Basic concepts of elementary particle physics

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O. Nachtmann, *Elementary Particle Physics: Concepts and Phenomena.* Springer-Verlag, Berlin; Heidelberg; New York; London; Paris; Tokyo, 1990. 559 p.

In starting specialization in the field of elementary particle physics, students of advanced courses usually turn to some specific problems and often become, according to the expression of Koz'ma Prutkov, "similar to a swollen cheek." The realization of the need for a broad acquaintance with the entire range of questions about the electroweak and strong nuclear particle interactions, and also with the theory of gravitation leads to a search for suitable literature.

O. Nachtmann's book can be suitably recommended as the first stage in this approach, which prevents a one-sided development of interests. It can be understood by anyone who has studied the fundamentals of quantum mechanics and of the theory of relativity. What is more, at first, as if emphasizing the sequence of this approach, in the first part of the book the author discusses the information necessary for subsequent sections about the relativistic kinematics of particle interaction processes, about different concepts in quantum mechanics, about fields and the properties of their transformations, and about the scattering matrix and interaction cross-sections.

The remaining three parts of the book are devoted to the problems of interacting fields. The unity of the description is based on the pre-eminence of the concept of gauge theories, and the sequence of the discussion is based on the principle of going from the simple to the complicated. Therefore, the second part of the book is allotted to quantum electrodynamics, to the Abelian theory of the interaction of photons with electrons. All the main principles for constructing the theory, which will be used (and developed) in the subsequent parts, are analyzed here. From the information about free fields and their quantization, the reader goes over to interaction problems; to perturbation theory, calculation of very simple reactions, allowance for external fields, and to the consideration of bound states and radiation corrections. This section prepares the reader well for mastering the following part, which is devoted to strong interactions. However, the author does not immediately start discussing the non-Abelian gauge theory of strong interactions, of quantum chromodynamics, but precedes the main part of this section with three chapters in which he discusses the main experimental information and phenomenology about processes in which strongly interacting particles take part, the properties of internal symmetry of strong nuclear interactions, quarks and gluons, and about the simplest parton model. Only after this are the fundamental principles described of quantum chromodynamics and its application to hard processes with the generation of particle streams and to a description of the bound states of the heavy quark and antiquark.

Finally, in the last, the fourth, part of the book, the unification of the electromagnetic and weak nuclear interactions into a single scheme of an electroweak, non-Abelian gauge theory is considered, where spontaneous symmetry breaking occurs. After a short discussion of the "four fermion stage" of the theory of weak interactions, the role of the discovery of parity breaking and the creation of the V–A theory, and the introduction of neutral currents and intermediate vector bosons, the Glashow–Weinberg–Salam theory with the mechanism of spontaneous symmetry breaking and the expansion of the number of quarks and leptons is discussed. This standard model is used to describe many experimental facts about the decays and scattering of particles. The physics of intermediate vector bosons and of Higgs particles, the system of neutral K-mesons (and the problem of CP-breaking connected with it), and finaly, a brief discussion of going beyond the standard model, the Grand Unification Theories, supersymmetry, etc., have been singled out in special subsections.

Many technical questions are set out in the appendices, where the solutions of certain problems which accompany the discussion of theoretical problems in the main text of the book are also shown.

One should not think that this book will be interesting only to students starting their specialization, as the opening words of this review might have implied. It is also clearly interesting to those who lecture, it will be useful to experimenters wishing to study theoretical approaches in more detail, and can serve as a reference aid on fundamental concepts and formulas that are used in elementary particle physics. Thus, Nachtmann's book undoubtedly will find an extensive readership for itself.

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