

Preface to the Second Edition

This book in this second edition has been enlarged (its size now is more than twice that of the first edition) and has been enriched in order to also serve as a senior undergraduate textbook; nevertheless, it retains its main feature of deriving most of the basic formulae governing the behavior of the various structures of the physical world by applying “a little thinking” and employing dimensional considerations.

Explicitly, in each chapter, besides more background information, new sections have been added: One of them includes a summary of the main relevant formulae; another contains many multiple choice questions/statements (their correct answers are given at the end of the book). Finally, there are two more sections in every chapter involving solved and unsolved problems respectively.

Moreover, six new appendices have been added in this new edition: In two of them a summary of the subjects of Electrodynamics of Continuous Media and of Thermodynamics and Statistical Mechanics is presented. These two appendices together with the last three, presenting a list of the required background concepts, formulae, and numbers, make the book to a large degree self-contained. In another new appendix a few basic concepts regarding semiconductor physics are introduced.

As I mentioned before, this book in this second edition may well serve a senior undergraduate course: The students in such a course will be asked to wrap up their basic knowledge and reasoning and apply them to *derive* and *understand* the basic features of the physical world. Of course, as it was stated in the preface to the first edition, graduate students, research scientists, physics teachers and others may find this book intellectually stimulating and entertaining.

I would like to thank again my colleague, Prof. V. Charmandaris, for reading the entire text of this second edition and for making many useful suggestions. Of course, whatever misprints or misrepresentations remained are my own responsibility only. I am also grateful to Ms. Maria Dimitriadi for her invaluable help in bringing my manuscript to its final form.

Iraklion

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Preface to the First Edition

This short book grew out of lectures presented to different audiences (physics students, physicists, material scientists, engineers) and on various occasions (colloquia and seminars in physics and other departments, conferences, special events). The main purpose of these lectures and, obviously, of the present book is to show that basic formulae concerning the various structures of the *physical world* pop out quickly, if some *basic ideas*, the *universal physical constants*, and *dimensional considerations* are exploited. Of course, as R. Feynman pointed out, “a little thinking has to be applied too”.

The basic ideas include the three cornerstones of science, namely the atomic idea, the wave-particle duality, and the minimization of free energy as the necessary and sufficient condition for equilibrium (these are presented in Chaps. 2, 3, and 4 respectively). These fundamental ideas exhibit their worth when accompanied by the values of the physical constants: the universal ones, \hbar , c , the coupling constants of the four interactions, G , e , g_w , g_s and the masses of the elementary particles, m_p , m_n , m_e , m_w , \dots . An important consequence of the atomic idea is that the relevant (for each case) physical constants will appear in the quantities characterizing the various structures of the world either microscopic or *macroscopic*. Combining this last observation—often overlooked—with dimensional analysis, presented in Chap. 5, and “a little thinking”, one can obtain, in several cases, an amazing short-cut derivation of formulae concerning the various structures of Nature from the smallest (baryons and mesons) to the whole Universe, as shown Chaps. 6–13. In each one of these 8 chapters, in parallel with a demonstration of the method just outlined, a *condensed* (sometimes too condensed) introduction to the relevant subject matter together with a few physical remarks are presented.

I must admit that the main fronts on which our scientific horizons are widened, namely the *small*, the *large*, and the *complex* could not be treated even remotely adequately in this short book. Actually the *complex*, as represented by the living matter, was too complex for our simple method; so it was left out completely (however, see the epilogue). The *large* (cosmology) and the *small* (elementary particles) tend to converge to a unified subject (the snake in Fig. 1.1, p.2, is biting

its tail) fed with novel observational data from special instruments mounted usually on satellites, and boosted by high experimental expectations from the Large Hadron Collider. Nevertheless, in these fields there are several open fundamental questions concerning conditions well beyond our present or near future experimental capabilities. This vacuum of confirmed knowledge is filled with new intriguing, imaginative ideas and novel proposed theories (such as supersymmetry, string theory, M-theory, see reference [P1]) which, if established, will radically change our world view. In spite of the wider interest in these ideas and theories and their high intellectual value, I decided for several reasons to restrict myself in the present book to experimentally or observationally tested ideas and theories.

The intended readers of this book are senior undergraduate or graduate students in Physics, Engineering, Applied Mathematics, Chemistry, and Material Science. They may find the book a useful supplement to their courses as a concise overall picture of the physical world. Research physicists, physics teachers, and other scientists may also find this short book intellectually stimulating and entertaining. The required background is no more than a *working* familiarity with the Science/Engineering material taught in the first University year.

I am deeply indebted to my colleague, Prof. V. Charmandaris, for his encouragement during the writing of this book and for reading my entire manuscript and making many useful suggestions. Of course, whatever misprints or misrepresentations remained are my own responsibility only. I am also grateful to Ms. Maria Dimitriadi for her invaluable help in bringing my manuscript to its final form.

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