Physics 310/610 – Cosmology

Homework Set R

1. For each of the decays below, the decay is a strong decay.
   (a) Consider the collision $p^+ + K^- \to K^+ + K^0 + \Omega$. Based on what you know, what is the baryon number, charge, and strangeness of the Ω? Give an argument that the Ω is none of the particles listed.
   (b) For the decay $\Lambda^{*0} \to \pi^- + X$, what is the baryon number, charge, and strangeness of the *X*? Find an upper limit on the mass of the *X*. Based on this, determine which particle *X* must be.
   (c) The Δ^{++} always decays to two particles, and it is always the same two particles. Figure out which two particles it is, and give an argument.

2. For each of the processes below, categorize the process as strong, electromagnetic, weak, or impossible. For this problem, you do not need to show your work.
   (a) $p^+ \to e^+ + \gamma$
   (b) $n^0 \to p^+ + e^-$
   (c) $K^0 \to \pi^+ + \pi^-$
   (d) $\Sigma^+ \to n^0 + K^+$
   (e) $\pi^+ \to \mu^+ + \nu_1$
   (f) $p^+ + e^- \to n^0 + e^+$
   (g) $\Sigma^0 \to \Lambda^0 + \gamma$
   (h) $\Delta^+ \to p^+ + \pi^0$

Graduate Problem: Do this problem only if you are in PHY 610.

3. In this problem we will discuss the difference between collider physics and cosmic ray physics.
   (a) Suppose a collider collides two particles with equal mass *m*, head on, with equal energy *E*. Assuming they combine into a single particle, what would be the particle mass *M* of the resulting particle? (This part is trivial)
   (b) Now suppose instead we collide two particles with mass *m*, but one is at rest, and the other has energy *E*. What would be the mass *M* of the resulting particle? (This part is *not* trivial)
   (c) The Large Hadron Collider (LHC) collides pairs of protons head on with energy 7 TeV each. Suppose instead, a cosmic proton of energy *E* collides with a stationary proton. How large would *E* have to be to achieve the same invariant mass *M* for the collision?