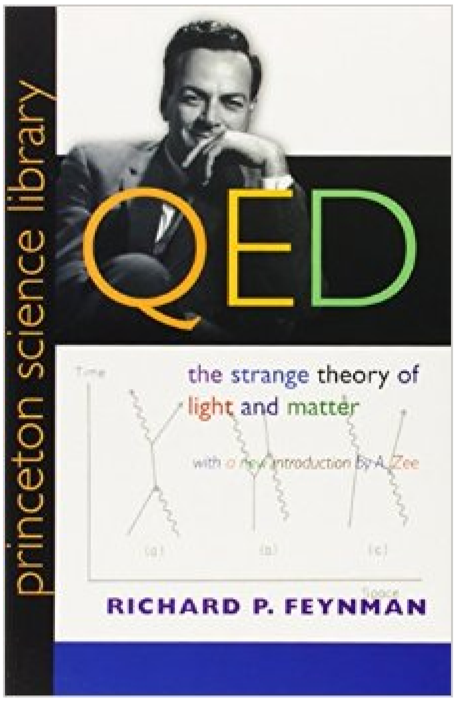
QED: The Strange Theory Of Light And Matter



Synopsis

Celebrated for his brilliantly quirky insights into the physical world, Nobel laureate Richard Feynman also possessed an extraordinary talent for explaining difficult concepts to the general public. Here Feynman provides a classic and definitive introduction to QED (namely, quantum electrodynamics), that part of quantum field theory describing the interactions of light with charged particles. Using everyday language, spatial concepts, visualizations, and his renowned "Feynman diagrams" instead of advanced mathematics, Feynman clearly and humorously communicates both the substance and spirit of QED to the layperson. A. Zee's introduction places Feynman's book and his seminal contribution to QED in historical context and further highlights Feynman's uniquely appealing and illuminating style.

Book Information

Paperback: 192 pages

Publisher: Princeton University Press (April 24, 2006)

Language: English

ISBN-10: 0691125759

ISBN-13: 978-0691125756

Product Dimensions: 8.4 x 5.5 x 0.6 inches

Shipping Weight: 4 ounces

Average Customer Review: 4.6 out of 5 starsÂ Â See all reviewsÂ (188 customer reviews)

Best Sellers Rank: #363,536 in Books (See Top 100 in Books) #114 inÂ Books > Science & Math > Physics > Optics #179 inÂ Books > Science & Math > Physics > Nuclear Physics #309 inÂ Books > Science & Math > Physics > Quantum Theory

Customer Reviews

Caveat - Be sure to read Professor Zee's introduction as well as Feynman's introduction before you read the rest of the book. More about this at the end of this review.In my opinion this is one of the best of Feynman's introductory physics books. He does close to the impossible by explaining the rudimentary ideas of Quantum Electro Dynamics (QED) in a manner that is reasonably accessible to those with some physics background. He explains Feynman diagrams and shows why light is partially reflected from a glass, how it is transmitted through the glass, how it interacts with the electrons in the glass and many more things. This is done via his arrows and the rules for their rotation, addition and multiplication.One reviewer has criticized this book because Feynman does not actually show how to determine the length of the arrows (the square of which is the probability of the action being considered occurring) and the how you determine their proper rotation. True, but as is stated in Feynman's introduction, this was never the intention of the book. If you want to learn how to create the arrows used in a Feynman diagram and use them to solve even the most rudimentary problem, you have to major in physics as an undergraduate, do well enough to get into a theoretical physics graduate program and then stick with the program until the second year, when you will take elementary QED. You will then have to take even more classes before you can solve harder problems. Clearly, it is not possible to do all this in a 150-page book aimed at a general audience. He does, however, give the reader a clear indication of what these calculations are like, even if you are not actually given enough information to perform one on your own. Feynman is fair enough not to hide the difficulties involved in actually computing things. He briefly discusses the process of renormalization (that he admits is not mathematically legitimate), which is required to get answers that agreed with experimental data and the difficulties in determining the coupling constants that are also required. In the end, he admits that there is no mathematically rigorous support for QED. Its virtue lies in the fact that it provides the correct answers, even if the approach to getting them involve a bit of hocus-pocus (again his words).The last 20 pages of the book show how the approaches used in QED, as strange as they are, were used to create an analogous approach for determining what goes on in the nucleus of an atom. This short section shows complexity of nuclear physics and the role that QED has played in trying to unify a baffling plethora of experimental data. Unfortunately, this last section is largely out of date and is hopelessly complicated. Fortunately, it is only 20 pages long.As mentioned in the beginning of this review, you should read Zee's introduction as well as Feynman's, before you get into the rest of the book. Zee puts QED into proper perspective. Along with wave and matrix mechanics, the Dirac-Feynman path integral method that is described in this book is another approach to quantum mechanics. Zee also points out that while it is a very powerful approach for many problems, it is unworkable for others that are easily solved by wave or matrix mechanics. Feynman's introduction is very important because he emphatically states that photons and electrons are particles and that the idea of their also being waves stems from the idea that many features of their behavior could be explained by assuming that they were waves. He shows that you can explain these effects using QED, without having to assume that they are waves. This eliminates the many paradoxes that are created when one assumes that photons and electrons exhibit dual, wave/particle behavior. QED is not, however, without its own complications. Some of this behavior depends upon the frequency of the photon or electron. Frequency is generally thought of as a wave property, but it can also be thought of a just a parameter that defined the energy of the photon or electron. This is a fundamental idea separating

QED from wave based quantum theories. Feynman does not try to speculate why photons and electrons obey the rules of QED because he does not know why, nor does anyone else and we probably are incapable of knowing why. He is completely satisfied that his calculations agree with experimental data to a degree that is unsurpassed by any other theoretical physics calculation.I would recommend this book to anyone who is interested in getting an idea of what QED is all about and to those who seek a deeper understanding of physical phenomena. You will learn how QED explains many things, some of which from the basis for the paradoxes discussed at length in books such as "In search of Schrodinger's cat". Reading this book is a good antidote for the head spinning paradoxes described in that book. Feynman believes that they stem from using a poor analogy (that of waves) to explain the behavior of particles. As far as the deeper questions of why photons and electrons obey the ruled of QED, he does not care, so long as he can get the right answer. This may therefore not be the book for you if you are interested in this deepest WHY, but it definitely is if you want to know more about Feynman's powerful approach to quantum mechanics.

This book covers four lectures that explains QED in terms of the path integral method, which was developed by the author. Needless to say, this is authoritative on this approach, but it also remarkably clear and comprehensible. Notwithstanding that, I would recommend slow and careful reading, as you may find a small sequence of statements that seem perhaps a little unjustified. Later, Feynman fronts up to some of these, and explains why he oversimplified to get things going. If you see them first, and this is not unreasonable, I believe you will get more from the text. The first lecture is a general introduction that shows how the path of the photon as a particle can be followed in terms of time-of-flight from all possible paths. The assertion is, the photon is a particle, not a wave, however there is no explanation for why there is a term that I would call the phase. The second lecture is a tour-de force and explains in terms of this particle treatment, why light reflects and diffracts, and is particularly interesting in why light behaves as if it is reflected only from the front and back of glass, whereas it is actually scattered by electrons throughout the glass. The third lecture covers electron-photon interactions, and covers Feynman diagrams and shows why QED is the most accurate theory ever proposed. The fourth lecture may seem a bit of a disappointment. The author tries to cover a very wide range of phenomena, which he terms "loose ends", and in some ways this chapter has been overtaken somewhat, nevertheless it also gives a look into Feynman's mind, and that also is well worth the price of the book. It is also here that the issue of renormalization is discussed - if you could call Feynman admitting it is "a dippy procedure" a discussion.Why buy the book? I suspect this is probably the best chance a non-specialist has of understanding the basis of QED. The biggest disappointment? Feynman dismisses wave theory, which everybody else uses, and replaces it with a monumental raft of integrals. My initial thoughts were that waves are effectively an analogue way of solving those integrals, perhaps a gift from nature, and it is a pity I can't ask Feynman why that option was dismissed.