Physics 5110 Homework 10 (due Mar 30)

March 21, 2012

1. Williams, problem 9.3.

2. Williams, problem 9.4.

3. A moving particle has a longer mean life ($\tau$) than a resting particle ($\tau_0$), according to $\tau = \gamma \tau_0$. Calculate the lifetime (years) of a very high energy cosmic ray neutron of total energy $10^{20}$ eV. (Hint: use the Lorentz transformation to go from the particle rest frame to the moving frame to find the relationship between $\gamma$, $E$, and $mc^2$.) Such neutrons might survive the journey from distant galaxies.

4. (a) A neutron decays at rest to a proton plus electron and neutrino. Calculate the least positive invariant four-momentum transfer from the neutron to the proton. (Hint: the least positive value comes when the electron is at rest.)

(b) Draw a Feynman diagram representing the decay process, showing the appropriate vector boson.

(c) Draw a Feynman diagram for the scattering of an electron-type-neutrino from a neutron, resulting in an electron and a proton, showing the appropriate vector boson.