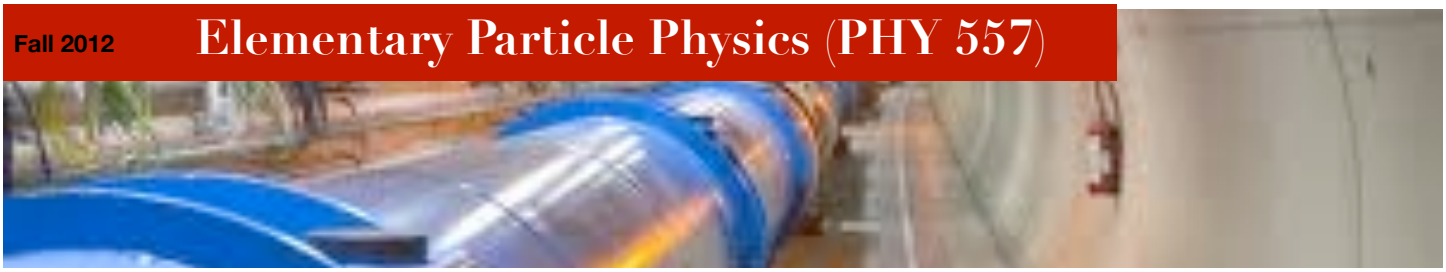
Fall 2012

Elementary Particle Physics (PHY 557)



Updates tracker

- August 23, 2012 - course syllabus added

Lecturer

Dmitri Kharzeev
Professor of Physics
C142A
email me

Date: Tuesday and Thursday; first lecture on August 28, 2011
Time: 10:00 - 11:20 am
Room: P128

Course Description

PHY 557 is an introductory course on elementary particle physics. With the 2012 discovery of the Higgs boson (or a particle that resembles it) at the Large Hadron Collider (LHC) at CERN, with the Relativistic Heavy Ion Collider (RHIC) at nearby BNL advancing the understanding of Quantum Chromo-Dynamics, and with newly emerging theoretical ideas and methods - this is a rapidly evolving field at the verge of new discoveries.

The goal throughout this course is to develop a deep understanding of the foundations of particle physics, to master computations of basic observables (cross sections, decay rates, etc), and to learn about new theoretical ideas, emerging directions, and the key role of experimental measurements.

Outline of the course

- Foundations of quantum mechanics and quantum field theory
- Symmetries, groups and equations of motion
- Gauge invariance and gauge field theories
- Klein-Gordon equation; antiparticles
- Dirac equation and electrodynamics of spin 1/2 fermions
- Perturbation theory; Wick theorem; Feynman diagrams
- $e^+ e^-$ annihilation; photon propagator
- Running coupling; renormalization
- Deep-inelastic scattering; Bjorken scaling and the parton model
- Quantum anomalies; neutral pion decay
- Dispersion relations and unitarity
- Quantum Chromo-Dynamics: quarks and gluons; symmetries; perturbation theory; evolution equations; ideas about confinement and chiral symmetry breaking
- Quark-Gluon Plasma: equation of state; transport properties; signatures
- Electroweak interactions; the Weinberg-Salam model and the Higgs mechanism
- Neutrino oscillations
- Baryon number violation at high energies and temperatures; instantons and sphalerons
- Beyond the Standard Model: supersymmetry; conformal theories and "unparticles"; extra dimensions

• Gauge-gravity duality; AdS/CFT correspondence

• Particle physics and cosmology: phase transitions in the Early Universe; baryogenesis; magnetic helicity; ideas about Dark Energy and Dark Matter

Pre-requisites

Students are expected to have a knowledge of quantum mechanics and relativity, but no previous acquaintance with quantum field theory is presumed.

Recommended texts and sources

1. A concise and comprehensive compilation of current knowledge in particle physics is provided by the Particle Data Group. The latest 2012 edition of the Particle Physics Booklet and the Review of Particle Physics will become available in September and can be ordered here, free of charge. In the meantime you can immediately download it here.
2. F. Halzen and A. Martin, "Quarks and Leptons: An Introductory Course in Modern Particle Physics", John Wiley & Sons
3. M. Peskin and D. Schroeder, "An introduction to quantum field theory"

Several of the topics covered in the course cannot yet be found in any textbook; the references to the original papers will be given.

Requirements

Regular attendance: you are expected to attend all classes

Homework: there will be regular homework assignments; you are expected to complete homework on time. In addition to doing course homework, the stu-

dents will study selected research papers relevant to the topics of the course and make presentations in the class.

Office hours

Monday, 3:00 - 4 pm, C142A

Thursday, 3:00 - 4:30 pm, C142A

I will also be responsible for the Graduate seminar (Nuclear, Particle, Astro)

that will take place on Monday 4:00 - 5:20, P123.

You can also contact me by email.

In addition, I will be glad to meet with you at other times; however to make sure that I am available please make a prior appointment.

Grading

Homework - 50%

Research paper presentation - 25%

Final exam - 25%

Students will be able to access the current status of their grades.

Class attendance will also be considered in the final evaluation.

Web page

Homework, lecture notes, etc will appear at Blackboard Suite:

https://blackboard.stonybrook.edu

Special Notes

Any excuses (medical or otherwise) are to be documented, and discussed with the instructor in a timely manner. If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact Disability Support Services at (631) 632-6748 or http://studentaffairs.stonybrook.edu/dss/. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website: http://www.sunysb.edu/ehs/fire/disabilities.shtml