

Preface

This book is intended to provide an introduction to quantum field theory at an elementary level. The reader is supposed to know special relativity, electromagnetism and quantum mechanics. Quantum field theory is a vast subject that provides us with the basic tools to understand the physics of the elementary constituents of matter. There are excellent textbook expositions of the subject in the literature (see the references to [Chap. 1](#)), and it is not our intention to write one more. We have selected a representative sample of topics containing some of the more innovative and challenging concepts and presented them without too many technical details. Few proofs are included, the concepts are exhibited by working out examples and analogies. We have been careful to include all numerical factors in the equations, although the reader is often not required to understand more than their general features. Adequate references are provided where one can find all the necessary technical details. We prime the discussion of the main ideas over the mathematical details necessary to obtain the final results, which often require a more in-depth presentation of the subject. As its title indicates, this book tries to motivate the reader to study quantum field theory, not to provide a thorough presentation.

The guiding principle for the topics chosen was to present some basic aspects of the theory that contain some conceptual subtleties, or at least we found them subtle when learning the subject ourselves. We have paid special attention to the realization of symmetries in particle physics. The notion of symmetry is central in modern physics, and we present its many different aspects: global and local symmetries, explicit, spontaneously broken, anomalous continuous symmetries, discrete symmetries. We give a detailed account of the standard model of the strong, weak and electromagnetic interactions, our current understanding of the origin of mass, the general features of renormalization theory, as well as a cursory description of effective field theories and the problem of naturalness in physics. Sometimes the presentation gets a bit more abstract, as in the chapters on discrete symmetries ([Chap. 11](#)) and effective field theories ([Chap. 12](#)). We have delayed on purpose the study of discrete space-time symmetries in order to develop all the necessary background needed to explore some of their fascinating consequences.

In particular we present an outline of the first principles derivation of the CPT theorem and the spin-statistics connection. Among the few Feynman diagrams evaluated in full detail we have chosen Compton scattering in the Thomson limit to understand polarisation in the cosmic microwave background radiation and its sensitivity to primordial gravitational waves.

By lack of space and purpose, few proofs have been included. Instead, very often we illustrate a concept or property by describing a physical situation where it arises. Full details and proofs can be found in the many textbooks in the subject, and in particular in the ones provided in the bibliography. We should nevertheless warn the reader that we have been a bit cavalier about references. Our aim has been to provide mostly a (not exhaustive) list of reference for further reading. We apologize to those authors who feel misrepresented.

The book grew out of lectures at the CERN—Latin-American schools of High Energy Physics held in Malargüe (2005), Medellín (2009) and Natal (2011), and of undergraduate and graduate courses at the University of Salamanca (2005–2010). We would like to thank in particular Gilvan Alves, Teresa Dova, Miriam Gandelman, Christophe Grojean, Nick Ellis, Egil Lillestøl, Marta Losada and Enrico Nardi, for the opportunity to present this material and for the wonderful atmosphere they created during the schools. We are also grateful to Bob Jaffe who motivated us (through our Springer editor Christian Caron) to turn the original notes into book form. We also want to thank Chris for his patience and understanding. We would like to thank José L. F. Barbón and Agustín Sabio Vera for reading a preliminary version of this book and their many suggestions.

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