Introduction to High Energy Physics, 4th Edition

This highly regarded text provides an up-to-date and comprehensive introduction to modern particle physics.

Extensively rewritten and updated, this fourth edition includes all the recent developments in elementary particle physics, as well as its connections with cosmology and astrophysics. As in previous editions, the balance between experiment and theory is continually emphasised. The stress is on the phenomenological approach and basic theoretical concepts rather than rigorous mathematical detail. Short descriptions are given of some of the key experiments in the field, and how they have influenced our thinking. Although most of the material is presented in the context of the Standard Model of quarks and leptons, the shortcomings of this model and new physics beyond its compass (such as supersymmetry, neutrino mass and oscillations, GUTs and superstrings) are also discussed. The text includes many problems and a detailed and annotated further reading list.

This is a text suitable for final-year physics undergraduates and graduate students studying experimental or theoretical particle physics.

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Preface

The main object in writing this book has been to present the subject of elementary particle physics at a level suitable for advanced physics undergraduates or to serve as an introductory text for graduate students.

Since the first edition of this book was produced over 25 years ago, and the third edition over 10 years ago, there have been many revolutionary developments in the subject, and this has necessitated a complete rewriting of the text in order to reflect these changes in direction and emphasis. In comparison with the third edition, the main changes have been in the removal of much of the material on hadron–hadron interactions as well as most of the mathematical appendices, and the inclusion of much more detail on the experimental verification of the Standard Model of particle physics, with emphasis on the basic quark and lepton interactions. Although much of the material is presented from the viewpoint of the Standard Model, one extra chapter has been devoted to physics outside of the Standard Model and another to the role of particle physics in cosmology and astrophysics.

Many – indeed most – texts on this subject place particular emphasis on the power and beauty of the theoretical description of high energy processes. However, progress in this field has in fact depended crucially on the close interplay of theory and experiment. Theoretical predictions have challenged the ingenuity of experimentalists to confirm or refute them, and equally there have been long periods when unexpected experimental discoveries have challenged our theoretical description of high energy phenomena. In this text, I have tried to emphasise some of the experimental aspects of the subject and have given brief descriptions of some of the key experiments. Some knowledge of elementary quantum mechanics has been assumed, but generally I have tried to present the material from a phenomenological and empirical viewpoint, with a minimum of theoretical formalism. A short chapter on experimental methods and techniques has been included, placed at the end of the book so as not to interrupt the flow of the main material.

Although the intention is that the different chapters should be read in sequence, I have tried to make each one reasonably self-contained, at the price of occasional repetition. For a shorter course, sections or even whole chapters could be left out without too much loss to the remaining material. For example, Chapters 9, 10 and 11 and possibly much of Chapter 3 could be omitted on a first pass through the text.

References to original papers are not comprehensive but have been cited where I thought this was necessary. At the end of the book I have included short bibliographies for further reading, relating to the chapter material in general as well as to specific topics. Sets of problems, mostly numerical, are included at the ends of chapters.

No textbook can cover this entire subject, even at a superficial level. I have tried to compensate for this shortcoming, and to put the subject matter on a historical footing, by including as Appendix B a chronological list of the most important advances in the subject over the last 100 years. This is accompanied by a short summary of the significance and importance of these developments.

For those readers who wish to delve into the theoretical aspects of the subject at a deeper level, I suggest the following texts, in ascending order of difficulty:

Gottfried, K., and V. F. Weisskopf, *Concepts of Particle Physics* (Oxford: Oxford University Press 1984)

Halzen, F., and A. D. Martin, *Quarks and Leptons: An Introductory Course in Modern Particle Physics* (New York: Wiley 1984)

Close, F. E., *Introduction to Quarks and Partons* (London: Academic 1979)

Griffiths, D., *Introduction to Elementary Particles* (New York: Wiley 1987)

Aitchison, I. J., and A. J. Hey, *Gauge Theories in Particle Physics* (Bristol: Adam Hilger 1982)

For a comprehensive text on the key experimental developments in particle physics, including many original papers, I recommend

Cahn, R., and G. Goldhaber, *The Experimental Foundations of Particle Physics* (Cambridge: Cambridge University Press 1991)

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