Quantum computing.

From linear algebra to physical realizations.


Ten years ago there were no textbooks on quantum computing; today there are more than 40 titles available. This is a good measure of the success of this discipline. In many cases, like this one, the textbook comes after some of its authors have given a series of lectures on the subject, suggesting that the reason for the proliferation of these textbooks is the high demand for courses on quantum information and computation around the world. This book has two clearly defined parts. The first covers theoretical aspects. It starts with linear algebra and the postulates of quantum mechanics and then immediately moves onto the notion of qubit, the EPR “paradox”, the BB84 protocol for key distribution, a list of quantum gates, the no-cloning theorem, dense coding, quantum teleportation, quantum algorithms (Deutsch’s, Deutsch-Jozsa’s, Bernstein-Vazirani’s, Simon’s, Grover’s and Shor’s), POVMs, decoherence and quantum error correction codes. The selection of topics is adequate, although some fundamental topics such as Schumacher’s theorem are missing. Unfortunately, the presentation suffers from several faults. There is a lack of depth and precision in the statements (e.g., the no-cloning theorem is referred to as “An unknown quantum system cannot be cloned by unitary transformations”, while a more pedagogical presentation should emphasize that what the theorem asserts is that “no quantum amplifier can duplicate accurately two nonorthogonal quantum states”). There is also a lack of reflection, something that is especially unfortunate in such a fascinating subject (e.g., quantum error correcting codes are justified simply as a way to overcome the no-cloning theorem, omitting the fact that, even if cloning were possible, observation in quantum mechanics entails its own challenges). There are much better textbooks covering these subjects, Nielsen and Chuang’s still being the best. The second part of the book is much more timely. It deals with possible physical realizations of quantum computing. It starts by enunciating DiVincenzo’s criteria and then devotes between 16 and 40 pages to discussing whether or not each of the following possibilities satisfies those criteria: NMR, trapped ions, neutral atoms, Josephson junctions and quantum dots. Again, this part suffers from lack of depth, but, at least, covers an important range of topics not addressed in other textbooks.

Reviewed by *Adán Cabello*