Preface

This book originated from the need for a suitable student text for the course *An Introduction to Modern Physics* first introduced by the authors at the Faculty of Agricultural, Food and Environmental Quality Sciences of the Hebrew University of Jerusalem. The primary goal of this course is to produce graduates who, whatever their field of specialisation, are 'modern physics literate'. It is open to all students who have successfully completed their first-year physics and mathematics studies.

The course sets out to recount, in terms amenable to non-physics majors, the development of the three seminal ideas—Special and General Relativity, Quantum Theory and the Nuclear Atom—out of which modern physics grew in the first half of the 20th century. These topics constitute the principle subject-matter of this book.

However, in addition to a final examination on these subjects, the students participating in the course are also required to submit a term-paper on any topic of their choice, providing it falls within the scope of modern physics or involves one or other of the industrial, technical or research applications derived from it. Accordingly, the scope of the book was widened beyond the narrow limits of the course material and chapters or sections devoted to such topics were added. Among those given a more detailed treatment are:

* Magnetism as a Relativistic Effect;
* The Interaction of Radiation with Matter—Spectroscopy;
* Fluorescence in Biological Systems and Membrane Research;
* Nuclear Structure and Elementary Particles—the Standard Model;
* The Design of Nuclear Weapons: fission and fusion weapons;
* Nuclear Reactors: the events at Chernobyl are described in detail;
* The Design and Use of Lasers;
* The Mössbauer Effect;
* Nuclear Magnetic Resonance and Magnetic Resonance Imaging;
* The Conduction of Electricity in Solids and Semiconductor Devices;

In each case, the underlying theory is presented together with a general description of the practical aspects of the application. For the sake of completeness we have also added:

* Quantum Electrodynamics—QED;
* Invariance, Symmetry and Conservation Laws.

In general, the presentation of the material emphasises the physical aspects of the phenomena. Problem solving is not a major or primary objective. Thus, the text presumes upon the spirit of the physical method recommended by J.J.Thomson:*

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* Sir Joseph J. Thomson 1856-1940, English physicist who was awarded the Nobel prize in 1906 for his research on the conduction of electricity through gases at low pressures.

The physical method has all the advantages in vividness which arise from the use of concrete quantities instead of abstract symbols ... we shall be acting in accordance with Bacon's dictum that the best results are obtained when a research begins with Physics and ends with Mathematics ...
The use of a physical theory will help to correct the tendency - which I think all will admit is by no means uncommon - to look on analytical processes as the modern equivalent of the Philosopher's Machine in the Grand Academy of Lagado, and to regard as the normal process of investigation in this subject the manipulation of a large number of symbols in the hope that every now and then some valuable result may happen to drop out.†

The impression that this is what doing physics is all about lies at the heart of the antipathy exhibited by so many students towards the subject. This text seeks to avoid this.

Notwithstanding, this is not a popular science book; it does not avoid the 'hard bits'. Studying physics requires a mental effort and there is no reason to hide this fact. Mathematics is incorporated into the main body of the text, but only to the extent required for descriptive or illustrative purposes. Most of the mathematical proofs have been separated from the main body of the text so as not to interrupt its flow; they appear in the worked examples and appendices and can be skipped at a first-reading. Questions, exercises and problems for student assignments will be found at the end of each part of the book; answers to these are to be found at the end of the book.

The techniques by which trigonometric functions, phasors (rotating vectors) and complex numbers are used in the mathematical description of wave motion are demonstrated in a supplementary section. A comprehensive index is also included.

In addition to its suitability as a student text for courses similar to that for which it was originally written, we would also recommend this book as a first reader and source text for students majoring in the physical sciences and engineering.

The authors acknowledge their deep indebtedness to the many excellent standard reference works to which they had recourse during the writing of this book. They also wish to thank Dr. German Kälberman who read and commented on parts of the text and Daniel Pfeffer who prepared the computer simulations and provided the technical advice without which this camera-ready manuscript could never have been completed.

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† *Notes on Recent Researches in Electricity and Magnetism*, J.J.Thomson, Oxford at the Clarendon Press (1893).