M.A. Thomson
Easter Term 2004

PART II PARTICLES EXAMPLES CLASS : HINTS

Note: questions 2,3 and 4 are meant to be tough. Don't worry if you get stuck - the aim is that by going through this questions your understanding of the subject will improve.

2. The Number of Neutrino Species.

b Calculate $(E, \vec{\mathbf{p}})$ for the electron after it has radiated assuming direction unchanged. Then use invariant $E^2 - \vec{\mathbf{p}}^2$ to get s'.

c A full derivation is not required but you need to relate $\sigma(s')$ to Γ_{ee} and $\Gamma_{\rm inv} = \Gamma_{\nu\nu}$

d You may not be familiar with the concept of integrated luminosity. In a real collider experiment one counts events (*i.e.* integrated event rate). The event rate is proportional to the cross section. It also depends on the beam currents, beam spot sizes, how well the e^+ and e^- beams overlap. The quantity integrated luminosity encompasses all of these variables. The number of events observed, N, is related to the cross section, σ, by

$\boldsymbol{N = \mathcal{L}\sigma}$, where $\mathcal{L}$ is the integrated luminosity.

e Note mean s' is significantly below the peak of the resonance.

g The W-boson diagram results in a $\nu_e\overline{\nu}_e\gamma$ final state. The pure EM process results in a single γ in the detector but doesn't produce neutrinos.

3. The Charmed Baryons

a Consider symmetry of two like fermions $\rightarrow S_{qq} = 1$. For number of different states think about symmetry of $\psi_{spin}\psi_{flavour}$. Each strange quark has -1 strangeness and $u(d)$ quarks have isospin $+\frac{1}{2}(-\frac{1}{2})$.

b Chromo-magnetic interaction $\frac{A\vec{S}_1\cdot\vec{S}_2}{2m_1m_2}$

c Note $\vec{S}_u \cdot \vec{S}_d = -\frac{3}{4}$ not $-\frac{1}{4}$.

e Think about conservation of flavour.

4. Experimental Determination of the Spin of the π^+ Meson

b Remember cross-section = transition rate/flux

e Think about the relation between two reactions in centre-of-mass frame.

For answers (from 24/5/2004) see
`http://www.hep.phy.cam.ac.uk/~thomson/particles`