chapter 4

Chenxi Gu
2017311017

April 21, 2018

1 4.1

$$G\left|\pi^0\right\rangle = -\left|\pi^0\right\rangle \tag{1}$$

So π^0 system is G-parity eigenstate, and eigenvalue is -1.

$$G\left|\pi^+\pi^+\pi^-\right\rangle = -\left|\pi^+\pi^+\pi^-\right\rangle \tag{2}$$

So $\pi^+\pi^+\pi^-$ system is G-parity eigenstate, and eigenvalue is -1.

$$G\left|\rho^+\right\rangle = \left|\rho^+\right\rangle \tag{3}$$

So ρ^+ system is G-parity eigenstate, and eigenvalue is 1.

2 4.2

3 4.3

$$\begin{aligned} \left|\pi^+\pi^-\right\rangle &= \sqrt{\frac{1}{6}}\left|2,0\right\rangle + \sqrt{\frac{1}{2}}\left|1,0\right\rangle + \sqrt{\frac{1}{3}}\left|0,0\right\rangle \\ \left|\pi^0\pi^0\right\rangle &= \sqrt{\frac{2}{3}}\left|2,0\right\rangle - \sqrt{\frac{1}{3}}\left|0,0\right\rangle \end{aligned} \tag{4}$$

So we know $\rho^0 = |1,0\rangle$.The isospin wave function is antisymmetric. $l = J$ is odd.$P = C = -1$. Because the decay produce two π, $G = 1$.

4 4.5

(a)$S = -1, \quad Y = 0, \quad I = 1, \quad I_3 = 1$
(b)$P = P_{\pi^+}P_{\lambda^0}(-1)^L = +, \quad J = \frac{1}{2} \quad or \quad \frac{3}{2}$

5 4.7

$\rho \to \pi^0\pi^0$ is strong interaction.
forbidding reason:

- C violation:$C_{\pi^0\pi^0} = +1$, but $C_{\rho^0} = -1$
- P violation:$P_{\rho^0} = -1$, but $\pi^0\pi^0$ system wave function is symmetric
- I violation

6 4.8

- $\rho^0 \to \pi^0\gamma$: allowed
- $f^0 \to \pi^0\gamma$: C violation

7 4.10

$$\Gamma(K^-p)/\Gamma(\bar{K}^0n) = 1 \tag{5}$$

$$\Gamma(\pi^-\pi^+)/\Gamma(\bar{K}^0n) = 1 \tag{6}$$

8 4.11

	$\bar{p}p^3S_1$	$\bar{p}p^3S_1$	$\bar{p}p^1S_0$	$\bar{p}p^1S_0$	$\bar{p}n^3S_1$	$\bar{p}n^1S_0$
J^P	1^-	1^-	0^-	0^-	1^-	1^-
C	-	-	+	+	X	X
I	0	1	0	1	1	1
G	-	+	+	-	+	-

$G_{\pi^-\pi^-\pi^+} = -1$, so only left $^1\mathrm{S}_0$

$$\sigma(\bar{p}n \to \rho^0\pi^-) : \sigma(\bar{p}n \to \rho^-\pi^0) = 1 : 1 \tag{7}$$

$$\sigma(\bar{p}p(I=1) \to \rho^+\pi^-) : \sigma(\bar{p}p(I=1) \to \rho^0\pi^0) : \sigma(\bar{p}p(I=1) \to \rho^-\pi^+) = 1 : 0 : 1 \tag{8}$$

$$\sigma(\bar{p}p(I=0) \to \rho^+\pi^-) : \sigma(\bar{p}p(I=0) \to \rho^0\pi^0) : \sigma(\bar{p}p(I=0) \to \rho^-\pi^+) = 1 : 1 : 1 \tag{9}$$

9 4.12

The isospin of $\pi^0\pi^0$ system might be $|0,0\rangle$, $\quad |2,0\rangle$

10 4.13

We can find the density 0 area in fig 4.12 on text book.

11 4.14

There are two kind of deuteron state:

$$^3S_1 \quad ^3D_1 \tag{10}$$

12 4.15

For $Q = 0$:

$$\bar{c}\bar{d}\bar{d}(C = -1) \quad udd(C = 0) \quad cdd(C = 1) \tag{11}$$

For $Q = 1$:

$$uud(C = 0) \quad ucd(C = 1) \quad ccd(C = 2) \tag{12}$$

13 4.16

The quark content is udc.

14 4.17

$$sss \quad uuc \quad ucs \quad css \quad udb \tag{13}$$

15 4.18

$$c\bar{d} \quad u\bar{c} \quad u\bar{b} \quad c\bar{b} \tag{14}$$

16 4.19

- positive strangeness and negative charm : $\bar{c}\bar{s}$ is fraction charge.
- spin 0 baryon : baryon spin is fraction.Because of the quark spin $\frac{1}{2}$
- antibaryon with charge +2 : $\bar{q}\bar{q}\bar{q}$ max charge is +1.
- positive meson with strangeness -1 : $Q(\bar{q}s) <> 1$ no quark with charge $\frac{4}{3}$

17 4.20

Using the formula $Q = I_z + \frac{Y}{2}$, we can get charge.

18 4.21

- meson : +1,0,-1
- baryon : +2,+1,0,-1

19 4.22

$$\tau_{J/\psi} = \frac{\hbar}{\Gamma_{J/\psi}} = 7.25 * 10^{-21} s \tag{15}$$

$$l = \frac{\beta ct}{\sqrt{1-\beta^2}} = 3.5 * 10^{-12} \tag{16}$$

(a)$p_J = 5GeV$

$$\begin{aligned} E &= 2.94GeV \\ \theta &= 0.55 \end{aligned} \tag{17}$$

(b)$p_J = 50GeV$

$$\begin{aligned} E &= 25.048GeV \\ \theta &= 0.062 \end{aligned} \tag{18}$$

20 4.23

We could calculate the distance between primary vertex and second vertex is 1.28mm, so we should use the silicon micro-strip detector.

21 4.24

$$\int \sigma(E) dE = \frac{6\pi^2 \Gamma_e \Gamma_f}{\Gamma M_R^2} \tag{19}$$

22 4.26

(1)The isospin of baryon is $|1,0\rangle$.
(2)The ratio between two observed channels is $1:1$.

23 4.27

- $-\frac{1}{2}A_{1,0} - \frac{1}{\sqrt{6}}A_{0,0}$
- $\frac{1}{\sqrt{6}}A_{0,0}$
- $\frac{1}{2}A_{1,0} - \frac{1}{\sqrt{6}}A_{0,0}$
- $-\frac{1}{\sqrt{2}}A_{1,1}$

- $\frac{1}{\sqrt{2}}A_{1,1}$