
Particle Physics - NPAC

October 16, 2019

1 Introduction and basics

- 1.1 The Standard Model in a nutshell
- 1.2 Feynman diagrams
- 1.3 Short history

2 Symmetries

- 2.1 Quantum angular momenta, spin and helicity
- 2.2 Flavor symmetries: isospin
- 2.3 Discrete symmetries: P , C and T
- 2.4 Neutral kaons oscillation, CP violation
- 2.5 Electric and magnetic dipole moments

3 Collisions and decays

- 3.1 Special relativity for particle physics
- 3.2 Cross sections and the concept of luminosity

4 Quantum Electrodynamics (QED)

- 4.1 The different types of particle fields
- 4.2 QED Feynman rules
- 4.3 Radiative corrections and running coupling constant (renormalization in a nutshell)

5 QCD

5.1 Historical and phenomenological introduction

5.2 Basics of the strong interaction: color and gluons

5.3 $SU(3)$ basic algebra

5.4 Flavor $SU(3)$: hadron multiplets

5.5 Probing internal structure of hadrons

5.6 Running QCD coupling constant and asymptotic freedom

5.7 Hadronisation and jets

5.8 Color $SU(3)$ and gluon generators

5.9 Experimental evidence of color

5.10 Basics of QCD theory, Feynman rules

5.11 Color factors

5.12 Measurement of the coupling constant α_s

5.13 Hadron collisions

5.13.1 Soft and collinear divergences

5.13.2 Parton density functions

5.13.3 Fragmentation functions

5.13.4 Dijet cross section

5.13.5 Monte Carlo event generators

5.13.6 Jet algorithms

5.14 Deep inelastic scattering

5.14.1 Formalism, hadronic tensor

5.14.2 More about hadronic structure functions

5.14.3 Bjorken scaling and applications

5.14.4 DGLAP

5.14.5 Usage of Parton Density Functions

6 Charged weak interaction

6.1 Couplings and applications

6.2 Theoretical basics and parity violation

6.3 Properties of the W boson

6.4 CP violation and flavor physics

6.5 Towards neutral currents

7 The Standard Model (SM)

7.1 Neutral currents

7.2 electroweak unification

7.3 Higgs boson: discovery and properties

7.4 Complete Lagrangian of the SM

8 Neutrinos

8.1 Neutrino Oscillations

8.2 Observables and their measurement

9 Open questions; beyond the SM

9.1 The limitations of the SM

9.2 Short introduction to searches for physics beyond the SM

References

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