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Books

Quantum Field Theory in a Nutshell

A. Zee

*Princeton U. Press, Princeton, NJ, 2003. \$49.50 (518 pp.).
ISBN 0-691-01019-6*

When writing a book on a subject in which a number of distinguished texts already exist, any would-be author should ask the following key question: What new perspectives can I offer that are not already covered elsewhere? Clearly, Anthony Zee thought the question through carefully. But perhaps foremost in his mind was

how to make *Quantum Field Theory in a Nutshell* as much fun as possible. His game plan is to arrive at the neatest and most elegant field theory as quickly as possible without getting bogged down in formalism. Zee's book is written in the colloquial style of a good blackboard lecture, with gems of wisdom and amusing but relevant anecdotes scattered throughout. Zee has an infectious enthusiasm and a remarkable talent for slicing through technical mumbo jumbo to arrive at the heart of a problem. *Quantum Field Theory in a Nutshell* is quite simply a triumph. I have not had this much fun with a physics book since reading *The Feynman Lectures on Physics* (Addison-Wesley, 1963).

The book, weighing in at more than 500 pages, is perhaps more aptly called a coconut shell than a nutshell, as Zee acknowledges. Squeezed into its pages is a broad range of topics drawn from quantum electrodynamics, gravity, renormalization, symmetry breaking, collective phenomena, condensed matter physics, grand unification, and even a taste of supersymmetry and string theory. Each chapter, however, does fit into a nutshell as advertised.

The author starts with a brilliantly intuitive introduction to the Feynman path integral, after which gravity is introduced. By introducing the basic notions of the brane-world picture of the universe, Zee needs only 40 pages to bring the reader to the frontier of current research. Then, by page 80, the basics of Feynman diagrams, the Casimir force, Noether's theorem, and the more advanced topic of quantum field theory in curved spacetime are covered. From there on, the pace only quickens, sweeping through more topics than can possibly be mentioned in a short review. Throughout the book, the viewpoint is thoroughly modern, with open problems and exciting areas of current research highlighted.

In a certain sense, the book is easy to criticize. Why is a particular topic not covered, or why is it presented only superficially? However, such criticism completely misses the point: The purpose of Zee's book is not to turn students into experts--it is to make them fall in love with the subject. And Zee succeeds brilliantly. Moreover, there is nothing superficial about the depth of understanding or the choice of topics in Zee's book. The author speaks with the clarity and authority that come only from a leading practitioner in the field.

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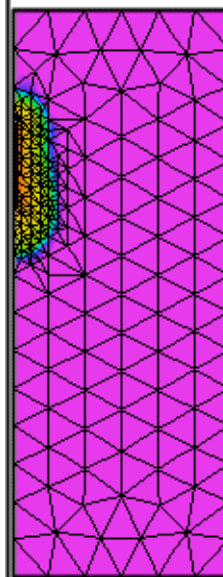
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Take, for instance, Zee's treatment of asymptotic freedom in quantum chromodynamics. This crucial property of non-abelian gauge theories led to quantum chromodynamics being widely accepted by physicists as the theory of strong nuclear interactions. I firmly believe that every student of quantum field theory needs to become intimately familiar with the ins and outs of the calculation leading to this profound result. The book, however, relegates the key calculation to a footnote pointing to Steven Weinberg's magnum opus, *The Quantum Theory of Fields* (Cambridge U. Press, 1995–2000). But this is precisely the way Zee's book should be. Why include a somewhat lengthy computation that is well described elsewhere? One calculation of this sort is all it takes to burst the nutshell and shatter the book's wonderful form.

As another example, Zee hardly discusses particle scattering cross sections. But here one should consult Michael Peskin and Daniel Schroeder's *An Introduction to Quantum Field Theory* (Addison-Wesley, 1995), which is by now standard text on field theory from the particle physics viewpoint. Dozens of similar examples can be found throughout Zee's book.

Although the book focuses mainly on particle physics, Zee rightfully believes that the usual separation between condensed matter and particle quantum field theory is somewhat artificial. What better way to illustrate his view than with a set of problems in condensed matter physics that are elegantly solved using quantum field theory? The chapters on condensed matter physics are chock-full of fascinating topics, including fractional statistics and quantum Hall fluids.

Zee's book does not replace other, more formal texts on quantum field theory, such as Weinberg's or Peskin and Schroeder's books, but it is one that no student of quantum field theory should be without. *Quantum Field Theory in a Nutshell* is the ideal book for a graduate student to curl up with after having completed a course on quantum mechanics. But, mainly, it is for anyone who wishes to experience the sheer beauty and elegance of quantum field theory.

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