Quantum Computing for Computer Scientists, N.S. Yanofsky and M.A. Manucci

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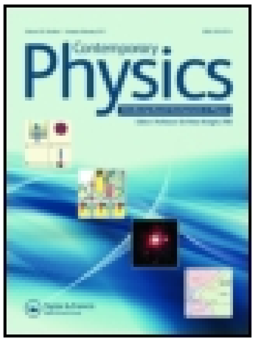

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pictures of Julia sets which can be found in many texts on complex and chaotic dynamics. Such pictures were not only of aesthetic value but also served as a springboard for further conjectures in the field. Then in the 1980s Sullivan realised that there was a link between Fatou–Julia theory and the theory of Kleinian groups – and specifically established a dictionary between the theories. By these means Sullivan proved a long-standing conjecture of Fatou on wandering domains and thereby ignited a new activity in the theory of iterations of rational functions.

The present monograph defines its goal to present the main tools that are relevant to these developments. Here it is necessary to pause and stress the nature of the book. The key word in the title is 'mathematical'. This text is aimed at 'graduate students and researchers working in dynamical systems and related fields'. Such students will, however, have their sights on exploring the mathematical nature of the dynamics. The 'tools' of the book's title include the Ahlfors–Bers theorem and a theorem on the extensions and quasi-conformality of holomorphic motions. These tools are deployed to examine, for example, the structural stability of rational maps. The take-home message is that this is not a book on mathematical methods which could be easily adopted by the many workers in the disparate areas of physics, engineering and the social and life sciences who have an interest in dynamical systems. It is emphasised that the authors explicitly signal that their text is 'for the study of complex dynamics at an advanced level'. With that caveat attention is now turned to the benefits which will accrue to the intended readership of this book.

The book is defined as being self-contained. Necessarily, however, in order to meet its goal of treating 'the very latest research' in a compact text the authors need to assume reasonable familiarity with basic complex analysis. In order to ensure that the reader is at the correct starting place a brief summary of expected knowledge is provided. Having broached those topics the book sets to work in a traditional mathematical way via theorems and lemmas to establish the mathematical machinery required for this study. Many of the chapters contain examples to illustrate the topics under consideration.

A pleasing feature of all the book chapters and indeed the book's appendix is the inclusion of exercises by which readers can check the progress of their understanding of the material The authors set themselves an aim of providing 'at least one interesting dynamical application for each tool presented' but admit that in this respect 'it was not possible to be systematic'.

Overall this is a well-structured monograph which will well serve the needs of workers wishing to get themselves to the cutting edge of mathematical analysis of complex dynamics.

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Quantum Computing for Computer Scientists, N.S. Yanofsky and M.A. Manucci, Cambridge, Cambridge University Press, 2008, 384 pp., £38.00 (hardback), ISBN 978 0 521 87996 5. Scope: textbook. Level: undergraduate.

I have taught for several years an undergraduate course on Information Theory and Coding in which some reference is made to the promised impact of quantum computers. For a while I have been considering whether there was a practical way in which to explain more precisely why quantum algorithms pose a threat to classical cryptography. Nielsen and Chuang's authoritative *Quantum Computation and Quantum Information*, although entirely fit for its purpose, would not be within the scope of the electronic engineering and computer science undergraduates who form my target audience. Yanofsky and Manucci have now given me an opportunity to bridge the gap between classical and quantum information in a way which I consider will be digestible by the students with whom I interact.

Quantum Computing for Computer Scientists is explicitly designed to be accessible to students with limited mathematical background and essentially zero quantum physics background. The use of many solved problems ensures that the reader grasps the mathematical essentials needed to grasp the deep concepts explained in the book. The text is peppered by exercises for the reader with answers to selected exercises being provided. Further material is available at a website on which the authors aim to provide periodic updates to the book as well as to note identified errata. With its aim of bringing computer scientists into the quantum world the book also includes many programming exercises. Students are thereby offered an opportunity to become pioneering quantum programmers. The authors have given careful thought to how the book can be used in a practical pedagogical setting and offer suggestions of different pathways through the material in order to meet a range of requirements. In a word this is a well-structured text which deserves careful consideration from instructors not only engaged with computer science teaching but also those in physics and electronic engineering.

One must express some admiration for the authors' courage in seeking to map such a fast-moving and burgeoning research area as quantum information into an undergraduate textbook. Clearly the key to the approach is a careful treatment of the fundamentals and that in turn has led to the self-contained nature of the book. A key decision has been to include basic material in the opening chapters of the book rather than relegating that to an appendix. In this way students who need to get up to speed in such material are sent a strong positive signal that this area of activity is one in which they can become immersed. Having made the decision to provide a pathway to the main features of quantum computing it is inevitable that some selectivity must be applied in the choice of topics to be treated. Moreover, in a number of places they have adopted a sensible approach where some mathematical detail is omitted in favour of making practicalities more explicit. The authors list a number of topics which they have omitted from the book including 'the latest hardware implementations'. On the other hand, they devote a chapter to hardware implementations and some speculation about future trends. As such the reader is made well aware of the challenges and opportunities in quantum computing.

If quantum computing is to realise its potential then there will be a need for an increasing number of scientists who can construct and operate quantum computers. This book will go a long way to helping develop future generations of quantum programmers.

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Three Steps to the Universe, D. Garfinkle and R. Garfinkle, Chicago, University of Chicago Press, 2008, 263 pp., $25.00 (hardback), ISBN13 978 0 226 28346 3, ISBN10 0 226 28346 1. Scope: introductory. Level: general reader and undergraduate.

All good bookshops have several shelves labelled 'Popular Science'. This book deserves to stand out in such company. For a rounded appraisal of a book aimed at the general public, the reviewer has sought advice from a non-scientist with an interest in science and a physics undergraduate (a family operation, as is the book itself).

The table of contents looks routine. There are three major sections: the first on the Sun, the second on black holes, the third entitled 'Dark Matter – Dark Energy'. What distinguishes the treatment is the concentration on process rather than on results and theory. This involves the division of the discussion of each section into three 'universes': what we perceive via our senses, what we detect via instrumentation and what we take as the theoretical underpinning of our perception and detection. The process of science then rests on experimentation in the perceived and detected universe to test the theoretical universe.

The section on the Sun, for example, begins with a discussion of human perception of the Sun's properties always attached to the question 'How do we know that?' and brief descriptions of the experiments which give results for the Sun's size, temperature and mass. The experiments which led to the identification of the Sun's constituents and the process of nuclear fusion are similarly discussed in sufficient detail to be comprehensible without a huge overload of theory.

The second and longest section is somewhat misleadingly titled 'Black Holes'. It starts with an approachable discussion of relativity then goes on to the life and death of stars culminating in discussion of gravitational waves and their (putative) detection.

'Dark Matter – Dark Energy' gives a good and clear explanation of the need to postulate the existence of dark matter and a run-through possible candidates for the job. The short section on dark energy is not so successful; this is perhaps to be expected, given the major debates over the properties and even the existence of dark energy.

Two final chapters have the aim of bringing the discussion back to earth: a brief outline of the way in which atomic physics builds into chemistry slides into a discussion of biological sciences. And finally a cautionary chapter on the uses and abuses of popular science is well worth reading. There is no index, but a glossary of scientific terms used in the text is probably quite adequate. The list of suggestions for further reading is brief and rather disappointing.

There are a few minor errors of compression. For example, a discussion of the solar neutrino problem omits any mention of the role of the Super Kamiokande experiments. The writing style is conversational, even jokey, and might be seen as too informal by readers expecting a 'textbook' presentation or the 'descent from Mount Sinai' approach of some popularisers. There is no reliance on sophisticated graphics – the diagrams look endearingly homemade.

In general, this book can be thoroughly recommended to non-scientists who want to know what scientists are really about, and to beginners in the trade. Teachers of high school physics may well find some of the explanations and examples useful.

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