

cases, dimensional considerations, and approximation methods as opposed to formal mathematics, which more often than not is irrelevant to fundamental understanding. With the fundamentals that the book instills, a beginning graduate student will have an easy transition to the detailed, professional atomic physics literature.

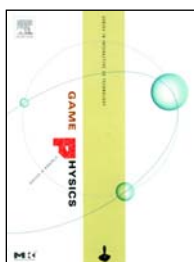
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Game Physics

David H. Eberly

Morgan Kaufmann / Elsevier, San Francisco, 2004. \$69.95 (776 pp.). ISBN 1-55860-740-4, CD-ROM



Although computer graphics researchers have long made reference to physical principles, only recently has physics assumed a prominent place in graphics textbooks. Increases in processor power now make it

feasible to run complex physical simulations in real time, which greatly increases their practical importance. Thus there is an increasing need for books like David Eberly's *Game Physics* that can give graphics programmers a grounding in the physical principles that underlie realistic computer animation. The standard computer graphics textbook is the second edition of *Computer Graphics: Principles and Practice* (Addison-Wesley, 1995), written for programming in C, by James Foley, Andries van Dam, Steven Feiner, and John Hughes; that book, in contrast, makes only passing reference to physics-based simulation. Eberly has worked on physics engines (that is, software packages that calculate the dynamics of physical systems) that have been incorporated into some popular game titles and has written other game-engine texts, so he has the appropriate background for writing such a book.

At the heart of most modern physics engines is a simulation of the dynamics of rigid bodies. In the typical approach, the programmer determines the mass of each body in the system, identifies the forces and torques applied to each body, uses differential equations to specify the changes in position and orientation of the bodies in accordance with Newtonian dynamics, and then uses a numerical differential equation solver to compute the motion over time. In the case of bodies collid-

ing, the engine must determine exactly when and where the collision occurs so that the dynamics of the collisions can be properly modeled.

Before presenting these simulation algorithms, Eberly covers the underlying classical mechanics in some depth. He shows how Lagrangian dynamics and Euler's equations can be used to model the motion of bodies under constraints, and analyzes a number of examples of such systems. Unfortunately, Eberly must present a lot of physics before the reader gets to any algorithms for computing motion. As I read the physics exposition, I found myself reaching for the CD that is included in the book to get a better sense of how the physics was actually going to be used.

There are still limits to how far one can go with physical simulations on commodity game hardware. It is difficult to model the dynamics of deformable bodies in real time, and programmers must resort to various tricks that are not physically based but give the impression of realism. For example, one can squash and stretch objects to give the appearance of elastic deformations during collisions. Although such techniques are necessary, Eberly's presentation of them seems out of place in a book that otherwise places such a heavy emphasis on physical principles. In any case, the techniques that Eberly describes do not yield very convincing results.

In other parts of the book, Eberly could have included more physics, not less. For example, the physics of illumination and reflection is increasingly important for games. Eberly describes techniques using common graphics cards to achieve various shading effects but explains the underlying physics only briefly. Nothing is wrong with that approach, but it is a surprising contrast to Eberly's in-depth treatment of rigid-body dynamics.

The book's organization makes it difficult to read from cover to cover. The mathematics and numerical analysis required to understand the physics simulations are appended at the end. Granted, it is hard to predict what material a given reader will need to review when approaching a topic such as this, but I think Eberly could have done a better job. For instance, the chapter on rigid-body simulation makes passing reference to quaternions, a famously difficult topic in computer graphics. The author's brief mention of the mathematics makes it necessary for the reader to skip ahead to the chapter dealing with that topic.

The figures in the book suffer from a number of problems. They lack realism and visual appeal, which is always a concern for a computer graphics text. A few renderings from commercial games that employ physics-based techniques would have helped illustrate the descriptions. Many of the images are difficult to make out in black and white. Moreover, the illustrations are not always consistent with the text that they accompany.

For readers who are more concerned with the basic practicalities of physics-engine programming, an alternative is *Physics for Game Developers* (O'Reilly, 2001), by David M. Bourg. Overall, *Game Physics* contains useful reference material for game-engine developers, but readers are likely to pick and choose the parts of the book that are of interest to them.

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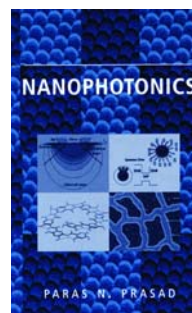
Nanophotonics

Paras N. Prasad

Wiley, Hoboken, NJ, 2004. \$84.95 (415 pp.). ISBN 0-471-64988-0

Paras Prasad has once again produced an invaluable reference source related to photonics. *Nanophotonics* maintains the tradition of his earlier books, *Introduction to Biophotonics* (Wiley, 2003) and *Introduction to Nonlinear Optical Effects in Molecules and Polymers* (Wiley, 1991). Like Prasad's previous texts, *Nanophotonics* is aimed at advanced undergraduates and graduates studying chemistry, physics, molecular biology, and biochemistry, as well as various engineering disciplines.

I, as have many chemistry and physics faculty members, have used Prasad's books as key references for graduate courses, including the new nanotechnology graduate course "Frontiers in Nanotechnology" at the University of Washington in Seattle. All of the Prasad texts are excellent in introducing key concepts and mathematical derivations of key equations. In particular, Prasad's treatment of basic concepts such as electrons and photons is comprehensible and attractive to students. The crucial importance of nanoscopic confinement of both electrons and photons is emphasized early in *Nanophotonics*. The



relevance of such confinement to both the real (index of refraction phenomena) and imaginary (absorption and emission phenomena) components of linear and nonlinear optical susceptibilities quickly becomes apparent to various practical applications of photonics.

As always, Prasad does an excellent job of explaining excited-state dynamics, the interplay of the radiation field, and material-dependent relaxation processes. He also has an exceptional knowledge of both inorganic and organic materials, and *Nanophotonics* provides a balanced coverage of all materials classes. Moreover, his texts have always been timely: *Nanophotonics* is no exception. Topics of the greatest current interest, ranging from photonic bandgap materials to sensors based on surface plasmon resonance, are well covered. Prasad also has a very broad understanding of specific materials topics, such as dendrimers, phase-separating block copolymers, micelles, inorganic nanocomposites, and metal nanoparticles. The subjects are treated at a greater depth and with greater insight than is commonly found in a reference text. Also, the final chapter gives a surprisingly detailed analysis

of marketplace applications of nanophotonics. In addition to being an excellent educational resource, the book will be an excellent reference text for industrial scientists.

Nanophotonics has 14 chapters with such titles as Near-Field Interactions and Microscopy, Plasmonics, Nanostructured Molecular Architectures, and Nanophotonics for Biotechnology and Nanomedicine. The titles are self-explanatory and illustrate the scope of the text. Although the subjects are at times amazingly disparate, Prasad does an excellent job of presenting them as a unified body of knowledge. His texts characteristically have an excellent reference list at the end of each chapter, and *Nanophotonics* maintains that tradition. The reader will not only be seduced into considering new topics in the field but will also be encouraged by the references to explore those topics in great depth. In summary, *Nanophotonics* is an indispensable reference text for anyone endeavoring to learn or teach photonics, particularly as it relates to materials with nanoscopic order.

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New Books

Astronomy and Astrophysics

Annual Review of Astronomy and Astrophysics. Vol. 42. G. Burbidge, R. Blandford, A. Sandage, eds. Annual Reviews, Palo Alto, CA, 2004. \$84.00 (763 pp.). ISBN 0-8243-0942-1

Clusters of Galaxies: Probes of Cosmological Structure and Galaxy Evolution. J. S. Mulchaey, A. Dressler, A. Oemler, eds. *Carnegie Observatories Astrophysics Series 3*. Cambridge U. Press, New York, 2004. \$130.00 (381 pp.). ISBN 0-521-75577-8

The Magnetic Universe: Geophysical and Astrophysical Dynamo Theory. G. Rüdiger, R. Hollerbach. Wiley-VCH, Weinheim, Germany, 2004. \$155.00 (332 pp.). ISBN 3-527-40409-0

The New Amateur Astronomer. M. Mobberley. *Patrick Moore's Practical Astronomy Series*. Springer-Verlag, New York, 2004. \$34.95 paper (229 pp.). ISBN 1-85233-663-3

Origin and Evolution of the Elements. A. McWilliam, M. Rauch, eds. *Carnegie Observatories Astrophysics Series 4*. Cambridge U. Press, New York, 2004. \$130.00 (496 pp.). ISBN 0-521-75578-6

Star Formation at High Angular Resolution. M. G. Burton, R. Jayawardhana, T. L. Bourke, eds. *International Astronomical*

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