September 26, 2014

Cornell University, Department of Physics

PHYS 7646, Elementary particle II, HW # 3, due: 10/9/14

Question 1: Custodial symmetry and LRS models

In HW1, question 3 we discuss the LRS model. Here we discuss its implications for custodial symmetry.

1. Write down the Higgs potential of the LRS model defined in HW1.

2. Show that the global $SO(4) \sim SU(2) \times SU(2)$ symmetry of the SM Higgs potential is part of the LRS gauge group. That is, show that the $SU(2)_L \times SU(2)_R$ gauge group of LRS is that of the SM Higgs potential.

3. The first SSB stage in LRS is

$$SU(2)_L \times SU(2)_R \times U(1)_X \to SU(2)_L \times U(1)_Y \tag{1}$$

   Yet, in the SM the $SU(2)_R$ is not broken in the Higgs potential. Show that this is the general case independent of the representation of Δ_R (assuming, of course, that Δ_R can generate the require breaking).

4. In general a triplet Higgs is not "healthy" for the ρ parameter. Yet, in LRS model we have them and it is not a problem. The reason can be traced down to the custodial symmetry argument. In general we expect

$$\langle \Delta_L \rangle \sim \frac{v^2}{\langle \Delta_R \rangle} \tag{2}$$

   Thus for very large $\langle \Delta_R \rangle$ the effect of the $SU(2)_L$ triplet is small. Show that the above relation, (2) is in general satisfied one you make one fine tuning of parameters that is needed in order to get $v \ll \langle \Delta_R \rangle$

Question 2: The q^2 expansion

Using general arguments, show that there is no new dimention 6 operator that contribute to Π'''.

Question 3: FCNCs in Nature

Consider the following decays

- $K^+ \to \pi^+ \mu^+ \mu^-$
- $K^+ \to \pi^0 \mu^+ \nu$
- $D^+ \to K^+ \mu^+ \mu^-$
- $D^+ \to K_S \mu^+ \nu$
- $B^0 \to \psi K_S$
- $B^0 \to \phi K_s$

1. To each decay determined if it is a FCNC or a FCCC one.
2. Use the PDG to fund the BR of each decay.
3. Can you see a pattren?