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Nonclassical Physics: Beyond Newton's View

Randy Harris
Addison-Wesley, Menlo Park, Calif., 1999. 608 pp. \$95.00 hc
ISBN 0-201-83436-7

By calling his book *Nonclassical Physics: Beyond Newton's View*, Randy Harris avoids the term "modern physics." This is not a bad idea, since the term refers to physics developed mostly in the first half of the 20th century. Nevertheless, this is a textbook intended for the traditional undergraduate modern-physics course.

Harris begins his book with a lengthy chapter on relativity. He then examines wave-particle duality, with one chapter on light behaving as particles and another on particles behaving as waves. The heart of the book is four chapters of conventional introduction to Schrödinger's wave mechanics, with applications to atomic physics. Then, after a chapter on statistical mechanics, he concludes with chapters on solid-state physics, nuclear physics, and fundamental particles and interactions.

A text on modern physics has several tasks to perform. It should introduce students to phenomena and experiments that inspired the creation of quantum mechanics. It should also stimulate student interest in contemporary physics and show its impact on present-day technology. Because of a widespread sense that it is urgent for students to become familiar with quantum theory early in the undergraduate curriculum, a text on modern physics increasingly has to

introduce the concepts and formalism of quantum mechanics. This means students need to deal with complex numbers and the solution of ordinary and partial differential equations earlier than they ordinarily would. They also need to explore in a thoughtful way the strange consequences of linearity and superposition.

How successful is this book at these tasks? It does a creditable job of introducing basic quantum mechanics up through the solution of the Schrödinger equation for the hydrogen atom. The treatment of a particle interacting

with various step and barrier potentials struck me as particularly clear and direct. But the author's claim that his book supplies the necessary math (mostly in an appendix) is unconvincing. Students with whom I deal go glassy-eyed unless some considerable time is spent accustoming them to complex exponentials, the harmonic oscillator differential equation, and separation of variables.

The book needs to give more attention to important concepts of quantum mechanics. Although there are explanations of why the wavefunction is

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complex, of what is the basis of the uncertainty principle, and of "what really causes quantization," I think a student will come away from this book without a clear concept of a quantum state and the significance of superposition. Some of the discussions of "matter waves" seem likely to mislead students to think of the wavefunction as an actual physical wave.

Phenomena such as x rays, the photoelectric effect, electron diffraction, and radioactivity are presented with remarkably little experimental detail. This approach removes the juice from the physics and gives the students dry husks. Too often "experiment tells us" is all the justification we are offered. Students will get no feeling of the texture of physics from this book.

Maybe Harris limits experimental detail in order to keep the book to a reasonable size. Perhaps this is also why several descriptions and explanations are vague and compressed to the point where I found myself wondering, "What will a novice student make of this?" But a lack of sympathy for specifics suffuses the book. The explanation of the Davisson-Germer experiment, along with the introduction of Bragg scattering and multi-slit diffraction, is an example. (It does not help that the angles describing these are the complements of those usually used.) Lack of detail also weakens the "Progress and Applications" sections that link the physics of the chapter to interesting current applications and mysteries.

The book is attractively designed. Its layout is clean and easy to follow. There are some first-printing glitches, such as the misspelling of Karl Schwarzschild's name; an occasional bad problem (of the 30 problems that I chose randomly and worked, two seemed incorrectly posed and one answer in the back of the book was wrong); and some typos (one of these makes cosmic rays into high energy photons instead of protons). One could live with these, but the larger deficiencies I have described make this an unsatisfactory book.

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