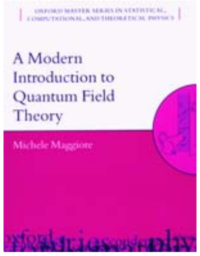

and special relativity, is one of the great intellectual edifices of the latter half of the 20th century. It is the language of modern particle physics. It has also become an essential part of the theoretical tool kit of condensed matter theorists and has found fruitful applications in diverse other fields.

But few undergraduates ever get exposed to quantum field theory, despite its importance to modern theoretical physics. More or less universally, it is offered only as a graduate course. That is a pity. No one expects in an undergraduate-level course to be able to treat such an admittedly difficult subject in the same depth as one would in a graduate course. Yet that limitation has not stopped instructors from teaching undergraduate quantum mechanics alongside the more thorough graduate course. We would consider an undergraduate education in physics incomplete without at least one course in quantum mechanics.

Other difficult subjects, such as general relativity, are routinely offered as undergraduate courses in many institutions. Even string theory now has an undergraduate text, *A First Course in String Theory* (Cambridge U. Press, 2004), by Barton Zwiebach, based on his MIT course for seniors (see the review by Marcelo Gleiser, PHYSICS TODAY, September 2005, page 57). But no undergraduate text on quantum field theory had existed—until now. So I welcome Michele Maggiore's *A Modern Introduction to Quantum Field Theory*. In 291 pages he introduces the basics of perturbative quantum field theory, the renormalization group, gauge theories, and the standard model.

Graduate texts, such as Michael Peskin and Daniel Schroeder's *An Introduction to Quantum Field Theory* (Addison-Wesley, 1995) or Steven Weinberg's *The Quantum Theory of Fields* (Cambridge U. Press, 1995–2000), are too advanced for an undergraduate course. Many physicists think that Weinberg's two-volume opus on quantum field theory is too expansive, even for a standard full-year graduate course. Anthony Zee's *Quantum Field Theory in a Nutshell* (Princeton U. Press, 2003) is written at the right level for undergraduates but is not focused enough to serve as a good undergraduate textbook (see the review by Zvi Bern, PHYSICS TODAY, April 2004, page 88).

Obviously, many topics essential to the working field theorist are omitted in Maggiore's book. He develops the rudiments of scattering theory, the LSZ reduction formula, and tree-level cross sections and decay rates. Loop amplitudes are discussed qualitatively, but none of the technical machinery—for instance, the Feynman-parameter trick for combining denominators—necessary for actual computations is developed. The author gives a nice conceptual discussion of divergences in loop amplitudes, the need to renormalize, and how both lead to the modern picture of the renormalization group, but most of the nitty-gritty of renormalization theory is omitted. When he finally arrives at non-abelian gauge theories, he does not discuss the necessity of gauge fixing and the introduction of ghosts.

For the most part, the simplifications that Maggiore makes are innocuous; he manages to convey the main ideas without getting lost in technical details. But occasionally the simplifications get in the way of understanding. For instance, in discussing Goldstone's theorem, Maggiore breezily asserts that the generator of the spontaneously broken symmetry does not annihilate the vacuum and hence generates another state of the same energy. I think his assertion may leave the reader with a serious misapprehension that there is some big Hilbert space with a continuous degeneracy of states. In fact, although the charge density does exist as an operator, the global charge—the generator of the symmetry—does not. The vacua, which would have been related by the action of the generator, are in fact states in different Hilbert spaces.

All in all, Maggiore's approach is precisely the one that should be taken in an undergraduate course: Introduce the "big" ideas and leave the computational and thornier technical details for subsequent courses. Toward the end, the book contains a brief discussion of critical phenomena and concludes with an introduction to spontaneous symmetry breaking, the Higgs mechanism, and the standard model—all the bases one would hope to cover in a one-year course in quantum field theory.

Will Maggiore's text find a place in the undergraduate physics curriculum? I don't know. For the most part, we physicists are terribly conservative about our undergraduate curricula. The most ambitious undergraduates at the best institutions take refuge in graduate courses, which is not altogether a bad thing. But the act is not the same as our delivering challenging undergraduate courses worthy of students' attention.

Whatever its role in the undergraduate curriculum, Maggiore's text would benefit another audience: graduate students who are working to become high-energy experimentalists. They really do need to learn a smattering of quantum field theory, if only to be able to communicate effectively with their theorist colleagues. For most experimentalists, a course on the level of Peskin and Schroeder's book would be too heavy-duty. Consequently, most seem to shy away from tackling a course in quantum field theory. A course based on Maggiore's text would be much more suitable than the standard graduate course geared toward theorists. Throw a little more particle physics into its content, and the book would make for an excellent course for high-energy experimentalists. With any luck, such a course will become the norm.

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Death Rays, Jet Packs, Stunts and Supercars: The Fantastic Physics of Film's Most Celebrated Secret Agent

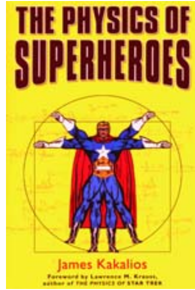
Barry Parker
Johns Hopkins U. Press, Baltimore, MD, 2005. $25.00 (231 pp.). ISBN 0-8018-8248-6

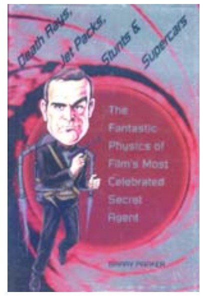
The Physics of Superheroes

James Kakalios
Gotham Books, New York, 2005. $26.00 (365 pp.). ISBN 1-592-40146-5

Following the enormous success of Lawrence Krauss's *The Physics of Star Trek* (Basic Books, 1995), we now have several attempts to take advantage of the surprisingly large market he discovered. Just fill in the blank: *"The Physics of ___,"* and one expects to have a winner. It sounds easy, but it isn't.

I frequently cite popular-culture images in my own introductory class, "Physics for Future Presidents," at the University of California at Berkeley. Thus I looked with eager anticipation to two new books—Barry Parker's *Death Rays, Jet Packs, Stunts and Supercars: The Fantastic Physics of Film's Most Celebrated Secret Agent* and James Kakalios's *The*





Physics of Superheroes. I was terribly disappointed.

The worst one is the book about Bond—James Bond—by Parker, a professor emeritus of physics at Idaho State University. The text drifts from merely annoying to sloppy. For example, he assumes every reader has a vivid memory of every moment of every Bond movie, and his ski-jump figure doesn't correspond to his text. The book also ranges from irrelevant to misleading to historically inaccurate to just plain wrong. Parker introduces a discussion on lasers by discussing Maxwell's equations and then never uses them; he implies that phase sensitivity is essential to three-dimensional perception; he wrongly asserts that Albert Einstein's $E = mc^2$ played a major role in the invention of the atomic bomb; and his description of nuclear weapons shows that he never read Richard Rhodes's excellent *The Making of the Atomic Bomb* (Simon & Schuster, 1986). Almost every page of Parker's book is seriously defective.

Kakalios's *The Physics of Superheroes* is better, but he is up against an impossible problem. Most science-fiction movies make a reasonable attempt at obeying physics, with a notable exception being Paramount Picture's *The Core*, but comic books make no attempt at all. Kakalios, a professor of physics at the University of Minnesota, Minneapolis, teaches a freshman seminar with the attractive name "Everything I Needed to Know About Physics I Learned from Comic Books." But his book shows that the seminar's catchy title is a gross exaggeration. Most of what superheroes do in comic books cannot be made compatible with physics. Kakalios hardly tries to reconcile the science fiction of comics with physics. Instead, he describes the powers of comic-book superheroes and uses those traits as an opportunity to launch into interesting physics. So, for example, a superhero who can walk through walls is used as an excuse to discuss quantum mechanical tunneling. But Kakalios's fundamental conclusion, which is correct, is that the hero's abilities are totally incompatible with quantum mechanics.

The author offers an interesting discussion of the historical development of some of the superheroes. For example, for the first year of Superman's comic-book existence, he couldn't fly; he could only "leap tall buildings in a single bound" as a consequence of his strength. Kakalios uses Superman's leaping ability to do some elementary physics calculations.

The beauty of physics is well hidden in both books. Parker writes down lots of equations, but he just pulls them out of the air, with no explanation or derivation or relationship to anything else. Kakalios offers virtually no equations, except for a one-dimensional version of the Schrödinger equation, apparently placed among the superhero images just to offer some mathematical dazzle. The contents of the books read like the sophomoric discussions by physics students who are making fun of comic books or Bond movies, and who are trying to show their wit and erudition. I can't figure out who would like the books. There are some nice moments, but they are too far apart to make them worth reading. I doubt that any reader of PHYSICS TODAY would enjoy either book, and I strongly advise against giving them as presents to either children or adult fans of comic books or James Bond—and I am a fan of both.

Krauss, author of the *Star Trek* book, wrote a foreword to Kakalios's book. He cleverly managed to write nearly two pages without endorsing it, other than calling it "far-reaching." He talked instead about the joy he has found in comic books. *The Physics of Superheroes* and *Death Rays, Jet Packs, Stunts and Supercars* are nowhere near the standard he has set. I give the books a thumbs-down—with both hands. If you want to give those who love reading about the science of science fiction a present, give them *The Physics of Star Trek*, still the best of its genre.

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Sculptured Thin Films: Nanoengineered Morphology and Optics

Akhlesh Lakhtakia
and Russell Messier
SPIE Press, Bellingham, WA, 2005. $75.00 (299 pp.). ISBN 0-8194-5606-3

The title of *Sculptured Thin Films: Nanoengineered Morphology and Optics*, by Akhlesh Lakhtakia and