Quantum Information and Computation, Vol. 7, No. 8 (2007) 799–800

BOOK REVIEW

on

An introduction to quantum computing

by Phillip Kaye, Raymond Laflamme and Michell Mosca

Oxford University Press, 2007

Paperback $54.00 (288 pages) ISBN: 0-19857-049-X

According to the web site, at the recent 2007 Federated Computing Research Conference, Christos Papadimitriou from UC Berkeley gave a talk on how computer science is transforming the sciences. The first sentence of his abstract states that:

> *Computational research transforms the sciences (physical, mathematical, life or social) not just by empowering them analytically, but mainly by providing a novel and powerful perspective which often leads to unforeseen insights.*

Quite justifiably, one of his examples was quantum computing. I am quite sure that the regular contributors to this journal would agree: our view of quantum mechanics has been transformed by the efforts of our pioneering colleagues in computer science. This helpful little book by Kaye, Laflamme and Mosca is an attempt to bring this new view to a wider undergraduate audience who, according to the preface,

> *...has an undergraduate education in some scientific field, and should particularly have a solid background in linear algebra, including vector space and inner products.*

The first few chapters make an attempt to get such a reader up to speed in quantum theory a la Dirac. The basic machinery is presented with admirable clarity, although any reader looking for a clear physical interpretation of the formalism will need to go elsewhere. Such statements as

> *It is not clear what it means for the photon to be in the state described by a vector like*

$$\frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ i \end{pmatrix}$$

might sap a beginners confidence. It does not help that the enigmatic concept of *'path-state' of a photon* makes a fleeting appearance in chapter 3. Such obscurities aside, it is clear what a throughly efficient job the authors have done in presenting the basic machinery of the quantum theory when they turn to the subjects of superdense coding and teleportation in Chapter 5 which are treated with elegant simplicity.

The real business, from a computer science perspective, gets underway in Chapter 6 which treats elementary quantum algorithms such as the Deutsch-Jozsa algorithm and Simon's algorithm. This is prefaced by a nice discussion of probabilistic versus quantum algorithms by way of Markov chains. In Chapter 6, after an introduction to the quantum Fourier transform, the authors serve up the main course with extremely transparent presentations of phase estimation, order finding algorithms (including Shor's algorithm), the discrete logarithm algorithm and the hidden subgroup problem. Grover's algorithm is discussed in Chapter 7. The book wraps up with a discussion of quantum computational complexity in Chapter 9 and a brief introduction to quantum error correction in chapter 10. Throughout, the presentation is lucid and the diligent reader upon completing the book, together with the many exercises, will be ready to move onto other sources to study those algorithms that are given scant mention here including adiabatic algorithms and quantum walk algorithms. Also missing is a discussion of the concept of quantum simulations, perhaps forgivable, as this subject would require a lot more physics background than the intended readership.

The authors have done an admirable job in addressing their stated target audience, although I expect that, in addition to a solid background in linear algebra, vector spaces and inner products, a first course in quantum physics might be advisable. Physics majors should also read this book. The refreshing change of perspective on quantum physics, wrought by the alliance with computer science, might just stimulate some unforeseen insights into this powerful and deeply puzzling description of our world.

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