# Preface to the Third Edition

This book has its roots in a book on *Leptons, Hadrons and Nuclei* which I published, under that title in 1983, and, naturally enough, in the lectures and courses on elementary particle physics that I have given over the years, first at the Eidgenössische Technische Hochschule in Zurich, and later at the Johannes Gutenberg University in Mainz. Since 1983 – the year of the discovery of the $W$ and $Z$ bosons – experimental tests of what is now called the standard model of electroweak and strong interactions have made dramatic progress and, in fact, have reached a qualitatively new level. It now appears that the standard model, in its minimal version, is very well confirmed and, as yet, there is little hint of physics at higher mass scales, going beyond the standard model. This consolidation of the standard model concerns not only its building blocks and its general pattern but also the radiative corrections it predicts. For the student and for the beginner in the field of particle physics it is important to learn about the way to the standard model, the experimental basis on which it rests, its predictive power and its limitations. In particular, the novice in theoretical particle physics who sets out either to find a better foundation for the model, or else to recklessly dethrone it, hence to revolutionize our field, should know where he or she is sailing and what he or she is searching for. This is the reason why I decided to concentrate on the foundations and the phenomenology of electroweak and strong interactions rather than giving yet another account of the intricacies of quantized gauge theory.

There are many excellent textbooks and monographs on quantized field theory (for example, [ITZ80], [ZIJ94], [COL84], [DWS86]) and, more specifically, on quantized gauge field theory ([CHL84], [HUA92], [OKU82], [BEB94] and many more), but only few books covering in depth the phenomenology or the contact to nuclear physics (noteworthy exceptions are [PER87], [NAC94], [POR95]). This book is at the level of what might be termed *advanced quantum mechanics;* that is, I assume that the reader is familiar with nonrelativistic quantum mechanics and with the foundations of special relativity. In writing it I made every effort to define, to explain and to illustrate the basic notions and to explicitly show the path from

them to the final physical results. Although the level is not elementary, with a little effort and perseverance, the reader, whether experimentally or theoretically oriented, should be able to follow the complete argument or derivation in every subject that this book addresses, without having to resort to other sources. I do hope, of course, that this aspect will contribute to the fun and the satisfaction in learning the topics dealt with in this book. Sections marked with an asterisk contain more detailed material that may be skipped in a first reading.

Being largely self-contained, the book can be read as an independent text by anyone eager to learn this physics or to refresh his or her knowledge. As it originated in graduate-level lectures it may also serve as an accompanying textbook for a one- or two-semester course, perhaps with some cuts. Every chapter is followed by a set of exercises, some of which are simple whereas others require a little more time and effort. Solutions to selected exercises are given at the end of the book. All exercises will help the reader to test his or her understanding, and some serve the purpose of further illustrating the content of the corresponding chapter.

As compared to the second edition of 1996 various new developments and experimental results in electroweak physics are brought to date. The sections on deep inelastic scattering and QCD in Chaps. 2 and 3, as well as the discussion of neutrino oscillations in Chap. 4 are revised and extended. In turn, the fields of hadron scattering on nuclei and of hadronic atoms no longer are in focus of present-day experimental and theoretical research. Therefore the two chapters dealing with these topics were dropped here. If the need arises they may be consulted in the earlier edition of 1996.

In a field as vast and rapidly expanding as particle physics, the bibliography is bound to be incomplete, biased and to some extent unbalanced. I have adopted the following compromise: Within each chapter and at its end I give a selection of references, mostly on experimental results, which have direct bearing on the content of the chapter. In addition, towards the end of the book, there is a list of handbooks, textbooks and monographs to which I refer throughout all chapters using the notation [ABCxy](author(s) and year). Anyone who wishes to delve deeper into some topic dealt with in this book is advised to turn first to the review articles quoted here which will be helpful in retracing the complete literature.

Theoretical physics is a synthesis of lonely work and lively interaction with others. My colleagues and friends, my collaborators and students from whom I learnt a great deal and who directly or indirectly contributed to the genesis of this book, are too numerous to list here. I am very grateful to all of them for much stimulation, fruitful criticism, lively discussions or simply for the pleasure of collaborating with them.

Let me, quite presumptiously, adapt for my purpose the beautiful dedication that Johann Sebastian Bach chose for his Well-Tempered Clavier in 1722,

> "Zum Nutzen und Gebrauch der Lehr-begierigen *Physicali*schen Jugend, als auch derer in diesem *studio* schon *habil* seyenden besonderem Zeit Vertreib auffgesetzet und verfertiget…"

which means “Written and composed both for the benefit and use of young physicists desirous of instruction and for the particular diversion of those already advanced in this study…”, (translation taken from British Library Music Facsimiles I, The British Library, 1980).

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