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Carlo M. Becchi · Giovanni Ridolfi

An Introduction to Relativistic Processes and the Standard Model of Electroweak Interactions

Second Edition

 Springer

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Preface

The natural framework of high-energy physics is relativistic quantum field theory. This is a complex subject, and it is difficult to illustrate it in all its aspects within a normal undergraduate course in particle physics, while devoting a sufficient attention to phenomenological aspects. However, in the small-wavelength limit, the semi-classical approximation is, in many cases of practical relevance, accurate enough to provide reliable predictions without entering the technicalities connected with radiative corrections. In particular, in the framework of the semi-classical approximation it is possible to obtain, in a limited number of pages, the expressions for relativistic cross sections and decay rates in a self-contained and rigorous presentation, starting from the basic principles of Quantum Mechanics. Furthermore, even in the case of the standard model of Electroweak Interactions, the construction of the theory in the semi-classical approximation is exhausted by the study of the classical Lagrangian; many difficult problems, such as those related to the unphysical content of gauge theories, can be dealt with by means of simple prescriptions.

These are the reasons that have determined our choice to base these lecture notes on the semi-classical approximation to relativistic quantum field theory. We believe that this approach leads to a description of the most relevant physical processes in high-energy physics, which is adequate to an undergraduate level course on fundamental interactions.

Of course, the lack of control on radiative corrections has some drawbacks, because they induce transitions which are absent at the semi-classical level. Important examples are the anomalies, the role of intermediate unstable particles and relevant processes such as the Higgs decay into a pair of photons. We have decided to present a simple discussion on each of these subjects, referring the reader to the literature for a complete presentation.

During the preparation of our manuscript we have benefited of the invaluable help and encouragement of Raymond Stora. We are also grateful to Riccardo Barbieri for discussions and suggestions during many years and to our editor Marina Forlizzi for her continuous assistance and friendly advices.

Genoa, February 2014

Carlo M. Becchi
Giovanni Ridolfi

Contents

1	Introduction	1
	References	3
2	Relativistic Field Theory	5
2.1	Scalar Fields	5
2.2	Symmetries in Field Theory	7
2.3	Particle Interpretation	9
2.4	Complex Scalar Fields and Antiparticles	12
3	Scattering Theory	17
3.1	Cross Sections	17
3.2	Decay Rates	26
3.3	Semi-Classical Approximation and Asymptotic Conditions	27
3.4	Solution of the Field Equation	31
3.5	Calculation of the Scattering Amplitude	35
3.6	The Asymptotic Field: An Explicit Example	38
4	Feynman Diagrams	41
4.1	The Method of Feynman Diagrams	41
4.2	The Invariant Amplitude	46
4.3	Feynman Rules for the Scalar Theory	48
4.4	Relativistic Particles in Matter	50
4.5	Unitarity, Radiative Corrections and Renormalizability	52
5	Spinor Fields	59
5.1	Spinor Representations of the Lorentz Group	59
5.2	Mass Terms and Coupling to Scalars	69
6	Gauge Symmetries	73
6.1	Electrodynamics	73
6.2	A Sample Calculation: Compton Scattering	81
6.3	Non-commutative Charges: The Yang-Mills Theory	83

7	The Standard Model	89
7.1	A Gauge Theory of Weak Interactions	89
7.2	Electroweak Unification	93
7.3	Hadrons.	96
8	Spontaneous Breaking of the Gauge Symmetry	101
8.1	Masses for Vector Bosons	101
8.2	Scalar Electrodynamics and the Abelian Higgs Model	103
8.3	Physical Content of the Abelian Higgs Model	107
8.4	The Higgs Mechanism in the Standard Model	112
9	Breaking of Accidental Symmetries	117
9.1	Quark Masses and Flavour-Mixing	117
9.2	Lepton Masses	120
9.3	Accidental Symmetries	121
10	Summary	125
10.1	The Standard Model Lagrangian in the Unitary Gauge	125
10.2	The Standard Model Lagrangian in Renormalizable Gauges	127
10.3	Parameters in the Standard Model	130
11	Applications	133
11.1	Muon Decay	133
11.2	The Decay Rate of the W Boson	136
11.3	Higgs Decay into a Vector Boson Pair	138
11.4	Weak Neutral Currents	140
11.5	Higgs Production in e^+e^- Collisions.	144
12	Beyond the Classical Approximation	147
12.1	The General Structure of Loop Diagrams and the Corresponding Amplitudes	147
12.2	The Decay $H \rightarrow \gamma\gamma$	148
12.2.1	The Matter Fermion Contribution	151
12.2.2	The W Contribution	153
12.3	Anomalies	158
12.4	The Z^0 Line Shape	161
12.4.1	The Z^0 Width	164

13 Neutrino Masses and Mixing 167

Appendix A: Large-Time Evolution of the Free Field 175

Appendix B: The S Matrix 177

Appendix C: Spectral Representation for the S Matrix 179

Appendix D: Transition Amplitudes in the High Resolution Limit 181

Appendix E: Scattering from an External Density 187

Appendix F: Dirac Matrices 189

Appendix G: Violation of Unitarity in the Fermi Theory 191

Index 195