Particle and Nuclear Physics
Homework-1
Due on September 19, 2012

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September 12, 2012

1. Show that orbital angular momentum operator, L, and spin operator, Σ, do not commute with Hamiltonian of Dirac equation, but combination $\frac{1}{2}\Sigma + L$ commutes and therefore is conserved.

2. Show that from the Klein-Gordon equation the probability density ρ can be negative, while from Dirac equation it can be only positive.

3. An electron with energy E_e=2.0 GeV in lab. frame scatters elastically on fixed hydrogen target on an angle $\theta = 15^0$. Find the momentum of the recoil proton and an angle of virtual photon versus incoming electron direction.

4. The LHC operates with two colliding beams of protons with $E_{p1} = E_{p2}$=7 TeV per beam. Find the energy of the proton beam interacting with a fixed proton target to have the same invariant energy in the interaction.

5. Draw a table showing all the elementary spin 1/2 fermions arranged in three families horizontally with the individual members of each family vertically. In the table give the names, symbols, electric charges, and approximate masses of each particle.