PHY 510 Relativistic Quantum Mechanics

Pre-requisites

I will assume a knowledge of quantum mechanics and electrodynamics at the level of our first year graduate courses. In practice, this means you can solve for the hydrogen and harmonic oscillator spectra; that you know the angular momentum algebra and about spin matrices; and how Maxwell's equations are invariant under Lorentz transformations. The course will start with a review of these topics.

Although no textbook is required, the book by Bjorken and Drell is a useful reference. The classic text remains "Principles of Quantum Mechanics" by P.A.M. Dirac.

There will be no examinations in the course; instead there will be some homework assignments. The course will be graded on a Pass/Fail basis.

Syllabus

Part I Review of Quantum Mechanics

- Observables in Quantum Mechanics; Symmetries as Unitary Transformations; De Broglie wavelength; The Schrödinger equation.
- Rotation invariance; Angular Momentum Algebra.
- Spin;Pauli Spin Matrices

Part II Review of Special Relativity

- Lorentz Transformations; Minkowski space; The wave equation.
- Energy-momentum relations.
- The Klein-Gordon equation.

Part III Relativistic Quantum Mechanics

- The spectrum of the pionic atom.
- The Dirac Equation

•The fine structure of Hydrogen: solution of the Dirac equation in a Coulomb potential.

•Negative energy states; The hole theory of Dirac.

•The Dirac equation on a circle;Partition function of Free fermions; Bose-Fermi correspondence.

•Canonical anti-commutation relations; Quantization of the Dirac field.

•Quantization of the Klein-Gordon and Maxwell fields.

•Rudiments of Quantum electrodynamics.