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Quantum Mechanics: Classical Results, Modern Systems, and Visualized Examples and Quantum Mechanics: Fundamentals and Applications to Technology

Richard W. Robinett, Jasprit Singh, and Suzanne Amador

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a reader who expects to find quick solutions to statistical problems may be disappointed. Equations are usually presented without derivation or justification. There is very little computer code and few sample applications of suggested techniques. It was clearly not the authors' intent to create a "Numerical Recipes for Astronomers." What the reader will find are descriptions of many current types of observations, with suggested methods for analysis, useful equations for better-known techniques and many references to relevant statistical material and to sources of software packages.

This book should prove to be a valuable handbook and guide for astronomers and astrophysicists. I trust that they will not be put off by the authors' criticism of their presumed lack of statistical expertise. Experimentalists in many fields could benefit from closer interactions with statisticians.

D. KEITH ROBINSON

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Quantum Mechanics: Classical Results, Modern Systems, and Visualized Examples

Richard W. Robinett
Oxford U. P., New York, 1997.
580 pp. \$65.00 hc
ISBN 0-19-509202-3

Quantum Mechanics: Fundamentals and Applications to Technology

Jaspri Singh
Wiley, New York, 1997. 505 pp.
\$64.95 hc ISBN 0-471-15758-9

The authors of two new quantum physics texts have worked hard at relating the topics covered in a standard course to truly modern applications. The first of these texts, Richard W. Robinett's *Quantum Mechanics: Classical Results, Modern Systems, and Visualized Examples*, can boast among its many strengths the "visualized examples" of the title: numerous plots showing data from important experiments and numerical calculations, the time evolution of wavepackets and interesting functional forms. Robinett uses problems from condensed matter, surface, nuclear, particle and atomic physics to illustrate the relevance of model systems. Throughout, he makes extensive use of comparisons between the

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quantum and classical probability distributions. These enriching additions are overlaid on an excellently written, comprehensive treatment of quantum physics fundamentals.

Robinett provides introductory chapters that develop such background topics as classical waves, Fourier transforms and probability. He also studies the one-dimensional infinite well in sufficient mathematical depth to make possible its use as a model system for studying such topics as

time-evolution, parity and many-particle solutions. He then moves on to a treatment of one-dimensional potentials, covering not only the finite well and the simple harmonic oscillator but delta-function potentials, uniformly accelerating particles and "half"-potential wells. The discussion of one-dimensional scattering solutions is supplemented by interesting sections on field emission, scanning tunneling microscopy and alpha decay. The chapter on approximation methods treats WKB

approximations and perturbation theory, but also covers numerical integration and Monte Carlo computations.

My favorite part of the book is the chapter on two-dimensional problems, including the quantum corral and quantum chaos. Students can more easily comprehend and visualize the effect of angular momentum in two dimensions, so this section makes a fine warm-up to the final, exhaustive treatment of the Schrödinger equation in three dimensions.

Each chapter ends with an especially rich and novel selection of problems at varying levels of difficulty. These require a mixture of analytical solutions, graphical analysis and the occasional computer project. Appendices address mathematical background topics, such as special functions, linear algebra and group theory. For a first edition, there are very few typographical errors in either the main text or the problems.

While I regret the lack of accompanying computer software and the absence of a discussion of Bell's theorem and decoherence, these omissions are understandable, given the inherent constraints on the standard quantum mechanics course. Students already well-grounded in such topics as special functions, the operator formalism and angular momentum will be comfortable with Robinett's concise treatment of such material, although those who have taken only a less-mathematical modern physics course will find the pace challenging. I definitely would choose Robinett's book as a main textbook, and I highly recommend it for the physics libraries.

Jasprit Singh's *Quantum Mechanics: Fundamentals and Applications to Technology* is aimed at the graduate quantum mechanics audience. Throughout, examples and exercises are chosen to emphasize problems of technological relevance. Singh has tried to produce a text that is applied enough to appeal to engineers while still rigorous enough for the standard physics graduate sequence. However, the work's success at achieving this difficult balance is mixed.

The book opens with a chapter on rudimentary historical background and then goes on to explain in great detail the connections between classical and quantum mechanics—a curious emphasis, given the primarily applied science audience. Many of the standard topics in one-dimensional quantum mechanics are next discussed and related to problems in solid-state physics. Spherically symmetric potentials are developed, but with an eye to applications in semiconductors rather than the usual discussion of atomic systems;

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angular momentum is discussed in depth in a separate chapter on symmetries. There is a brief discussion of particle statistics and second quantization, but no relativistic quantum mechanics. Two chapters on approximation methods cover most of the usual material, with interesting sections on the origins of van der Waals interactions, excitons and other applications.

While the selection of material covered is quite good, I found the pedagogy in these early chapters lacking. All too often, the discussion of basic material feels rushed, and the author's interest seems to lie with the more applied and advanced material to come. This text probably would be heavy going for the average graduate student and confusing for the student with weak preparation.

Specifically, I found the development of many important basic concepts erratic and confusing. Fundamental topics are often introduced without adequate explanation, including Fourier transforms, the uncertainty principle, boundary conditions, state vectors and stationary states. For example, basis sets are introduced and used several pages before they are defined fully; students must wait even longer to learn about geometrical analogies or the importance of energy eigenfunctions. The unclear description of the variational method could easily leave the student confused about whether the trial wavefunctions used are already eigenfunctions of the Hamiltonian.

Basic concepts such as band structure and effective mass, as well as the physics of semiconductor devices, are not adequately explained for the intended audience. As a result, many of the applied problems following each chapter will be very difficult for first-year graduate students. In general, the emphasis on complicated problems from solid state rather than on standard exercises in basic quantum mechanics makes for an overly difficult first encounter with the subject. Also, a significant number of typographical errors and related problems were apparent on a first reading, including confusing mathematical notation, which often does not discriminate between vectors, scalars and operators.

While I would not recommend this book as a text, readers will find many interesting sections on device physics and topics in solid state, with actual numbers provided for mapping basic exercises in quantum mechanics onto problems of technological interest.

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96971-0 *hc* (0-471-96972-9 *pb*)

High-Sensitivity Radio Astronomy. Cambridge Contemporary Astrophysics. Proc. Mtg., Manchester, England, Jan. 1996. N. Jackson, R. J. Davis, eds. Cambridge U. P., New York, 1997. 303 pp. \$69.95 *hc* ISBN 0-521-57350-5

An Introduction to Active Galactic Nuclei. B. M. Peterson. Cambridge U. P., New York, 1997. 238 pp. \$69.95 *hc* (\$27.95 *pb*) ISBN 0-521-47348-9 *hc* (0-521-47911-8 *pb*)

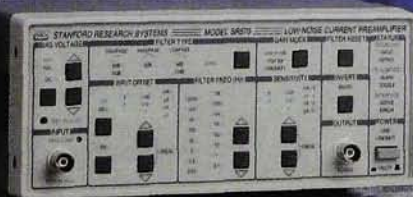
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