of the present textbook aims at filling the gap between elementary introductory books and more advanced reference manuals. The choice of topics and the emphasis on concepts rather than mathematical technicalities makes it good choice for an introductory course of Quantum Information Theory for physicists or computer scientists with little background in this area. Of particular interest is the description of the links between quantum computation and quantum chaos, a research area in which the authors are leading experts, a topic rarely treated in introductory textbooks. The present volume is a welcomed addition to the existing choice of textbooks in quantum information theory and quantum computation.” Professor G Massimo Palma University of Milan, Italy “This book gives a clear and exhaustive introduction to quantum computation and quantum communication. Together with the second volume it covers all the main topics in the field of quantum information...
Elements of Quantum Computing

Seiki Akama 2014-07-14

A quantum computer is a computer based on a computational model which uses quantum mechanics, which is a subfield of physics to study phenomena at the micro level. There has been a growing interest on quantum computing in the 1990's and some quantum computers at the experimental level were recently implemented. Quantum computers enable super-speed computation and can solve some important problems whose solutions were regarded impossible or intractable with traditional computers. This book provides a quick introduction to quantum computing for readers who have no backgrounds of both theory of computation and quantum mechanics. “Elements of Quantum Computing” presents the history, theories and engineering applications of quantum computing. The book is suitable to computer scientists, physicists and software engineers.

Quantum Information Processing and Quantum Error Correction

Ivan Djordjevic 2012

Quantum Information Processing and Quantum Error Correction is a self-contained, tutorial-based introduction to quantum information, quantum computation, and quantum error-correction. Assuming no knowledge of quantum mechanics and written at an intuitive level suitable for the engineer, the book gives all the essential principles needed to design and implement quantum electronic and photonic circuits. Numerous examples from a wide area of application are given to show how the principles can be implemented in practice. This book is ideal for the electronics, photonics and computer engineer who requires an easy-to-understand foundation on the principles of quantum information processing and quantum error correction, together with insight into how to develop quantum electronic and photonic circuits. Readers of this book will be ready for further study in this area, and will be prepared to perform independent research. The reader completed the book will be able design the information processing circuits, stabilizer codes, Calderbank-Shor-Steane (CSS) codes, subsystem codes, topological codes and entanglement-assisted quantum error correction codes; and propose corresponding physical implementation. The reader completed the book will be proficient in quantum fault-tolerant design as well. Unique Features Unique in covering both quantum information processing and quantum error correction - everything in one book that an engineer needs to understand and implement quantum-level circuits. Provides an intuitive understanding by not assuming knowledge of quantum mechanics, thereby avoiding heavy mathematics. In-depth coverage of the design and implementation of quantum information processing and quantum error correction circuits. Provides the right balance among the quantum mechanics, quantum error correction, quantum computing and quantum communication. Dr. Djordjevic is an Assistant Professor at the University of Pavia, Italy.

The first volume of the two-volume edition is an introduction to the main concepts of quantum computation and information. The book offers a simple, clear and systematic treatment of qubits, quantum gates, various quantum algorithms and quantum communication. The chapters on classical information theory and quantum mechanics make the book easy to read. The book is recommended to undergraduate as well as graduate students in physics, mathematics and computer science. The large number of exercises is supplemented by solutions. The reader is encouraged for active work. "Professor Ioannis Antoniou Aristotle University of Thessaloniki, Greece "Besides giving an excellent introduction to the field it provides a unique perspective on the blending and cross-fertilization between the methods of quantum information and quantum chaos, both areas in which the authors are leading experts." Marcos Saraceno Comision Nac. de Energia Atomica, Argentina "The authors have done a very good job, succeeding to present the main topics of this domain with remarkable concision and clarity." Bertrand Georgeot CNRS/Universite Paul Sabatier, France "This book is, on the whole, well-written and readable. The material is presented concisely, and illustrated with simple examples and exercises ... the material in the current book is much more compact and easily learned than the phonebook-sized compendium of Nielsen and Chuang. It could serve well as the text for an introductory course ... It also contains numerous exercises, which mostly seem well thought out and appropriate to the material presented." Mathematical Reviews "Reading this book one remarks from the very beginning that it is outstanding and well formulated with both mathematical and verbal respects ... This book is didactically well organized and written in a clear language. It can be best recommended to people to whom it is addressed by the authors." Zentralblatt MATH
Professor in the Department of Electrical and Computer Engineering of College of Engineering, University of Arizona, with a joint appointment in the College of Optical Sciences. Prior to this appointment in August 2006, he was with University of Arizona, Tucson, USA (as a Research Assistant Professor); University of the West of England, Bristol, UK; University of Bristol, Bristol, UK; Tyco Telecommunications, Eatontown, USA; and National Technical University of Athens, Athens, Greece. His current research interests include optical networks, error control coding, constrained coding, coded modulation, turbo equalization, OFDM applications, and quantum error correction. He presently directs the Optical Communications Systems Laboratory (OCSL) within the ECE Department at the University of Arizona. Provides everything an engineer needs in one tutorial-based introduction to understand and implement quantum-level circuits Avoids the heavy use of mathematics by not assuming the previous knowledge of quantum mechanics Provides in-depth coverage of the design and implementation of quantum information processing and quantum error correction circuits


Quantum Information and Computation for Chemistry-Sabre Kais 2014-01-31 Examines the intersection of quantum information and chemical physics The Advances in Chemical Physics series is dedicated to reviewing new and emerging topics as well as the latest developments in traditional areas of study in the field of chemical physics. Each volume features detailed comprehensive analyses coupled with individual points of view that integrate the many disciplines of science that are needed for a full understanding of chemical physics. This volume of the series explores the latest research findings, applications, and new research paths from the quantum information science community. It examines topics in quantum computation and quantum information that are related to or intersect with key topics in chemical physics. The reviews address both what chemistry can contribute to quantum information and what quantum information can contribute to the study of chemical systems, surveying both theoretical and experimental quantum information research within the field of chemical physics. With contributions from an international team of leading experts, Volume 154 offers seventeen detailed reviews, including: Introduction to quantum information and computation for chemistry Quantum computing approach to non-relativistic and relativistic molecular energy calculations Quantum algorithms for continuous problems and their applications Photonic toolbox for quantum simulation Vibrational energy and information transfer through molecular chains Tensor networks for entanglement evolution Reviews published in Advances in Chemical Physics are typically longer than those published in journals, providing the space needed for readers to fully grasp the topic: the fundamentals as well as the latest discoveries, applications, and emerging avenues of research. Extensive cross-referencing enables readers to explore the primary research studies underlying each topic.

Quantum Computing Since Democritus-Scott Aaronson 2013-03-14 Takes students and researchers on a tour through some of the deepest ideas of maths, computer science and physics.

Introduction to Quantum Mechanics-Sy M. Blinder 2012-12-02 Introduction to Quantum Mechanics provides a lucid, up-to-date introduction to the principles of quantum mechanics at the level of undergraduates and first-year graduate students in chemistry, materials science, biology and related fields. It shows how the fundamental concepts of quantum theory arose from classic experiments in physics and chemistry, and presents the quantum-mechanical foundations of modern techniques including molecular spectroscopy, lasers and NMR. Blinder also discusses recent conceptual developments in quantum theory, including Schrödinger's Cat, the Einstein-Podolsky-Rosen experiment, Bell's theorem and quantum computing. Clearly presents the basics of quantum mechanics and modern developments in the field Explains applications to molecular spectroscopy, lasers, NMR, and MRI Introduces new concepts such as Schrödinger's Cat, Bell's Theorem, and quantum computing Includes full-color illustrations, proven pedagogical features, and links to online materials
Dancing with Qubits- Robert S. Sutor 2019-11-28

Explore the principles and practicalities of quantum computing

Key Features

- Discover how quantum computing works and delve into the math behind it with this quantum computing textbook
- Learn how it may become the most important new computer technology of the century
- Explore the inner workings of quantum computing technology to quickly process complex cloud data and solve problems
- Book Description

Quantum computing is making us change the way we think about computers. Quantum bits, a.k.a. qubits, can make it possible to solve problems that would otherwise be intractable with current computing technology. Dancing with Qubits is a quantum computing textbook that starts with an overview of why quantum computing is so different from classical computing and describes several industry use cases where it can have a major impact. From there it moves on to a fuller description of classical computing and the mathematical underpinnings necessary to understand such concepts as superposition, entanglement, and interference. Next up is circuits and algorithms, both basic and more sophisticated. It then nicely moves on to provide a survey of the physics and engineering ideas behind how quantum computing hardware is built. Finally, the book looks to the future and gives you guidance on understanding how further developments will affect you. Really understanding quantum computing requires a lot of math, and this book doesn’t shy away from the necessary math concepts you’ll need. Each topic is introduced and explained thoroughly, in clear English with helpful examples. What you will learn

See how quantum computing works, delve into the math behind it, what makes it different, and why it is so powerful with this quantum computing textbook

Discover the complex, mind-bending mechanics that underpin quantum systems

Understand the necessary concepts behind classical and quantum computing

Refresh and extend your grasp of essential mathematics, computing, and quantum theory

Explore the main applications of quantum computing to the fields of scientific computing, AI, and elsewhere

Examine a detailed overview of qubits, quantum circuits, and quantum algorithm

Who this book is for

Dancing with Qubits is a quantum computing textbook for those who want to deeply explore the inner workings of quantum computing. This entails some sophisticated mathematical exposition and is therefore best suited for those with a healthy interest in mathematics, physics, engineering, and computer science.