Aug. 2013

PHY 680, Topics in Advanced Particle Physics, Fall 2013

Instructors: Profs. R. Essig, P. Meade, and R. Shrock

Meeting Times: For the first two weeks this course will meet on Thur. 5-8 pm in D-122 (i.e., on Aug. 29 and Sep. 5). Subsequently it will meet Mon. 5-8 pm in Rm. P-130.

Prerequisites: The course prerequisites include a working knowledge of quantum field theory and the Standard Model (SM), as covered in the PHY 610, 611, 612 sequence at Stony Brook. If a student has equivalent preparation as part of an M.A. or M.S. degree, this should be acceptable; the student should check with the instructors.

Course materials: The course does not have a formal textbook; the instructors will suggest readings and resource materials during the semester.

Grading: The course requirements include homework and a final presentation on a topic related to the course material. (For YITP thesis students, this presentation may be on their thesis research.) The grade is based on homework, the final presentation, and class participation. This course should help advanced students move into thesis reseach projects and/or broaden their knowlege of particle physics. We strongly encourage interested students to register for this class, rather than auditing it.

Topics: The course will cover topics from the list below:

- Models of quark and charged lepton mass matrices and comparison with data on CKM parameters and flavor physics.
- Neutrino masses and lepton mixing as confirmed physics beyond the original Standard Model, including theory and discussion of data from reactors experiments, solar and atmospheric neutrino experiments, accelerator neutrino oscillation experiments, and astrophysical/cosmological constraints.
- Lattice gauge theory, including results on confinement, spontaneous chiral symmetry breaking, and hadron masses in quantum chromodynamics; also phase structure of SU(N_c) gauge theories with various fermion contents.
- Effective field theory; application to QCD and physics beyond the SM.
- Electroweak symmetry breaking; Higgs mechanism in SM; properties of the 126 GeV Higgs boson discovered by the LHC; searches for possible non-SM properties of this boson; collider phenomenology
- Hierarchy problem in SM; supersymmetry, including duality and phenomenology; status of searches for superparticles.
- Renormalization group, β function, ultraviolet to infrared evolution of asymptotically free gauge theories.
- Grand unified theories and searches for baryon number violation.
- Dark matter, primordial nucleosynthesis, early universe cosmology