This book discusses the classical foundations of field theory, using the language of variational methods and covariance. There is no other book which gives such a comprehensive overview of the subject, exploring the limits of what can be achieved with purely classical notions. These classical notions have a deep and important connection with the second quantized field theory, which is shown to follow on from the Schwinger Action Principle. The book takes a pragmatic view of field theory, focusing on issues which are usually omitted from quantum field theory texts. It uses a well documented set of conventions and catalogues results which are often hard to find in the literature. Care is taken to explain how results arise and how to interpret results physically, for graduate students starting out in the field. Many physical examples are provided, making the book an ideal supplementary text for courses on elementary field theory, group theory and dynamical systems. It will also be a valuable reference for researchers already working in these and related areas.

MARK BURGESS obtained his PhD in theoretical physics from the University of Newcastle Upon Tyne in 1990. He held a Royal Society fellowship at the University of Oslo from 1991 to 1992, and then had a two-year postdoctoral fellowship from the Norwegian Research Council. Since 1994, he has been an associate professor at Oslo University College. Dr Burgess has been invited to lecture at universities and institutes throughout the world, and has published numerous articles, as well as five previous books.
Classical Covariant Fields

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*Foreword*  

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Foreword

This book is a collection of notes and unpublished results which I have accumulated on the subject of classical field theory. In 1996, it occurred to me that it would be useful to collect these under a common umbrella of conventions, as a reference work for myself and perhaps other researchers and graduate students. I realize now that this project can never be finished to my satisfaction: the material here only diverges. I prefer to think of this not as a finished book, so much as some notes from a personal perspective.

In writing the book, I have not held history as an authority, nor based the approach on any particular authors; rather, I have tried to approach the subject rationally and systematically. I aimed for the kind of book which I would have appreciated myself as a graduate student: a book of general theory accompanied by specific examples, which separates logically independent ideas and uses a consistent notation; a book which does not skip details of derivation, and which answers practical questions. I like books with an attitude, which have a special angle on their material, and so I make no apologies for this book’s idiosyncrasies.

Several physicists have influenced me over the years. I am especially grateful to David Toms, my graduate supervisor, for inspiring, impressing, even depressing but never repressing me, with his unstoppable ‘Nike’ philosophy: (shrug) ‘just do it’. I am indebted to the late Peter Wood for kind encouragement, as a student, and for entrusting me with his copy of Schweber’s now ex-masterpiece Relativistic Quantum Field Theory, one of my most prized possessions. My brief acquaintance with Julian Schwinger encouraged me to pay more attention to my instincts and less to conforming (though more to the conformal). I have appreciated the friendship of Gabor Kunstatter and Meg Carrington, my frequent collaborators, and have welcomed occasional encouraging communications from Roman Jackiw, one of the champions of classical and quantum field theory. I am, of course, indebted to my friends in Oslo. I blame Alan McLachlan for teaching me more than I wanted to know about group congruence classes.

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Foreword

Thanks finally to Tai Phan, of the Space Science Lab at Berkeley for providing some sources of information for the gallery data.

Like all software, this book will contain bugs; it is never really finished and trivial, even obvious errors creep in inexplicably. I hope that these do not distract from my perspective on one of the most beautiful ideas in modern physics: covariant field theory.

I called the original set of these notes: The $X_{\mu}$ Files: Covert Field Theory, as a joke to myself. The world of research has become a merciless battleground of competitive self-interest, a noise in which it is all but impossible to be heard. Without friendly encouragement, and a pinch of humour, the battle to publish would not be worth the effort.

Mark Burgess
Oslo University College
“The Dutch astronomer De Sitter was able to show that the velocity of propagation of light cannot depend on the velocity of motion of the body emitting the light... theoretical investigations of H.A. Lorentz...lead[s] conclusively to a theory of electromagnetic phenomena, of which the law of the constancy of the velocity of light in vacuo is a necessary consequence.”

– Albert Einstein

“Energy of a type never before encountered.”

– Spock, Star Trek: The motion picture.