Chapter 5: Hadron quantum numbers

In a fixed target experiment a π^--beam is used on a proton target and the process

$$\pi^- + p \rightarrow \Delta^0 \rightarrow \pi^0 + n$$

can occur.

a) Draw a quark diagram for this process and estimate the mean distance travelled by Δ^0 before it decays, assuming it was produced with $\gamma = E/m \approx 10$.

Using 4-vectors (and perhaps Mandelstam variables):

b) Compute the π^--beam energy required to produce the above process at the Δ^0 resonance, $m(\Delta^0)$= 1230 MeV.

c) Show that, if the π^0 and n are produced with an angle $\theta=\pi/2$ between them, they can only obtain the energies

$$E(n)\ (E(\pi^0)) = E(\pi^-),$$

and

$$E(\pi^0)\ (E(n)) = m(p),$$

assuming that $m(\pi^-) = m(\pi^0)$ and m(n) = m(p).

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Chapter 6: Quark states and colours

Resonance Δ^{++} has a baryon number B=1, electric charge Q=2, and $S = C = \tilde{B} = T = 0$.

Explain why such particle can not exist unless colour charge is introduced.
Could a baryon with three down-quarks exist?