

# PARTICLE PHYSICS 2 : EXERCISE 1

## 1) Symmetries of the $\Omega^-(sss)$

Explain under the consideration of the wavefunction symmetry, why the existence of the  $\Omega^-(sss)$  L=0 baryon provides evidence for a degree of freedom in addition to space×spin×flavour.

## 2) Running couplings

From the expression for the running of  $\alpha_S$  with  $N_f = 3$ , determine the value of  $Q^2$  at which  $\alpha_S$  appears to become infinite. Comment on this result.

## 3) QCD Feynman diagrams lowest-order

Draw the lowest-order QCD Feynman diagrams for the process  $p\bar{p} \rightarrow 2\text{jets} + X$  where  $X$  represents the remnants of the colliding hadrons.

## 4) Drell-Yan production

Drell-Yan production of  $\mu^+\mu^-$  pairs with an invariant mass  $Q^2$  has been studied in  $\pi^\pm$  interactions with Carbon (which has equal numbers of protons and neutrons). Explain why the ratio

$$\frac{\sigma(\pi^+C \rightarrow \mu^+\mu^-C)}{\sigma(\pi^-C \rightarrow \mu^+\mu^-C)} \quad (1)$$

tends to unity for small  $Q^2$  and tends to 1/4 as  $Q^2$  approaches s.