

Contents

PREFACE	vii
1. CLASSICAL FIELD THEORY	1
1.1. The Lagrangian and Hamilton's principle	2
1.2. The Lagrangian for continuous systems	8
1.3. Classical relativistic field theories	13
1.4. Symmetries	22
1.5. Currents and conservation laws	27
2. FEYNMAN DIAGRAMS FOR SPINLESS FIELDS	39
2.1. External sources	39
2.2. Particles and propagators	43
2.3. Pion scattering by an electromagnetic potential	51
2.4. Feynman rules for spinless fields	56
2.5. An example: pion-pion scattering	67
2.6. Quantum corrections	73
3. CROSS SECTIONS AND DECAY RATES	83
3.1. Relativistic wave functions	84
3.2. The probability amplitude	87
3.3. Cross sections	92
3.4. Kinematics for (quasi-)elastic scattering	97
3.5. On polarization vectors	102
3.6. Unstable particles and decay rates	104
3.7. Three-particle phase space	114
3.8. Hadronic decays of neutral K-mesons	119
4. PARTICLES WITH SPIN ONE	131
4.1. Massive spin-1 particles	131
4.2. Massless spin-1 particles	137
4.3. Electromagnetic scattering of pions	142
4.4. Pion-Compton scattering	147
4.5. Decay rate for $\pi^0 \rightarrow \gamma\gamma$	151
4.6. Bremsstrahlung in the decay $K_S^0 \rightarrow \pi^+ \pi^- \gamma$	157
5. PARTICLES WITH SPIN ONE-HALF	171
5.1. Feynman rules for spin- $\frac{1}{2}$ fields	171

5.2. Lagrangians for fermions	179
5.3. Properties of spinors	186
5.4. Invariant amplitudes for spinors	192
5.5. An application: boson decays into two spin- $\frac{1}{2}$ fermions	197
5.6. Weak and electromagnetic two-particle decays and universality	201
6. CROSS SECTIONS FOR PROCESSES INVOLVING FERMIONS	219
6.1. Introduction	219
6.2. The four-fermion amplitude	223
6.3. Lepton scattering on a pointlike fermion	232
6.4. Lepton-nucleon elastic scattering	242
6.5. Lepton-nucleon inelastic scattering	246
6.6. Quark constituents	256
6.7. Annihilation processes involving pointlike fermions	264
7. QUANTUM CORRECTIONS	283
7.1. The $\pi^0 \rightarrow \gamma\gamma$ triangle diagram	284
7.2. Infinities	290
7.3. Renormalization of quantum electrodynamics	295
8. DIMENSIONAL REGULARIZATION AND RADIATIVE CORRECTIONS	305
8.1. Field theories in n space-time dimensions	305
8.2. Evaluation of Feynman integrals in n space-time dimensions	308
8.3. Feynman parameters	316
8.4. Divergent one-loop diagrams in quantum electrodynamics	320
8.5. The eey amplitude	335
8.6. Radiative corrections	341
9. ASYMPTOTIC BEHAVIOUR	367
9.1. The renormalization group	368
9.2. Minimal subtraction	373
9.3. The running coupling constant	381
9.4. Asymptotic behaviour	386
9.5. Vacuum polarization	390
Appendix A. Lorentz-covariant notation	411
Appendix B. Conventions	419
Appendix C. Introduction to group theory	425
Appendix D. Dilogarithmic functions and phase-space integrals	447
Appendix E. Gamma matrices	457
Appendix F. Feynman integrals in n dimensions	475
Appendix G. Standard model of electroweak and strong interactions	477
Bibliography	483
Subject index	485