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Foreword

The Alix G. Mautner Memorial Lectures were conceived in honor of my wife Alix, who died in 1982. Although her career was in English literature, Alix had a long and abiding interest in many scientific fields. Thus it seemed fitting to create a fund in her name that would support an annual lecture series with the objective of communicating to an intelligent and interested public the spirit and achievements of science.

I am delighted that Richard Feynman has agreed to give the first series of lectures. Our friendship goes back fifty-five years to our childhood in Far Rockaway, New York. Richard knew Alix for about twenty-two years, and she long sought to have him develop an explanation of the physics of small particles that would be understandable to her and to other non-physicists.

As an added note, I would like to express my appreciation to those who contributed to the Alix G. Mautner Fund and thus helped make these lectures possible.

LEONARD MAUTNER
Los Angeles, California
May 1983

Preface

Richard Feynman is legendary in the world of physics for the way he looks at the world: taking nothing for granted and always thinking things out for himself, he often attains a new and profound understanding of nature's behavior—with a refreshing and elegantly simple way to describe it.

He is also known for his enthusiasm in explaining physics to students. After turning down countless offers to give speeches at prestigious societies and organizations, Feynman is a sucker for the student who comes by his office and asks him to talk to the local high school physics club.

This book is a venture that, as far as we know, has never been tried. It is a straightforward, honest explanation of a rather difficult subject—the theory of quantum electrodynamics—for a nontechnical audience. It is designed to give the interested reader an appreciation for the kind of thinking that physicists have resorted to in order to explain how Nature behaves.

If you are planning to study physics (or are already doing so), there is nothing in this book that has to be "unlearned": it is a complete description, accurate in every detail, of a framework onto which more advanced concepts can be attached without modification. For those of you who have already studied physics, it is a revelation of what you were *really* doing when you were making all those complicated calculations!

As a boy, Richard Feynman was inspired to study calculus from a book that began, "What one fool can do, another

can." He would like to dedicate this book to his readers
with similar words: "What one fool can understand, an-
other can."

RALPH LEIGHTON
Pasadena, California
February 1985

Acknowledgment

This book purports to be a record of the lectures on quantum electrodynamics I gave at UCLA, transcribed and edited by my good friend Ralph Leighton. Actually, the manuscript has undergone considerable modification. Mr. Leighton's experience in teaching and in writing was of considerable value in this attempt at presenting this central part of physics to a wider audience.

Many "popular" expositions of science achieve apparent simplicity only by describing something different, something considerably distorted from what they claim to be describing. Respect for our subject did not permit us to do this. Through many hours of discussion, we have tried to achieve maximum clarity and simplicity without compromise by distortion of the truth.

CALCULUS MADE EASY:

BEING A VERY-SIMPLEST INTRODUCTION TO
THOSE BEAUTIFUL METHODS OF RECKONING
WHICH ARE GENERALLY CALLED BY THE
TERRIFYING NAMES OF THE

DIFFERENTIAL CALCULUS

AND THE

INTEGRAL CALCULUS

BY

SILVANUS P. THOMPSON, F.R.S.

THIRD EDITION

MACMILLAN

> What one fool can do, another can.
> *(Ancient Simian Proverb)*

PROLOGUE

CONSIDERING how many fools can calculate, it is surprising that it should be thought either a difficult or a tedious task for any other fool to learn how to master the same tricks.

Some calculus-tricks are quite easy. Some are enormously difficult. The fools who write the text-books of advanced mathematics—and they are mostly clever fools—seldom take the trouble to show you how easy the easy calculations are. On the contrary, they seem to desire to impress you with their tremendous cleverness by going about it in the most difficult way.

Being myself a remarkably stupid fellow, I have had to unteach myself the difficulties, and now beg to present to my fellow fools the parts that are not hard. Master these thoroughly, and the rest will follow. What one fool can do, another can.

COMMON GREEK LETTERS USED AS SYMBOLS

Capital	Small	English Name	Capital	Small	English Name
A	α	Alpha	Λ	λ	Lambda
B	β	Beta	M	μ	Mu
Γ	γ	Gamma	Ξ	ξ	Xi
Δ	δ	Delta	Π	π	Pi
E	ϵ	Epsīlon	P	ρ	Rho
H	η	Ēta	Σ	σ	Sigma
Θ	θ	Thēta	Φ	ϕ	Phi
K	κ	Kappa	Ω	ω	Omega