

## Homework Set 2, due Feb. 2, 2020

**HW.1.** The  $H^+$  particle is an unstable baryon, composed of  $u, d$  and a quark, but you don't need to know that to solve this problem. The  $H^+$  used to have  $u$  spin up,  $u, d$  and is electrically neutral. Consider decay of the  $H^+$  particle into a proton and a pion  $\pi^+$ . (a quark particle with charge  $+\frac{2}{3}$ ).

- Find the direction of spin components of the  $H^+$  the  $z$ -direction (i.e. it can be along  $\pm z$  or  $\pm x$  or  $\pm y$  directions). Using conservation of angular momentum, show the first quark that decays the  $H^+$  is the  $u$  or  $\bar{u}$  quark.
- Given going up along  $z$  with spin up, given going down,  $\pm \frac{1}{2}$ .
- Compute the probability the decay along a direction  $\theta$  relative to the initial spin of the  $H^+$ . Express your answer in terms of  $\cos \theta$  and  $\sin \theta$ . (Show that you can't possibly have  $\cos \theta = 0$ .)

**HW.2** Chapter 5, Problems 5.1 to Solution 5, Neglecting. (Please refer to HW.1, see.)

**HW.3** Chapter 5, Problems 5.2 to Solution 5, Neglecting. (2000 1.1)

**HW.4** Chapter 5, Problems 5.3 to Solution 5, Neglecting.

**HW.5** Chapter 5, Problems 5.4 to Solution 5, Neglecting.

**HW.6** Chapter 5, Problems 5.5 to Solution 5, Neglecting.

**HW.7** Chapter 5, Problems 5.6 to Solution 5, Neglecting. (2000 1.1)

**HW.8** Chapter 5, Problems 5.7 to Solution 5, Neglecting.

If you have time, take a look at HW.9 and HW.10, but you don't need to solve them in. If you want to see a more challenging problem, consider trying HW.11.

(Note: QM10-1 to Solution Problem 5.8. I suggest to keep it as a bonus problem.)

1

1

H.2.1

 (a)  $\Delta^+$  decays to  $\pi^+$  and  $\pi^0$ 


(b)


 For  $\Delta^+$  spin up

$$\begin{aligned} \frac{1}{\sqrt{2}} |+\rangle &= \frac{1}{\sqrt{2}} \begin{pmatrix} u\bar{u} & -u\bar{d} \\ u\bar{d} & -u\bar{u} \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} \\ &= \frac{1}{\sqrt{2}} \begin{pmatrix} u\bar{u} \\ -u\bar{d} \end{pmatrix} = \frac{1}{\sqrt{2}} |+\rangle \end{aligned}$$

 For  $\Delta^+$  spin down

$$\begin{aligned} \frac{1}{\sqrt{2}} |-\rangle &= \frac{1}{\sqrt{2}} \begin{pmatrix} u\bar{u} & -u\bar{d} \\ u\bar{d} & -u\bar{u} \end{pmatrix} \begin{pmatrix} 0 \\ 1 \end{pmatrix} \\ &= \frac{1}{\sqrt{2}} \begin{pmatrix} -u\bar{d} \\ -u\bar{u} \end{pmatrix} \end{aligned}$$

2

# Sakurai Solutions Chapter

**Nikolay Ivanov Kolev**



**Sakurai Solutions Chapter :**

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