Physics 582, Fall 2006

Particle Physics II

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Summary

This course is introduction to the Standard Model of Particle Physics. We'll talk about the electromagnetic, weak, and strong interactions, and how they fit together in the SM. We'll discuss what it means that SU(3) X SU(2) X U(1) describes those interactions, that the electroweak force breaks down to U(1) of electromagnetism, and what this has to do with the Higgs boson. We will also talk about how it fits in with past, present, and future experiments.

- Course Outline

1. Introduction and Overview
   -The Standard Model and its limitations
   -Anatomy of a cross section

2. Electromagnetic Interactions
   -Review of relativistic kinematics
   -Gauge invariance in classical E&M and nonrelativistic QM
   -Quick review of Klein-Gordon and Dirac equations
   -Dirac Lagrangian and Feynman rules for QED
   -Cross section for $e^+e^- \to \mu^+\mu^-$
3. Weak Interactions and Electroweak Theory
   -GIM mechanism, CKM matrix, and CP violation
   -SU(2) X U(1)
   -Physics at the Z
   -Electroweak symmetry breaking
   -Physics of the Higgs Boson
   -EWSB beyond the SM
   -Neutrinos
4. QCD and the Parton Model
   -Deep inelastic scattering and structure functions
   -Hadron-hadron collisions
   -Renormalization and asymptotic freedom

- Class time

  The class will meet on Tuesdays from 12:30pm - 3:00pm Eastern time (with a break in the middle) in B&L room 207. The class will be "simulcast" at Fermilab by videoconference, hence the once-weekly marathon sessions. At Fermilab the class meets in the Industrial Center Building #2 Conference room. The industrial center buildings are across the street from CDF; for more detailed directions contact Jennifer Gimmel, jennifer@pas.rochester.edu.

- Prerequisites

  This course is more or less self-contained, and can be taken without having had P581 first. I will assume that most students are in the 2nd year of graduate school or beyond, and I will assume familiarity with some basic ideas in particle physics. I will also use some results from advanced quantum mechanics and field theory, so knowing these will help but is not required.

- Course materials

  Course materials — lecture notes, mainly — will be posted on the course web page, `http://www.pas.rochester.edu/~orr/p582.html`. I hope to have each Tuesday's notes posted by Friday of the preceding week. Because of the course's videoconference format, it will be easier to follow the lectures if students download the notes in advance and bring them to class.

- Recommended texts

  There is no required text for this course; the lectures are drawn from a variety of sources. Students looking for supplemental reading may find the following texts helpful (they will be put on reserve in the POA library):

  D.H. Perkins, *Introduction to High Energy Physics*
  R.N. Cahn and G. Goldhaber, *The Experimental Foundations of Particle Physics*
  C. Quigg, *Gauge Theories of the Strong, Weak, and EM Interactions*
  F. Halzen and A. Martin, *Quarks and Leptons*
  M. Peskin and D. Schroeder, *Introduction to Quantum Field Theory*
  V.D. Barger and R.J.N. Phillips, *Collider Physics*

  In addition, everyone should have a copy of the Particle Data Booklet, available for free from `http://pdg.lbl.gov/` .

- Requirements

  1. I will give several homework assignments during the semester. Collaboration is allowed and encouraged, but each student must do his or her own write-up.

  2. There will be no exams, but near semester's end each student will give a brief presentation ($\sim$15 minutes) on a topic of current interest in particle physics.