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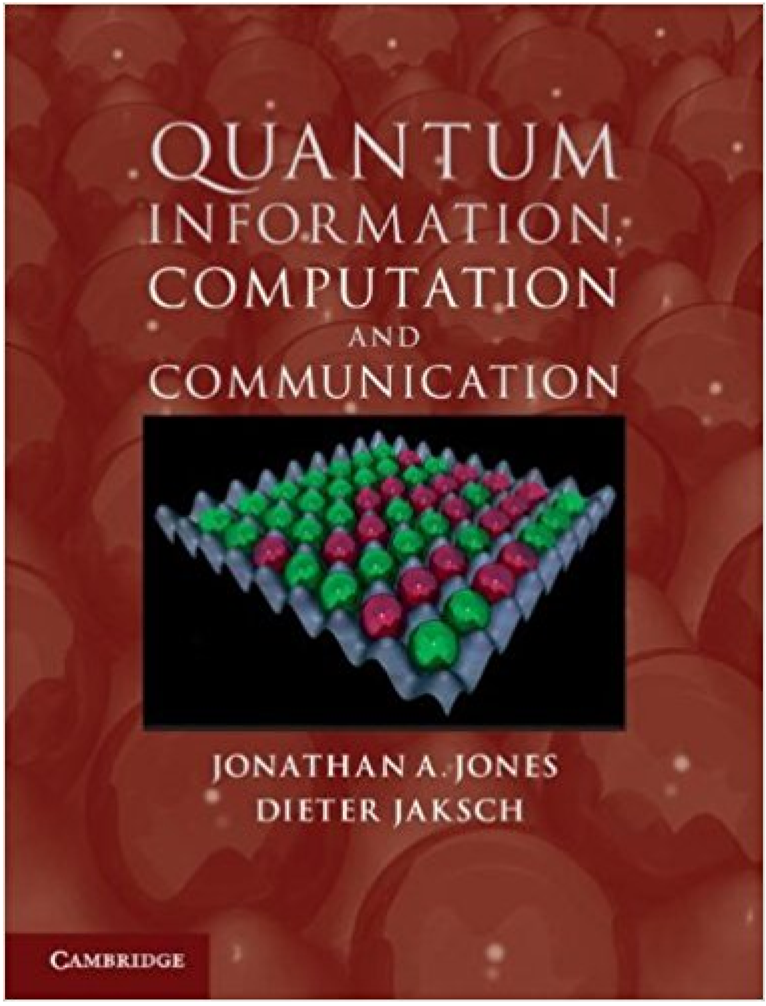
Quantum Information, Computation And Communication



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Synopsis

Quantum physics allows entirely new forms of computation and cryptography, which could perform tasks currently impossible on classical devices, leading to an explosion of new algorithms, communications protocols and suggestions for physical implementations of all these ideas. As a result, quantum information has made the transition from an exotic research topic to part of mainstream undergraduate courses in physics. Based on years of teaching experience, this textbook builds from simple fundamental concepts to cover the essentials of the field. Aimed at physics undergraduate students with a basic background in quantum mechanics, it guides readers through theory and experiment, introducing all the central concepts without getting caught up in details. Worked examples and exercises make this useful as a self-study text for those who want a brief introduction before starting on more advanced books. Solutions are available online at www.cambridge.org/9781107014466.

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Customer Reviews

"Each chapter is clearly written and provides exercises and suggestions for further reading. It is an excellent guide for anyone studying the challenging area of quantum computing." Mircea Dragoman, National Research and Development Institute on Microtechnology, Bucharest, Romania for Optics and Photonics News"This relatively brief introductory text by Jones and Jaksch (both, Univ. of Oxford, UK) focuses on a rapidly moving area of physics research with important potential applications to things like unbreakable codes and computers many times more powerful than those available today." M. C. Ogilvie, Choice"... newcomers will enjoy that each chapter ends with a section suggesting further reading for each topic and a few exercises. A nice feature is that it makes many references to common experimental techniques, from which a theoretician may profit. It is recommendable as a first overview to students and scientists with a little background in quantum mechanics." Zentralblatt MATH

Quantum information has made the transition from an exotic research topic to part of mainstream undergraduate courses in physics. Based on years of teaching experience, this textbook guides undergraduate students in physics through theory and experiment to cover the essentials of the field.

First thing that should be said is that this is not an introduction to quantum mechanics, far from it. This book starts off where many introductory texts end, explaining how quantum computing is different from traditional computing with 1s and 0s. The book is really written as a text book suitable for upper division undergraduates or perhaps graduate students already having a foundation in the physics part of quantum computing. To make the book useful, the student will ideally have some foundation in programming methods, but quite honestly, most of the book is dealing with the constructs used in quantum computing and not focused on actual code (no code comes with the book). In reality, a great deal of quantum computing is hardware based, which makes it significantly different than processor-based algorithm development. So, step one for any budding quantum programmer is to team up with some with a strong hardware background, so really the actual computing is a hardware/software (with software providing command and control of the hardware processing).As for me, this was the ideal book for me once I had completed some 5-6 books on the history and basics of quantum mechanics. This is really the road map to how it really can be done (or will be done since they have not gotten very far with the factoring problem, at least not that I have heard in the last couple of years). But this work is truly going to change the world since much of what we depend on involves established methods of cryptography.There are probably only three classes of users for this book: the budding student/researcher/developer, the person needed a good reference for this material, and people like me who are technically interested and found the introductory books lacking do to any kind of specifics on the constructs for quantum processing. If you’re one of the three, this is probably a good choice. If not, it might be an expensive mistake.

In the 1930’s, Einstein and two colleagues wrote a seminal paper on the ’paradox’ of quantum mechanics, that systems whose parts interacted in the past could remain correlated in the future, even if the parts became widely separated. What Einstein considered to be an illustration of the impossibility of the quantum description of the natural world has turned out instead to be not only the experimentally verified reality but the basis of a future technology of immense power as well. Quantum mechanics is not absurd; it is the way the universe actually works, if only we can accept it. Indeed, the main problem has been a psychological one, how to embrace such a counterintuitive landscape. Books like this one are the answer; to educate a generation of technologists who grow up thinking quantum mechanically.This year the Nobel Prize in physics was given for the development of quantum entanglement as a new paradigm of computation with promising laboratory realization. Because the quantum wavefunction can encode many co-existing possibilities in one coherent state and propagate them all simultaneously through a dynamical configuration, it becomes possible to envision new types of computers with powers vastly beyond the familar architecture of binary devices piled up; bits replaced by infinitely more flexible q-bits. This book by Jones and Jaksch explains all this in a clear, systematic progression, assuming only that the reader has a grasp of undergraduate physics. The subject of quantum encryption, likely to be the first real application, is particularly well explained. I wonder what Einstein would think if he knew that the features he pointed to as incomprehensible would end up the basis of commercial products one day!Of course quantum computation is still nascent and it will be years before it is fully applied. Nevertheless, it is not too early for future computer scientists to learn about it. Highly recommended.

This is a book based on the lectures given by the authors to advanced (fourth year) undergraduate students at Oxford University. The students were expected to have "some" background in quantum mechanics and maybe computer science as well, but after reading the book, I can tell that there is almost no computer science in this book. In contrast, there is a lot of good physics in it, and some of it (especially the physics of EPR paradoxes and Bell inequalities for entangled states) is quite a bit beyond the understanding of an average physics undergraduate major with "some" background in quantum mechanics. In my opinion, to understand this stuff in depth, you need a solid background in quantum mechanics, preferably at the graduate level or even better.My biggest complaint about this book is that it teaches the reader very little about any subject in depth. The book is presented as a very quick and very broad survey of quantum information and computing without getting into the details of any subject, and certainly not into questions like why and how. If you don’t know much about quantum computing, you will learn a lot of new buzzwords from this book, and you will have some idea what two scientists may be talking about, but you still will not be able to understand the details and the subtleties of the conversation. As an example take the famous "no-cloning theorem". This central theorem is discussed only for about a page and a half, and if you did not understand it before reading the book, you will be no wiser to the subject. None of the fundamental implications of this theorem (for building quantum computers) are even mentioned in the book.If you are not a physicist but if you have a good background in quantum mechanics you can still read and learn some things from this book. But you will not get satisfactory answers to questions like "why have we not built quantum computers yet that go beyond just a few q-bits", or "can quantum computers go around the current encryption systems". The computer scientists will be most intrigued by questions like the second one, because quantum computing has the potential (though there is no proof it yet) of solving NP-hard problems in polynomial time, thus bypassing the famous P-versus-NP problem in classical computer science. I wish the book made more of an attempt to expose, explain and discuss the most intriguing, controversial, and promising aspects of quantum computing, and the details of the difficulties of achieving these ends. The gedanken experiments with Bob and Alice sending each other entangled q-bits and making measurements loses its luster after a while when the user sees no connections between what’s being discussed, and what he really wants to hear about.Maybe my expectations were set too high. But I did not get what I hoped to get out of this book. I will give it a lukewarm recommendation.

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