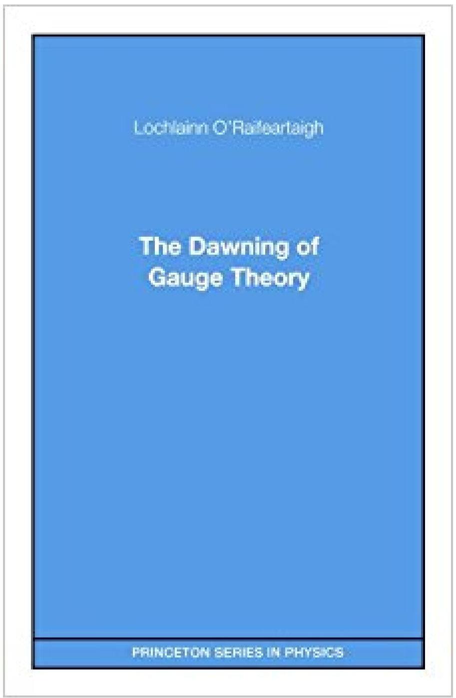
# The Dawning Of Gauge Theory



## Synopsis

During the course of this century, gauge invariance has slowly emerged from being an incidental symmetry of electromagnetism to being a fundamental geometrical principle underlying the four known fundamental physical interactions. The development has been in two stages. In the first stage (1916-1956) the geometrical significance of gauge-invariance gradually came to be appreciated and the original abelian gauge-invariance of electromagnetism was generalized to non-abelian gauge invariance. In the second stage (1960-1975) it was found that, contrary to first appearances, the non-abelian gauge-theories provided exactly the framework that was needed to describe the nuclear interactions (both weak and strong) and thus provided a universal framework for describing all known fundamental interactions. In this work, Lochlainn O'Raifeartaigh describes the former phase. O'Raifeartaigh first illustrates how gravitational theory and quantum mechanics played crucial roles in the reassessment of gauge theory as a geometric principle and as a framework for describing both electromagnetism and gravitation. He then describes how the abelian electromagnetic gauge-theory was generalized to its present non-abelian form. The development is illustrated by including a selection of relevant articles, many of them appearing here for the first time in English, notably by Weyl, Schrodinger, Klein, and London in the pre-war years, and by Pauli, Shaw, Yang-Mills, and Utiyama after the war. The articles illustrate that the reassessment of gauge-theory, due in a large measure to Weyl, constituted a major philosophical as well as technical advance.

## Book Information

Series: Princeton Series in Physics

Paperback: 272 pages

Publisher: Princeton University Press (May 5, 1997)

Language: English

ISBN-10: 0691029776

ISBN-13: 978-0691029771

Product Dimensions: 6 x 0.6 x 9.2 inches

Shipping Weight: 10.4 ounces (View shipping rates and policies)

Average Customer Review: 3.3 out of 5 stars 5 customer reviews

Best Sellers Rank: #2,459,417 in Books (See Top 100 in Books) #74 inÃ Â Books > Engineering & Transportation > Engineering > Aerospace > Gas Dynamics #343 inÃ Â Books > Science & Math > Physics > Applied #496 inÃ Â Books > Science & Math > Physics > Waves & Wave Mechanics

## Customer Reviews

"The book thus performs a double service: it offers a rewarding description of the development of the gauge symmetry idea that is complete even without the original papers, and it makes those original papers readily accessible to physicists and mathematicians. . . . This book represents an important contribution to the history of fundamental ideas in physics."--American Journal of Physics

Lochlainn O'Raifeartaigh is Senior Professor at the Dublin Institute for Advanced Studies, where he teaches courses in Quantum Field Theory and Particle Physics. He is the author of Group-Structure of Gauge Theory.

Once thought of as merely a mathematical curiosity, the concept of gauge invariance now plays the dominant role in theoretical particle physics. Gauge invariance is not a really difficult concept in which to understand, but it does have some hidden subtleties that can seem rather obscure in the context of modern quantum field theories. The reader of this book will walk away with a deeper appreciation of the history of gauge invariance, due to the inclusion of original articles written by some of the early contributors to the theory. These contributions were attempts to generalize Einstein's theory of gravitation, and, just as in that theory, made use of concepts from differential geometry. Ideas from the mathematical theory of groups were also used, setting the stage for later developments in particle physics. One can only wonder of course what these individuals would have thought about modern theories of gravitation and particle interactions, making use of highly esoteric and complex mathematical constructions. Their thinking at the time was itself thought of as very exotic, but it pales in comparison with the level of abstraction that now permeates elementary particle physics in the language of superstring and M-theory. The author has written additional papers on the history of gauge theory,which can easily be found via an online search, and this book could be considered an excellent introduction to them. He addresses more modern developments in gauge theories as they relate to the early history, such as superstring theory. Readers who study this book, will not only come away with a deeper appreciation of the underlying concepts in gauge theory, but will be prepared to appreciate in greater detail these modern developments, being as they are the best current hope for understanding the nonperturbative region in quantum field theories and string theories.

it is recommend. for my friend , i will come next time . i love the product, it is very well balanced, has lot of weight to it, and it is very sharp. it cuts through bread so easily and makes perfect slices.

quality. I’ll be buying again. fast and in time,

I picked this book up when it first came out and gave it a quick read. Now, five years later, having just read it again, I cannot believe that it was not as indelible in my mind then as it is now. A combination of original papers, peppered with O’Raifeartaigh’s informed remarks and hindsight, produces an eligant book that follows a timeline that begins with the greatest minds in physics of the last century. The fits and starts of physicists such as London, Fock, Schrodinger, and Klein, though viewed as disparate attempts at the time, give way to an understanding of analogous formulations, and the suggestion of something powerful and underlying. This, of course, being gauge invariance, has equipped the modern physicist with tools that has produced the most striking conclusions: QED and electroweak theory to name a few. The way in which these notions arose, I suspect, is not common knowledge. Just as understanding a breakthrough may only require the reading of a few seminal papers by a few people, the foundation of a good theory often is the result of many people and many false starts. O’Raifeartaigh uses excellent judgement in what to include, and what not to, in his book. It does, incidentally, start with Kuluza-Klein, and run all the way though the 50’s to Yang and Mills theory of isotopic spin and gauge invariance (conservation).A knowledge of tensor analysis (the index (i.e., f_i,j) type), group theory, and differetial geometry is assumed. Topology would broaden the experience.

If you’re reading this, then you undoubtedly know all about the usual mathematical symmetries: translational, rotational, etc., and you also know that they are responsible for the conservation of momentum, energy, angular momentum, etc.But maybe you’ve never heard of gauge symmetry, and how it accounts for the conservation of electric charge and, indeed, why Nature demands electrodynamics in the first place.Well, this wonderful book explains how it all came about, from Weyl’s brilliant but ill-fated 1918 theory to the modern gauge theories of Yang-Mills, Utiyama and beyond. Gauge symmetry is deceptively simple, but it’s what lies behind the most profound idea of modern physics: that Nature is invariant under a local rescaling of scalar and spinorial wave functions. It’s the real power behind quantum electrodynamics, the Higgs hypothesis, much of quantum field theory, and perhaps even gravitation. The real question: why does Nature place such emphasis on this kind of obvious, run-of-the-mill symmetry?After reading O’Raifeartaigh’s book, you’ll be in a better position to appreciate the fact that, for whatever reason, Nature loves simplicity, and that simplicity is nothing less than beauty and truth.

A powerhouse collection of papers in modern Physics! O'Raifeartaigh's introduction and commentary brings each paper's contribution into sharp focus (with benefit of hindsight, of course). The papers by Weyl and Kaluza are startling in their simplicity and boldness. If you haven't read them yet, these two alone justify buying the book. The book does assume familiarity with General Realitivity and tensor analysis. I would highly reccomend Lawden's "An Intoduction to Tensor Calculus, Relativity and Cosmology", or Misner's very complete "Gravitation".