

**Elementary Particle Physics: Assignment # 8**  
**Due Tuesday March 29th**

- (1) Quarks are in the fundamental representation of color SU(3) (triplet) and antiquarks are anti-triplets. A baryon is a color singlet formed by three quarks while a meson is a color singlet formed with a quark and an antiquark. A pentaquark is a physical state (ie a color singlet) formed with 4 quarks and one antiquark. By explicit composition of the SU(3) representation of the five components, show that a pentaquark could be a “molecule” of a baryon and a meson, or a purely strong bound state of the five components.
- (2) a) Plot the strong coupling constant  $\alpha_S$  as a function of  $\sqrt{q^2}$

$$\alpha_S(q^2) = \frac{12\pi}{(11N_c - 2N_f) \ln \frac{q^2}{\Lambda^2}}$$

for  $10 \text{ GeV} < \sqrt{q^2} < 100 \text{ GeV}$  with  $\Lambda = 0.3 \text{ GeV}$ ,  $\Lambda = 1 \text{ GeV}$  and  $\Lambda = 0.1 \text{ GeV}$ .

- b) The measured value of  $\alpha_S(Mz) = 0.1185 \pm 0.0006$ . What value of  $\Lambda$  and for what number of flavours would give this value of  $\alpha_S(Mz)$ ?
- c) How can you explain that according to the PDB the corresponding extracted value of  $\Lambda = 214 \pm 7 \text{ MeV}$ ?