PREFACE

The term *modern physics* is generally used to describe those parts of physics whose theoretical foundations were laid after the year 1900. In practice, this means that modern physics comprises the two great theories that revolutionized 20th-century physics — relativity and quantum theory — and those fields, such as the physics of atoms or solids, that can be understood properly only with the help of these two theories. The term *modern physics* is used to distinguish these fields from classical physics, which comprises those fields, such as Newtonian mechanics and classical electromagnetism, that were well established before 1900.

This book is an introduction to modern physics for students in the physical sciences and engineering. The introductory physics curriculum at colleges and universities varies widely from institution to institution and is undergoing some revision. Nevertheless, it is probably safe to say that the "normal" procedure is to introduce classical physics first, in a calculus-based course that lasts nearly a year — often two semesters or three quarters. This is followed by an introduction to modern physics in a course that often lasts only half a year — one semester or, perhaps, two quarters. We have designed our book for use in this introductory course in modern physics.

Given the type of course for which our book is intended, we have made two important assumptions. First, we have assumed that our readers already have a reasonable knowledge of classical physics and the way it uses calculus. Second, since there is far more modern physics than can possibly be covered in half a year, some choices have to be made. For the most part, we have arranged the book so as to leave these choices to the teacher of the course (or the reader of the book).

With a few exceptions, we have included everything that seemed a reasonable candidate for inclusion, but have tried to organize the book so that many topics can be omitted without loss of continuity. First, each chapter is divided into sections, and a number of these sections have been flagged with a star ⋆, to indicate that they could be omitted if you are pressed for time. More importantly, the whole book is divided into four parts as follows:

Part I	Chapters 1 and 2	Relativity	THEORIES
Part II	Chapters 3 to 11	Quantum Mechanics	
Part III	Chapters 12 to 15	Systems with Two or More Atoms	APPLICATIONS
Part IV	Chapters 16 to 18	Subatomic Physics	

Parts I and II are designed to be read sequentially and (with the exception of the starred sections already mentioned) should be regarded as more or less mandatory. By contrast, Parts III and IV are designed to be studied "cafeteria style." To a large extent, you can choose to cover whatever attracts your interest. In particular, either Part III or Part IV could be omitted entirely. Furthermore, the chapters within Parts III and IV are nearly independent. Thus, it is possible to pick and choose within Parts III and IV, or even to cover bits of both. It has been our experience that in one semester one can, with reasonable comfort, cover the "mandatory" Parts I and II (omitting most of the starred sections) and either Part III or Part IV (again omitting most starred sections). Anyone with the luxury of a year to teach modern physics should be able to cover all four parts of the book, including the starred sections. For the majority, who have to make choices, we offer more suggestions at the beginnings of Parts III and IV.

As with all physics texts, the problem sets at the end of each chapter form an essential part of the book. Anyone who is serious about learning modern physics must do several problems for each chapter. To help teachers and students select problems, we have classified them in two ways. We have indicated the approximate difficulty of each problem with a system of dots, ranging from one dot (•), which indicates a straightforward problem involving just one main concept, to three dots (•••), which indicates a challenging problem that may involve several ideas and lengthy calculations. In addition, we have grouped the problems according to the section to which they relate.* At the end of most problem sets, we have included a few that require the use of a computer. None of these require significant programming skills — most use the computer only to make plots of various functions. Nor do any of them require any particular software; they can all be done using Mathcad, Mathematica, Maple, MATLAB, or several other systems. The main purpose of these computer problems is to cultivate the habit of using computers to gain insights into the behavior of the functions of physics.

We have ended each chapter with a "checklist" of the main ideas the student should have gleaned from the chapter. We hope that readers will use these as an immediate check on how well they have absorbed the chapter's ideas and will go back to reread anything that needs revisiting.

Another feature to be aware of is the information given on the front and back end sheets. In particular, the front sheet contains a list of physical constants, to three or four significant figures. (This is ample accuracy for most purposes; the best known values are given in Appendix A.) This list of constants, and the periodic table on the back sheet, should be valuable references, especially for working the problems. Additional information (more accurate constants, mathematical formulas, further data, picture credits, and suggestions for further reading) is given in the appendices.

In the matter of units and notation, we have tried to follow accepted practice and to avoid too many eccentricities. With few exceptions, we use SI units throughout. (For example, we measure wavelengths of light in nanometers, not in angstrom units.) The only non-SI unit used with any regularity is the electron volt (eV), and we use this without apology. The eV and its cousins, the keV, MeV, etc., are used regularly in almost every branch of modern physics, and a work-

* This convenient scheme is sometimes criticized for fostering problems that are narrowly focused on a single topic. However, when a problem is listed as relating to a certain section, it does not mean that the problem relates *only* to that section; rather, the problem almost certainly involves ideas from earlier sections as well. Thus, the designation is just a promise that the problem does not require material from any sections *after* the section indicated.

ing familiarity with the eV is an essential part of the training of any modern physicist.

As we have already mentioned, we have assumed that our readers will have been exposed to an introductory calculus-based course in classical physics. In particular, we take for granted a familiarity with elementary calculus and its applications. However, we have tried to introduce ideas that are more advanced, such as partial differentiation and differential equations, in such a way that readers who have never met them before can pick them up as we go along.

If you used our first edition, you will notice a number of changes. First among these is the addition of our third author, Michael Dubson, whose expertise in condensed matter physics made him the ideal choice to write the new chapters on solid-state devices and statistical mechanics — not to mention hundreds of improvements to all the others. In addition to the two new chapters, which many reviewers of the first edition had requested, we have added several sections on kinetic theory and on various applications of modern physics, such as the global positioning system, magnetic resonance imaging, and many others. The chapter on atomic transitions and radiation has been completely rewritten, with a more honest discussion of transition probabilities. We have added many new end-of-chapter problems and several more biographies and portraits of famous physicists. The "checklists" at the end of each chapter are a new feature, as are the aforementioned computer problems. We have eliminated a few sections and have compressed the three chapters on relativity into two.

Ancillaries for this text, including an Instructor's Solutions Manual, may be requested by adopting professors by contacting the Publisher-Professor Liaison at University Science Books. Contact information may be found online at www.uscibooks.com/profref.htm.

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