PH5211 High Energy Physics   **Problem Set 2**   **28.8.2014**

1. Which of the following are allowed as strong processes? If allowed, are they real or virtual. List the complete set of quantum numbers which are not conserved, if the process is not allowed.

   1. $\Delta^+ p \to \Sigma^+ \Sigma^+$
   2. $\pi^+ \rho^- \to \lambda^0 K^0$
   3. $\Delta^{++} \Delta^0 \to \gamma\gamma$

2. At a certain value of the 4-momentum transfer, it is found that the total cross-section for $\pi^+ n \to \pi^+ n$ is equal to that for $\pi^- p \to \pi^- p$. However at this same value of the 4-momentum transfer, it is found that the cross-section for $K^+ n \to K^+ n$ is equal to 22 mb, but the crossection for $K^- p \to K^- p$ is different from this value. It is in fact 55 mb. Explain why this is so.

3. Both the ρ^0 meson and the K^0 meson decay predominantly into $\pi^+\pi^-$. But the mean life time of ρ^0 is 10^{-23} sec, while that of the K^0 is 10^{-10} sec. Explain this observation.

4. Consider the following process:
   $\Omega^- \Sigma^0 \to \Xi^0 \Xi^-$
   The relative orbital angular momentum quantum number in the initial state is equal to 0. Can this process occur at all, strongly, with final state relative orbital angular momentum equal to 0?

5. What are the Coleman-Glashow mass formulae for the baryon decimet, and the two meson octets? Are they obeyed well?

6. Write down the isospin and spin wavefunctions of the deuteron.

7. Consider a disc rotating with uniform angular velocity about the perpendicular axis of rotation passing through its centre. The disc has radius R, and upto radius a (less than R) the disc has uniform surface charge density σ. It has uniform charge density σ_1 in the rest of the disc. Try to choose the constants a, σ and σ_1 appropriately so that the total charge on the disc is 0 but there is a non-zero dipole moment, as is the case with the neutron.