

page on the World Wide Web (<http://www.haverford.edu/physics-as-tro/Roelofs/Roelofs.html>).

Vibrations and waves and their applications to mechanical waves, sound and optics are important in their own right in the physics curriculum. However, a course covering these topics can also prepare students for the mathematics they will encounter in upper-level courses, especially the complex exponential function, the eigenvalue problem and Fourier analysis. The study of classical waves also lowers some of the barriers for students when, later, they take their first courses in quantum mechanics. The course at Haverford is built around these general objectives.

In that context, *Vibrations and Waves*, despite its several attractive features, is not the choice for me. Gough and his coauthors treat the coupled vibrator problem quantitatively for two particles only, and the treatment is not put into the general context of eigenanalysis. (This failing also precludes the elegant segue from  $N$  coupled oscillators to waves on a massive string using the large  $N$  limit.) The book also does not support our mathematical course objectives in that it solves the differential equation for the single oscillator—with and without damping—without use of the complex exponential function. Another drawback is that some key applications, especially sound and waves on strings, are not discussed until the penultimate chapter; their integration into the earlier mathematical presentation of wave motion would improve a student's development of intuition. A final important concern is that there are not enough exercises in some of the chapters.

It is becoming more common for textbooks in this field to include demonstration programs. The 1983 edition of *Vibrations and Waves* included programs as lists rather than on diskette. The seven programs on the diskette that comes with the second edition will run only on IBM-compatible platforms. But they do allow user control and are simple in design and use. They are not overly glitzy; students will not confuse them with video games. The authors have made sensible choices of what to demonstrate, although the soliton simulation does not succeed because of numerical instabilities. I would fault the demonstration programs only in that there are no end-of-chapter exercises requiring their use; these are necessary, in my experience, to get students to engage fully with computational demonstrations. (Instructors wishing to incorporate a substantial simulation and demonstration component into a waves course should con-

sider as a supplemental text *Waves and Optics Simulations*, by Wolfgang Christian and others (Wiley, 1995).

*Vibrations and Waves* is mostly well and clearly written, although American students may find some of the Britishisms puzzling: treacle for molasses, the anachronistic gramophone and pulchance for angular frequency, to list a few. Although on topical grounds *Vibrations and Waves* is not the choice for my course, its applications and simulations have enriched and informed my teaching.

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## Reasoning About Luck: Probability and Its Uses in Physics

Vinay Ambegaokar  
Cambridge U. P., New York, 1996.  
247 pp. \$59.95 hc (\$19.95 pb)  
ISBN 0-521-44217-6  
(0-521-44737-2 pb)

Many physicists bemoan the public's ignorance of physics. Few invest time to consider what the public should know about physics. Vinay Ambegaokar has selected the basics of probability and its physical consequences as the key to public understanding—and as the basis of *Reasoning About Luck*, which he wrote as a text for a one-semester course for liberal-arts students. Beginning with basic statistics and Newton's laws, he relates the molecular model of matter to macroscopic thermodynamics. He then discusses the direction of time and introduces chaos and quantum mechanics, basing the discussion on the fundamental principles of statistics and probability that he introduced at the beginning of the book.

Ambegaokar has correctly identified a major area of public ignorance: No one regularly exposed to television and the other popular media can escape the proliferation of junk physics based on ignorance of the role of statistics in understanding the physical world. Chaos, thermal fluctuations and quantum mechanics are routinely used to justify phenomena ranging from psychic healing to ghosts. If students who are not majoring in science understood no more physics than that presented by Ambegaokar, they would have a solid basis for thinking about physics and the other sciences, as well as practice in constructing logical arguments.

*Reasoning About Luck* uses no mathematics beyond basic algebra and geometry. It is unusually well written, and the author's dry sense of humor

considerably increased my pleasure in reading it. Examples early in the book range from baseball to planning a lobster dinner. At the end, the same basic ideas are used to discuss such ideas as why macroscopic events are not reversible in time even though they are based on physical laws that are completely time-reversible. The solved problems at the ends of the chapters provide a profusion of interesting paper-and-pencil activities. Unsolved problems would also have been helpful.

Although I thoroughly enjoyed reading this slim volume, I do not think that the typical student in a freshman physics course for nonscientists would find it equally appealing. The mathematics is well explained and basically simple, and the physical arguments are elegant and clearly presented. However, most freshmen have never tried to think this way and would need more guidance than is provided here.

While unsuitable for a general liberal-arts physics course, *Reasoning About Luck* would be a superb choice for an upper-division honors seminar aimed at students from all the sciences or as supplementary reading in an undergraduate course in modern physics. Many senior-year physics students become adept at solving problems in thermodynamics without understanding the statistical basis of the subject. Ambegaokar's well-written, mathematically simple treatment would clearly benefit them. It is comparable to Richard Feynman's *The Character of Physical Law* (MIT Press, 1965), also aimed at liberal-arts students but very good reading as well for senior physics majors.

In thinking carefully about the minimum knowledge of physics that an educated citizen should have, Ambegaokar has made a real contribution to the discussion. In addition, he has produced a thoroughly enjoyable physics book.

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## Cellular Biophysics

Thomas F. Weiss  
Vol. 1: Transport  
MIT P., Cambridge, Mass., 1996.  
693 pp. \$50.00 hc  
ISBN 0-262-23183-2

Vol. 2: Electrical Properties  
MIT P., Cambridge, Mass., 1996.  
557 pp. \$45.00 hc  
ISBN 0-262-23184-0

Available as a set for \$85.00

Physicists are often at a loss to know how to tackle the study of biological systems. If you are interested in learning where physics interfaces with cel-

lular biology, then a good place to start is with these *Cellular Biophysics* volumes by Thomas Fischer Weiss, who is Thomas and Gerd Perkins Professor of Electrical and Bioelectrical Engineering at MIT. Weiss proposes that the cell membrane is "where all the action is." So he bases the texts on four questions: "Which molecules are transported across cellular membrane and what are the mechanisms of transport? How do cells maintain their composition, volume and membrane potential? How are potentials generated across the membranes of cells? What do these potentials do?" Answering these questions allows the author to teach about cells in a physical way.

He divides the material into transport (volume 1) and electrical properties (volume 2). The course these books delineate has been designed for one semester and, in one form or another, has been taught to bioengineering undergraduates at MIT since 1966. There are exercises and problems for each chapter and a companion reference (*Journal of Science Education and Technology*, 1992 1:259–274) that describes the use of computers in the course.

*Transport* covers membranes and solvent-, solute- and carrier-mediated transport, ion transport, resting potentials, diffusion and cellular homeostasis. *Electrical Properties* introduces the electrical characteristics of cells, the Hodgkin-Huxley model of nerve conduction, saltatory conduction and voltage-gated ion channels. The biological language barrier is scaled with an introduction to each chapter that leads the reader through relevant biological questions and definitions. For example, the chapter that introduces osmotic pressure asks the reader to consider transport in a mangrove tree: The roots of the tree reach into seawater, but the water the tree transports to its upper branches should have a low concentration of salt. Chapter 1 in Volume 2, "Introduction to Electrical Properties of Cells," contains an accolade to the giant axon of the squid. The first two chapters in Volume 1 are a concise introduction to cellular biology.

A primary focus is the experimental history of each topic. In addition, there are lots of data and background papers and enough descriptive biochemistry to excite the reader about the living world. Each chapter contains extensive mathematical development of the appropriate transport theory, which requires a knowledge of calculus—especially differential equations. The course will be difficult for students who do not have excellent preparation in static electricity and a rudimentary knowledge of circuits.

These texts are a departure from

standard biophysics and cellular biology texts. I wish they had been available when I started working in biological physics. Questions about concepts and ideas, which intruded on my learning, are anticipated by the author at exactly the places a physicist would raise these questions, and they are answered in a manner that makes assimilation easy. Cell biologists organize information differently than physicists do, but in order to understand cellular biology, physicists need to leap into biologists' constructs. For many, such a leap constitutes a near-drowning. Weiss has assembled a life raft.

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## An Introduction to High-Performance Scientific Computing

Lloyd D. Fosdick, Elizabeth R. Jessup, Carolyn J. C. Schauble and Gitta Domik  
MIT P., Cambridge, Mass., 1996.  
750 pp. \$55.00 hc  
ISBN 0-262-06181-3

Calculation is certainly an indispensable part of the work that one does in physics, and whether one is extracting quantitative results from theory or performing analysis of data from experiment, the computer represents an essential tool. With calculational tasks in many areas of science and engineering increasing in complexity—as more realistic world models are used, for instance—the need to introduce students to advanced computational techniques becomes ever more important. The authors of *An Introduction to High-Performance Scientific Computing*—Lloyd Fosdick, Elizabeth Jessup, Carolyn Schauble and Gitta Domik—have taken up the challenge of developing materials to introduce concepts of high-performance computing to undergraduates in science and engineering.

The book is an outgrowth of a National Science Foundation grant received by the authors for the development of a laboratory-based undergraduate course on scientific computing, a two-semester course for students majoring in areas other than computer science. To make up for deficiencies such students might bring to the course, a sizable portion of the book is devoted to topics such as the use of the Unix operating system and its various utilities and to introductory topics in numerical analysis. Likewise, a chapter on the elements of FORTRAN is included, giving the students some

background in the language that continues to be the lingua franca of scientific computing (even though it is no longer a mainstream language in computer science). In keeping with the authors' avowed hands-on approach to the subject, tutorials on Matlab, IDL (Interactive Data Language) and AVS (Application Visualization System) are also to be found within the central part of the book.

A relatively large section of the book is rightly devoted to topics involving special-purpose architectures for high-performance computers. Topics such as pipelining, vector processing, SIMD (Single Instruction, Multiple Data) and MIMD (Multiple Instruction, Multiple Data) machines, performance measures and other related concepts are clearly discussed. The section on SIMD computing includes simple but useful examples of FORTRAN codes that implement some of the parallel constructs used with such machines. The material in this section is similar to that in texts such as *High Performance Computing* by Kevin Dowd (O'Reilly & Associates, 1993), *Designing and Building Parallel Programs* by Ian Foster (Addison-Wesley, 1995) and *Parallel Programming—An Introduction* by Thomas Brauml (Prentice Hall, 1993).

The latter part of the book deals with applications, namely molecular dynamics, advection (atmospheric horizontal wind flow) and computerized tomography, and I found these discussions particularly interesting. Here the authors present very clearly written expositions on the computational fundamentals of these topics. From an instructional point of view, the chapter on molecular dynamics is especially appropriate for physics students. Multiple particle collisions are treated according to three models for the interparticle force—a Hooke's-law model, a model based on the Lennard-Jones potential and the hard-sphere model. The discussion of the equations of motion is thorough and provides the student with the information needed to solve the equations computationally using any one of the force models.

All in all, the material in the book is well written and easy to read. However, the lack of questions or problems at the ends of chapters is a drawback if one is to use the book as a stand-alone text (although project assignments for the course are available via anonymous ftp from the authors, and some questions are interspersed in the text). I was surprised to find the GOTO statement mentioned in the section on FORTRAN, and was shocked to see it actually used in example code: Such examples harken back several decades,