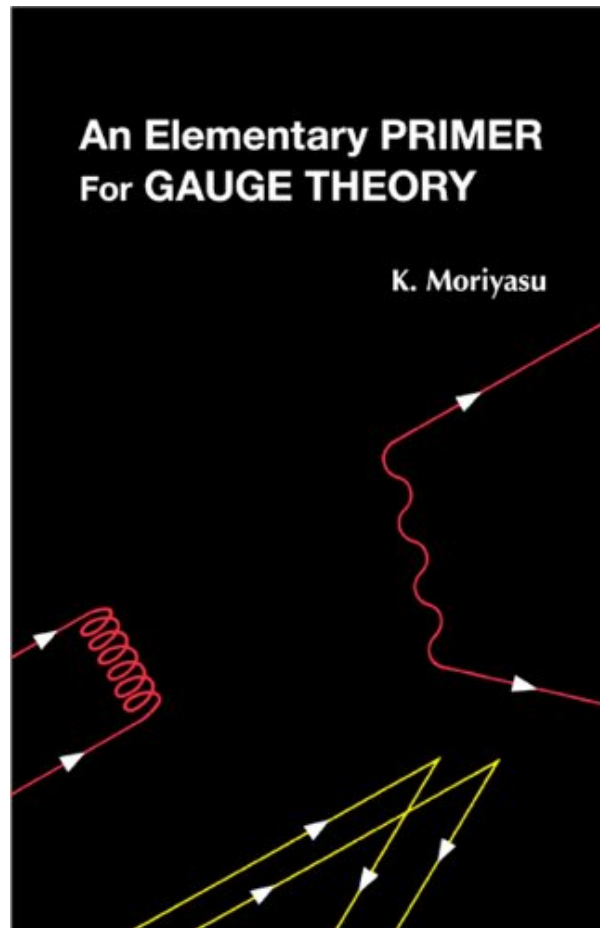


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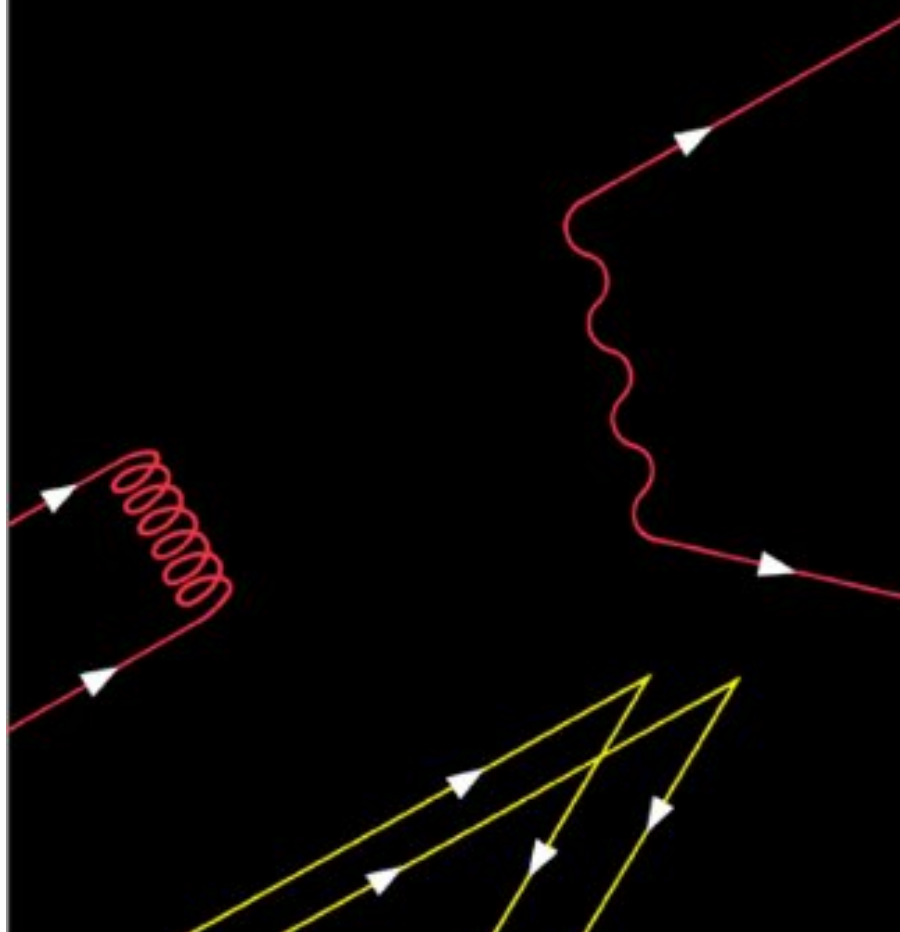


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Review

“This is a first-rate entry to the subject ... It is a deal deeper than the wordy analogies and parables that must suffice for the usual popular accounts.” Scientific American, USA

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Gauge theory is now recognized as one of the most revolutionary discoveries in physics since the development of quantum mechanics. This primer explains how and why gauge theory has dramatically changed our view of the fundamental forces of nature. The text is designed for the non-specialist. A new, intuitive approach is used to make the ideas of gauge theory accessible to both scientists and students with only a background in quantum mechanics. Emphasis is placed on the physics rather than the formalism. Contents:

- Introduction
- The Einstein Connection
- Weyl's Gauge Theory
- The Aharonov-Bohm Effect
- Isospin and the New Gauge Theory
- Yang-Mills Gauge Theory
- Maxwell Equations in Gauge Theory
- Leptons and Quarks
- The Weak Interaction
- The Dark Age of Field Theory
- Symmetry Breaking in Gauge Theory
- The Superconductor Analogy
- Weinberg-Salam Unified Theory
- Unification and Renormalization
- Color Gauge Theory
- Asymptotic Freedom and the Running Coupling Constant
- Topology in Gauge Theory
- Flux Trapping and Vortices
- Dirac Magnetic Monopole
- Appendix on Key Concepts in Group Theory

Readership: Students and researchers in high energy physics and mathematical physics.

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- Published on: 1983-10-01
- Released on: 1983-10-01
- Format: Kindle eBook

Review

“This is a first-rate entry to the subject ... It is a deal deeper than the wordy analogies and parables that must

suffice for the usual popular accounts.” Scientific American, USA

Most helpful customer reviews

9 of 10 people found the following review helpful.

Outstanding on Kindle, Don't Hesitate!

By Let's Compare Options Preptorial

There are 6 top books written on gauge theory today, including a brand new one from the pioneer in the field (Quigg, see below) for \$70 US, and a great little Dover edition for under \$12 (Gauge Theory and Variational Principles (Dover Books on Physics)). None, however, give as intuitive and quasi-mathematical a description of the importance of gauge theory in unifying particle physics as this little gem.

On top of that, this is the ONLY one of the bunch that works well on Kindle! The reason isn't that the publisher has some e-reader magic that everyone else forgot about, it is that the author avoids many of the complex differential equations, matrix calculus, tensors, etc. needed to correctly explain this representational system mathematically (in general), and where he does use partial differential equations, they are the tiny "mice type" versions that don't break in the middle of a page. Indeed, the author uses analogies and descriptions, plus geometry, much like the famous Feynman "clocks," which allowed intelligent non physicists to understand QED at a level previously reserved for those with years of graduate work in physics and math. Even so, the PDE's that ARE given are daunting (see level considerations in last two paragraphs below).

I say this even though I'm an applied mathematician. Even if you intend to study gauge math (God bless you) at some point, this little pony will truly help you get there with the verbal adjuncts to the math. There are minimal (and only tiny) LaTeX equation systems to be slaughtered on e-readers (and the English descriptions fill them in well), so don't hesitate to save money by picking it up on Kindle.

Obviously the Hadron collider, Higgs, etc. have greatly updated gauge theory, but not to the detriment of this book. The foundations are all here, and date to pre-1960 (60-80 in the case of the foundations and Weyl, leading up to Yang-Mills, which itself dates back to 1954), and this great little text will give you the intuitive foundation to fill in on more recent discoveries. Even if you are buying the latest and greatest by the master himself (Quigg) for almost \$70 (Gauge Theories of the Strong, Weak, and Electromagnetic Interactions: Second Edition), this little volume on Kindle, at a fraction of the price, will help you get through grad-level expositions like Quigg with much more facility. Highly recommended, including for intelligent lay readers and advanced HS students.

I've read all the best selling books on gauge available, and used a number of them to teach classes in applied math, and this ranks at the top for clarity, despite the missing and newer equations and adjustments to the theory based on more recent new particle attribute discoveries.

Level warning: Some reviews have pegged this at "intelligent layman/ advanced High School." Huh? Are we talking about China or Germany? I tutor AP HS and beginning undergrad kids in calc, and know very few who study partial differential equations before Junior year UNDERGRAD. For example, Gauge indifference is "intuitively" related to Einstein linking time-space to geometric curvature, via gauge vectors, but you still need to get the basics of relativity (at a pde/tensor level) AND QED to understand the equations this author uses. The value is that even if you skip the equations, he takes the time to give geometric analogies and explain, in English, what the equations mean at a "gist" level. Laplacians and Lagrangians are a must at some point before translating to the higher math also.

Intelligent layfolk: The best exposition of gauge theory for a layman I've found that does NOT require good

differential equation skills is Schumm: *Deep Down Things: The Breathtaking Beauty of Particle Physics*. He does a marvelous job of relating $SU(N)$ groups to the Standard Model in general, and puts everything in the bigger context of why we even care about field invariance between models and unobservables/ measurables.

34 of 43 people found the following review helpful.

Pre W- and Z-boson book

By Dr. Lee D. Carlson

Although published in 1983, this book predates the discoveries made at CERN of the intermediate vector bosons. This discovery coupled with the discovery of weak neutral currents more than a decade before, solidified the role of gauge theories in providing a unified theory of elementary particle interactions. The author does a fine job of introducing the history of gauge theory, and also its conceptual foundations, emphasizing the physics, and not the mathematical formalism.

In the book, the Einstein theory of gravitation is explained, naturally, as the first successful gauge theory, the local coordinates of which can be defined as the gravitational field. This, the author explains, motivated H. Weyl to generalize this to one of the other forces of nature, namely electromagnetism. Weyl needed a quantity that would transform like the electromagnetic potential under changes of position. For this he chose to assert that the norm of a physical vector should depend on position (i.e. a change of "scale"), and thus to compare lengths at different places in space-time one needs a connection. This connection did transform like a vector potential and thus gave Weyl what he needed. His theory was rejected however by Einstein and Bergmann, and many others. The soundest of their objections was based on an argument from quantum theory, namely that a natural scale involving the particle's wavelength is characteristic of the quantum theory, and the wavelength is dependent on mass, which cannot depend on position.

The author also overviews the role of gauge invariance in the Hamilton-Jacobi formulation of electromagnetic theory. The inclusion of this discussion is rare in books and articles written on gauge theory at the time of this one (or before), but it does serve to motivate nicely the place that gauge invariance holds in the quantum theory of electromagnetism. In this context, the Aharonov-Bohm effect is discussed, and asserted to be proven experimentally. This is a controversial assertion however, and the one can say without any mental reservations that after a thorough study of the literature on the experiments studying this effect, that they are inconclusive as of this date.

In addition, the author discusses the reasons that gauge invariance took so long to be accepted by the physical community. In the quantum realm, one of these reasons, he argues, is due to the fact that gauge transformations were related to the phase of the wavefunction, and not to coordinates in space-time. The latter geometric view was thus missing from the concept of gauge invariance in quantum physics. In addition, the gauge group did not seem to play a role in the dynamics of the quantum theory, it merely being a sort of ancillary property that had no predictive power.

Such beliefs ended of course with the rise of Yang-Mills theories, but the road to acceptance of Yang-Mills gauge theories was not a smooth one. It took many years before the non-renormalizability of these theories was worked out. In the meantime, mathematicians were becoming more attracted to the study of gauge theories, and the formulation of gauge theories from a mathematically rigorous point of view was gaining major advances, excluding the path integral quantization of these theories, which to this date, has defied a mathematically rigorous treatment. The author details well the development of gauge theories from the paper of Yang-Mills, up until the time of the book's publication. The Weinberg-Salam theory and its triumph in the prediction of neutral currents is outlined, and a brief introduction is given to quantum chromodynamics, the gauge theory of the strong interaction. The Weinberg-Salam theory was further solidified in the early eighties due to the experimental evidence for intermediate vector bosons.

That gauge theories are successful in predicting elementary particle phenomena has now become a cliché. There is still of course an enormous amount of work to be done, particularly from the standpoint of the calculation of quantities in low-energy strong-interaction physics, and the prediction of bound states using quantum gauge field theories. Superstring and M-theories have supplanted a lot of the research in gauge

theories, this research also involving the mathematical community to a large degree. Indeed, Weyl, Einstein, Yang, and Mills would no doubt be astonished at the level of mathematics now being used in these theories. The mathematical constructions used in their theories was considered esoteric at the time, but it pales in comparison to the dizzying heights that mathematics has been taking in superstring and M-theories. These developments are very exciting and one can probably say with a fair degree of confidence that the role of gauge theory will remain in research in high energy physics in the 21st century.

1 of 2 people found the following review helpful.

Good Primer

By Isn't it obvious

This is a very good book for someone just getting started in Gauge Theory. Although a more modern edition should be issued, since a lot has happened since 1983.

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“This is a first-rate entry to the subject ... It is a deal deeper than the wordy analogies and parables that must suffice for the usual popular accounts.” *Scientific American*, USA

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