EXERCISES

Ex. 3 Determine what types of heavy particle could generate (à la Fermi) the $d=5$ operator

$$\frac{\kappa_{ij}}{\Lambda}(L_{L_i}H)(L_{L_j}H) + \text{h.c.}$$

that leads to Majorana masses for ν_L's. Find all different possibilities, giving for each the quantum numbers of the heavy particle being exchanged.

Ex. 4 Given that neutrinos are massive and their flavors mix, they induce a contribution to $\mu \to e\gamma$, which gives

$$BR(\mu\to e\gamma) = \frac{3\alpha}{32\pi}\left|\sum_i U^*_{\mu i} U_{ei} \frac{m^2_{\nu_i}}{M^2_W}\right|^2 \sim 10^{-52} \quad (!)$$

where $U_{\alpha i}$ is the flavor mixing matrix for neutrinos, that relates flavor and mass eigenstates as $\nu_{L\alpha} = \sum_i U_{\alpha i}\nu_i$. Draw the diagram that contributes to this decay and explain, using symmetry arguments, why the BR above is proportional to the fourth power of neutrino masses.