

The Weak Nuclear Force

Question 1:

Consider a *real* scalar field, ϕ , with potential

$$V = \lambda(\phi^2 - m^2)^2$$

What symmetry does this theory possess (if it's not obvious sketch the potential). Find the vev of ϕ at the minimum and value of the potential in the vacuum. Are there Goldstone bosons in this example of the higgs mechanism?

Question 2:

Explain why a straight piece of string breaks translational invariance. Explain why waves on a string are Goldstone bosons.

Question 3:

Show that the coupling of the Z to a fermion is of the form

$$\frac{e}{\cos \theta_w \sin \theta_w} (T^3 - \sin^2 \theta_w Q)$$

Question 4: (hard)

This question explains why Cabibbo mixing only happens in the down quark sector.

Write down the most general possible form of the mass matrices that the higgs could generate in the u, c and s, d sectors being careful to include chirality labels.

What flavour rotations can you make on the quark doublets? Which of these will effect the weak eigenstate basis?

Given that in general one needs two matrices, U, V to diagonalize an arbitrary matrix ($M_{diag} = V^\dagger M U$) explain why Cabibbo mixing is only in the down quark sector.