

Preface

Our understanding of the physical world was revolutionized in the twentieth century—the era of “modern physics”. This book is based on a sophomore, one-semester modern physics course taught twice at William and Mary, as well as on a one-quarter advanced freshman physics course taught once at Stanford. In both cases, the course was aimed at the very best students (there were many outstanding students at both places), with a goal of exposing them to the foundations and frontiers of today’s physics. Of course, every effort was made to ensure that no one was left behind. Typically, students have to wade through several courses to see many of these topics, and I wanted them to have some idea of where they were going, and how things fit together, as they went along. Hopefully, they will then see more inter-relationships, and get more original insights, as they progress. I felt the courses were successful, and I know that many of the students in these courses went on to pursue careers in physics.

Physics is an *experimental science*, and it is assumed, as is usual in most schools, that such a course as this is to be accompanied by a good, thorough laboratory course in *experimental* modern physics.

In this book, the central topics of “classical physics” are first reviewed: newtonian mechanics, statistical mechanics, and electricity and magnetism. Then, after presenting several observed contradictions with classical physics, the book focuses on the following topics in modern physics: quantum mechanics; applications in atomic, nuclear, and particle physics; special relativity; relativistic quantum mechanics; general relativity; quantum fluids; and quantum fields. The aim is to cover these topics in sufficient depth that things “make sense” to students and that students achieve an elementary working knowledge of them. The coverage has expanded somewhat from the courses, and to get back down to one semester, some choices

will probably have to be made.

Many problems are included, some for each chapter. While there are problems that directly amplify the material in the text, there are also a great number of them that will take dedicated readers just as far as they want to go in modern physics. The problems are not difficult, and the steps are clearly laid out. Although the book is designed so that one can, in principle, read and follow the text without doing any of the problems, the reader is strongly urged to attempt as many of them as possible in order to obtain some confidence in his or her understanding of the basics of modern physics and to hone working skills.

The book assumes the reader has had a good one-year, calculus-based freshman physics course, along with a good one-year course in calculus. While it is assumed that mathematical skills will continue to develop, several appendices are included to bring the reader up to speed on any additional mathematics required at the outset. With very few exceptions, the reader should then find the text, together with the appendices and problems, to be self-contained. The phrase “it can be shown” is anathema.

An extensive bibliography has not been attempted, although several primary references are included. Most of the key names and dates are also included in the text. To help provide historical context, there is an appendix with a chronological list of many of the theoretical physicists whose work forms the basis for the material presented here. Most of the existing modern physics texts are referenced, as are many of the author’s choices for further study. Today, the existence of the world-wide web provides instant access to any required data, as well as further introduction to almost all of the topics covered here. Key websites are also referenced.

I was again delighted when World Scientific Publishing Company, which had done an exceptional job with three of my previous books, showed enthusiasm for publishing this new one. I would like to thank Dr. K. K. Phua, Executive Chairman of World Scientific Publishing Company, and my editor Ms. Lakshmi Narayanan, for their help and support on this project. I would also like to thank my colleagues Paolo Amore and Brian Serot for their reading of the manuscript.

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