PHYS 340a Part II. Homework #1

Due date: March 25th, 2010

1. Show that S +U+T is Lorentz invariant
2. For fixed target experiments, given a kinetic energy of the beam, calculate the beam energy and momentum in the laboratory frame, the rapidity covered in the lab, y_{proj} -y_{targ}, the center-of-mass rapidity, the velocity of the beam in the laboratory frame, E_{cm}, p_{cm}, and the velocity of the beam in the center-of-mass frame. Write the expression used to calculate each quantity. Assume pp interactions with a proton mass of 0.938272 GeV. The velocities should be in c = 1 units so that v =β. The values of E_{kin} are 10 MeV, 1, 10, 60, 160 and 200 GeV.
3. For collider experiments, given a value of sqrt(S), calculate E_{cm}, p_{cm}, total rapidity coverage, y_{proj} -y_{targ}, the velocity of the center-of-mass frame and the equivalent value of E_{lab} for a fixed-target experiment. Write the expression used to calculate each quantity. Assume pp interactions with a proton mass of 0.938272 GeV. The velocities should be in c = 1 units so that v=β. The values of sqrt(S) are 60, 200, 500, 1800, 5500 and 14000 GeV.
4. Show that for small velocity the rapidity y≅β.
5. Show that for p>>m , the rapidity y≅η