The New Quantum Age: From Bell's Theorem to Quantum Computation and Teleportation FREE

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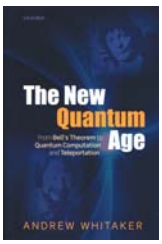
This book is an ode to science and the importance it holds today more than ever. It reminds us that the pursuit of science gives us the joy to wonder about and find answers to the mysteries of the universe, but also provides us with the tools needed to address future societal challenges. *The Universe Within* invites other scientists to move out of their shells and participate more actively in this endeavor. It is an excellent and inspiring read.

The New Quantum Age

From Bell's Theorem to Quantum Computation and Teleportation

Andrew Whitaker
Oxford U. Press, New York, 2012.
$45.00 (394 pp.).
ISBN 978-0-19-958913-5

Subtitles seem to be mandatory for popular science books, and the subtitle of *The New Quantum Age* tells us it covers topics "From Bell's Theorem to Quantum Computation and Teleportation." If I were in a position to suggest an edit to the subtitle, I would add "…but Mostly Bell's Theorem." The book provides a concise introduction to quantum mechanics and quantum information and gives an in-depth look at the history and science of the Bell inequalities. Author Andrew Whitaker shows his hand when he introduces John Bell as "undoubtedly the main hero of this book." Although some other scientists appearing in the book are also labelled heroes, none gets quite as enthusiastic an endorsement, and none receives more than a fraction of the attention that Whitaker lavishes on Bell and his work.



The New Quantum Age is divided into three parts. Part 1, titled "The First Quantum Age," gives a careful introduction to quantum mechanics as it was understood in the 1930s and culminates with a discussion of the famous 1935 Einstein-Podolsky-Rosen (EPR) paper. Part 3, "An Introduction to Quantum Information Theory," gives a quick but dated overview of the basic results in the field of quantum information processing, including quantum computation. Sandwiched between the two and occupying more than half the book, part 2 is entitled "The Foundations of Quantum Theory," but actually it is mostly about hidden variables and John Bell. Whitaker does offer a brief summary of non-hidden-variable approaches to quantum mechanics, but it is half-hearted. For instance, he devotes the same amount of space, roughly three pages, to the much more accepted many-worlds interpretation as he does to the fringe view that a local hidden-variable approach may still be possible.

The first two parts rise to a much higher standard of technical correctness than one normally finds in a popular book on quantum mechanics. Admittedly, that is not a high standard at all, but someone who thoroughly reads the first two parts of this book will have a pretty good lay understanding of the subject. Parts 1 and 2 have a number of typos and some statements I disagree with—inevitable, I think, in a book that talks seriously about interpretations of quantum mechanics—but I found nothing substantially incorrect.

The book's accuracy comes with a price, as the technical parts can be tough going for a novice. The author eschews some of the usual tropes of popular science writing; in particular, his book is almost completely devoid of analogies. Personally, I am not that fond of analogies when explaining quantum mechanics, since they are invariably misleading in one way or another, but a few well-chosen ones can liven things up.

The author indulges in a good deal of philosophical hair-splitting. Some of it, such as the distinction between parameter independence and outcome independence, is helpful for understanding the material; some, such as the author's insistence that the EPR paper was correct, is not. Also, the book is littered with formulas, mostly state vectors written as kets. Although perhaps sometimes abstract, none of the math in the book is in other respects more difficult than addition, but a reader unwilling or unable to parse statements containing mathematical symbols will not get far.

Unfortunately, part 3 is not as reliable as the first two parts. It contains several errors, mostly small but a few more significant. For instance, in the discussion on private-key cryptography, the author appears to confuse the one-time pad with DES, a now-retired private-key encryption protocol. The one-time pad is completely secure, independent of how much computer power the eavesdropper Eve can throw at the problem, so long as the sender Alice and the receiver Bob use a secret key that is as long as the message and is not reused. By contrast, DES can be broken with a concerted computational effort by Eve. Outdated portions in this section include the discussion of how to build a quantum computer.

The New Quantum Age fits into an unusual niche. It provides an exceptionally detailed look at the physics and the historical development of the notion that hidden classical variables underlie quantum indeterminacy, and it also carefully examines the major theoretical and experimental results bearing on it. And it does this at a level completely accessible to a layperson, albeit one who is willing to work to attain understanding. For someone interested in other interpretations of quantum mechanics or wishing to learn about quantum computation, this is not the place to go. But for those interested in hidden variable theories, *The New Quantum Age* provides an authoritative introduction.

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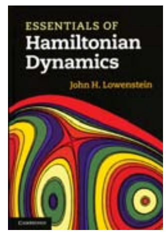
Essentials of Hamiltonian Dynamics

John H. Lowenstein
Cambridge U. Press, New York, 2012.
$60.00 (188 pp.).
ISBN 978-1-107-00520-4

If two people are teaching separate courses on Hamiltonian dynamics, there is a good chance that the classes will be completely different. A course for mathematicians will be quite different from one for physicists; an introductory course will be different from one for advanced students. Also, the instructor's selection of topics will usually reflect his or her personal taste.

The choice of a textbook certainly depends on a course's aim and style. For a course aimed at students who intend to study the internal structure of Hamiltonian dynamics rather than to use it for applications, one good option is Vladimir Arnold's *Mathematical Methods of Classical Mechanics* (2nd edition, Springer, 2010). For students looking for tools to attack problems in celestial mechanics, there's the useful text by Kenneth Meyer, Glen Hall, and Dan Offin, *Introduction to Hamiltonian Dynamical Systems and the* N*-Body Problem* (2nd edition, Springer, 2010).



John Lowenstein's *Essentials of Hamiltonian Dynamics* will be particularly helpful for physics instructors. The ideal reader for this book is a graduate physics student who has already been exposed to the Lagrangian and Hamiltonian formulations of classical mechanics, has a basic knowledge of the theory of dynamical systems, and now needs sufficient familiarity with Hamiltonian dynamics to apply its methods and results to specific models and systems.

The introductory chapter is a review of the fundamentals of classical mechanics; it introduces the notion of configuration space as a differential manifold, briefly covers the Lagrangian and Hamiltonian formulations, and works through some basic examples. Chapter 2 introduces the Hamiltonian formalism. Chapter 3 defines integrable systems; considers several examples, including the spherical pendulum and the three-particle Toda model; and formulates the Liouville–Arnold theorem and gives an idea of its proof. The basics of canonical perturbation theory are described in chapter 4. Then in chapter 5,