909.

Problem 56.15 (RHK)

Use the conservation laws to identify the particle labelled x in the following reactions, which proceed by means of the strong interaction. (a) $\mathrm{p} + \mathrm{p} \rightarrow \mathrm{p} + \lambda^0 + x$; (b) $\mathrm{p} + \bar{\mathrm{p}} \rightarrow \mathrm{n} + x$; (c) $\pi^- + \mathrm{p} \rightarrow \Xi^0 + K^0 + x$.

Solution:

(a)

In strong interactions charge, baryon number and strangeness are conserved. In the reaction

$$\mathrm{p} + \mathrm{p} \rightarrow \mathrm{p} + \lambda^0 + x,$$

As the baryon number of a proton is 1, the total baryon number of the initial particles is 2. As the strangeness of a proton is zero, the strangeness of the initial particles is zero. As the charge of a proton is *e*, the total charge of the final particles has to be +2*e*. Now we note that of the final particles p and λ^0 are baryons and each has a baryon number 1, so the particle *x* has to be a meson. As the strangeness of λ^0 is -1, the missing particle is a

meson with strangeness +1 and charge *e*. From the octet of mesons, we note that the particle that has strangeness +1, and charge +*e* is K^+, the particle *x* is K^+.

(b)

In the reaction

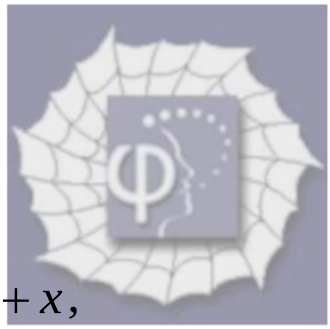
$$\mathrm{p} + \bar{\mathrm{p}} \rightarrow \mathrm{n} + x,$$

the total baryon number is 0 as proton and antiproton have baryon number of 1 and -1, respectively. As one of the two final particles is a neutron, the particle *x* is an antineutron, $\bar{\mathrm{n}}$.

(c)

In the reaction

$$\pi^- + \mathrm{p} \rightarrow \Xi^0 + K^0 + x,$$



the total charge and strangeness of the initial particles are zero, and the total baryon number is +1, as π^- is a meson and proton is a baryon and its baryon number is 1.

Of the final particles Ξ^0 is a baryon with baryon number 1 and strangeness -2, and K^0 is a meson with strangeness $+1$ and baryon number 0, therefore, the particle *x* has to have strangeness $+1$, baryon number 0, and is uncharged. Therefore, it is another K^0.