Physics 492 homework IX, due Fri Apr 2

Reading: Chapter 9

Problems:

1. Williams, Problem 9.1.

2. Williams, Problem 9.2. Hint: Here "free particle" means "real particle" for which

$$E^2 - \vec{p}^{\,2}\, c^2 = m^2\, c^4\,.$$

The photon mass is 0, of course.

3. Williams, Problem 9.3.

4. Williams, Problem 9.4.

5. Consider the charged pion decays, with their branching ratios in parentheses,

$$\pi^- \longrightarrow \mu^- + \overline{\nu}_\mu \qquad (\simeq 100\%)$$

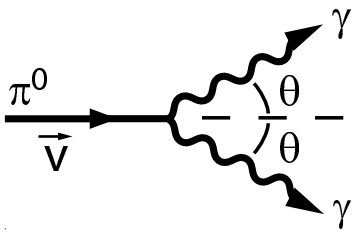
$$\pi^- \longrightarrow e^- + \overline{\nu}_e \qquad (\simeq 0.01\%)$$

(a) In the π^- rest frame, what are the μ^- and $\overline{\nu}_\mu$ energies?
(b) In the π^- rest frame, what are the e^- and $\overline{\nu}_e$ energies?
(Particle masses: Williams, Tables 10.3 and 12.1)

6. Consider the common neutral pion decay

$$\pi^0 \to \gamma + \gamma\,.$$

In the π^0 rest frame the photons have equal energies, equal to $m_\pi\, c^2/2$. Consider a Lorentz frame in which the π^0 energy is ϵ_π and in which the photons are emitted symmetrically as shown:



(a) Determine the angle between the photon directions as a function of ϵ_π. (Hint: In the pion rest frame, the photon momenta are equal in magnitude and opposite, perpendicular to the direction of $\vec{v}$. Apply a Lorentz transformation.)

(b) Calculate 2θ for $\epsilon_\pi = 1$ GeV and 10 GeV.

Note:
First paper draft is due on Wednesday, Apr 7.