

Physics 556/714 Problem Set #1

due *beginning of class* Thursday 18 Sept

- 1) For a charged particle moving in a uniform magnetic field, how does the radius of curvature depend upon the momentum, charge and magnetic field? Derive it.
Do not assume that the particle is non-relativistic.
- 2) Griffiths problem 1.1: "If a charged particle is undeflected ... "
Do not assume that the particle is non-relativistic.
- 3) Griffiths problem 1.3: "In the period before the discovery of the neutron ..."
- 4) Griffiths problem 1.7: "Members of the baryon decuplet ..."
In this problem you are working backwards from the authors of the eight-fold way. By analyzing the patterns of many particle decays, they were able to deduce the assignments of strangeness that led to the model of octets and decuplets.

If you need to look up any of the particles masses in this problem, and you do not find what you want in the front of your textbook, it is useful to know about the online particle listings put out by the Particle Data Group: http://pdg.lbl.gov/2003/contents_listings.html
Incidentally, if you wish to receive a copy of the full review version or of the condensed booklet version of particle properties you can send email to pdgrequest@lbl.gov or go to <http://pdg.lbl.gov/pdgmil/>.
- 5) Griffiths problem 1.8: "Analyze the possible decay modes of the Ω^- ,"
Note the typo in this problem: "Figure 1.11" should be "Figure 1.10" instead.
- 6) It is said that production of an electron positron pair from a single photon cannot happen in free space. Prove it rigorously.

714 students please also do the following:

- 7) Consider a long-lived resonance whose energy is described by the non-relativistic Breit-Wigner distribution:

$$\text{Prob}(E) = \frac{A}{(E - E_R)^2 + \frac{\Gamma^2}{4}}$$

where A and Γ are constants, and E_R is the mean energy of the resonance.

- a) What is the half-width of the energy distribution? That is, how far off resonance do you have to go before the probability has dropped to half its peak value?
- b) Assuming this particle decays according to the standard exponential decay distribution:
 $\text{Prob}(t) = Ae^{-\Gamma t/\hbar}$
What is the RMS of the time distribution?
- c) Assuming the half-width represents the uncertainty in energy and the RMS represents the uncertainty in time, show that this resonance obeys the uncertainty principle.
- d) Part c) is a somewhat contrived problem. Instead of the half-width, it is more correct to use the RMS for the energy uncertainty. Show that this too obeys the uncertainty principle (by a wide margin).