

Syllabus, Particle Physics, Fall 2014

Instructor: Dr. Stefan Bathe
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Class Schedule: Th 9:30am–12:40pm, Graduate Center, room 3209.

Objectives:

The class is intended as an introduction to elementary particle and nuclear physics. Key experimental observations that lead to our current understanding of particle physics and their theoretical interpretation will be discussed. The emphasis is on the phenomenology. Rigorous mathematical discussion of quantum field theory will be left to the complementary QFT course.

Pre-requisite: The class is open to first, second, and third year graduate students; undergraduate students are asked to check with the instructor first.

Preparation: Studying the recommended textbook(s); reviewing lecture notes; homework.

Resources:

- **Recommended textbooks:** Introduction to Elementary Particles, by David Griffiths (2008); Quarks and Leptons: An Introductory Course in Modern Particle Physics, by Francis Halzen and Alan D. Martin (1984); Introduction to High Energy Physics, by Donald H. Perkins (2000).
- **Particle Data Group web site:** <http://pdg.lbl.gov>

Covered Material:

- 1 Introduction
 - 1 Experimental techniques
 - 1 Interaction of particles with matter
 - 2 Detectors
 - 3 Accelerators
- 2 Global properties of nuclei
 - 1 The atom and its building blocks
 - 2 Nuclides
 - 3 Parameterization of binding energy
- 3 Stability of nuclei
 - 1 Beta decay
 - 2 Alpha decay
 - 3 Fission
 - 4 Decay of excited states
- 4 Discovery of elementary particles
 - 1 Photon
 - 2 Mesons
 - 3 Antiparticles
 - 4 Neutrinos
 - 5 Strange particles
 - 6 The Eightfold Way
 - 7 Quark Model
 - 8 The November Revolution
 - 9 Intermediate Vector Bosons
- 5 Particle Dynamics
 - 1 Quantum Electrodynamics

- 2 Quantum Chromodynamics
- 3 Weak Interactions
- 4 Decays
- 6 Relativistic kinematics (if interest)
 - 1 Lorentz transformations
 - 2 Four-vectors
 - 3 Energy and momentum
 - 4 Collisions
- 7 Symmetries
 - 1 Angular momentum
 - 2 Flavor
 - 3 Parity, Charge Conjugation, and CP
 - 4 Neutral kaons and CP violation
 - 5 Time reversal and TCP theorem
- 8 Bound states
 - 1 Schroedinger Equations and Hydrogen
 - 2 Fine Structure, Lamb Shift, and Hyperfine Splitting
 - 3 Positronium
 - 4 Quarkonium, Charmonium, and Bottomonium
 - 5 Light Quark Mesons
 - 6 Baryons
- 9 Scattering
 - 1 Cross sections
 - 2 Fermi's Golden Rule
- 10 Recent developments
 - 1 The Higgs Boson

2 Grand Unification

3 Matter/Antimatter Asymmetry

4 Supersymmetry, Strings, and Extra Dimensions

5 Dark Matter/Dark Energy

Homework: Weekly homework will be assigned and graded.

Exams: One final exam.

Grades: (percent of course grade)

- homework: 50 %.
- final exam: 50%.