Part I
LeptoQuark Mediated Neutrino Mass:

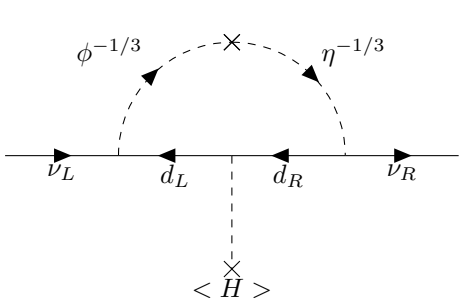
1 2×LQ

2 options:

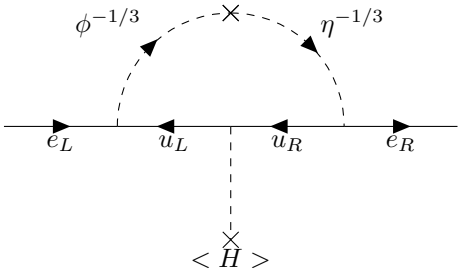
1. $e_R = +(S) \implies$ tree level
2. $e_R = -(S) \implies$ 1 loop level

$$m_\nu \propto x\left(M_d\right) x\prime \quad m_e \propto x\left(M_u\right) x\prime\prime \quad h \implies e^- e^+ \left(1+?\right) \text{ where } \mathcal{A} \sim m_e$$

- Phenomenology of the LQ→? and h→? decays?!
- Rare processes!

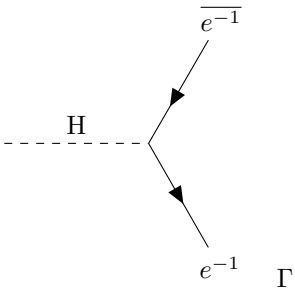


(a) Diagram contributing to Direac Neutrino Mass.

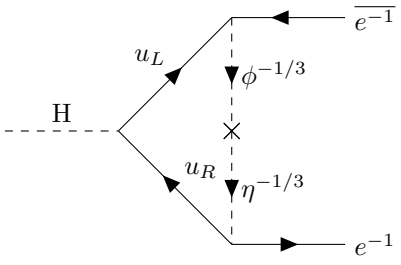


(b) Diagram contributing to Dirac Charged Lepton Mass.

Figure 1: LeptoQuark mediated 1 loop Lepton Mass Diagrams.

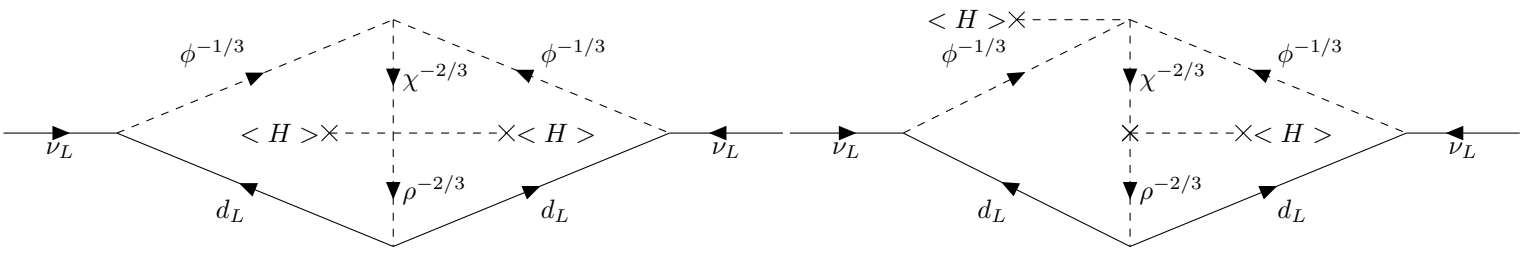


$\Gamma \sim m_e$?



$\Gamma \sim m_e f\left(1+?\right)$?

2 Other tries



3 1 loop, 1 LQ, d_R mixing model

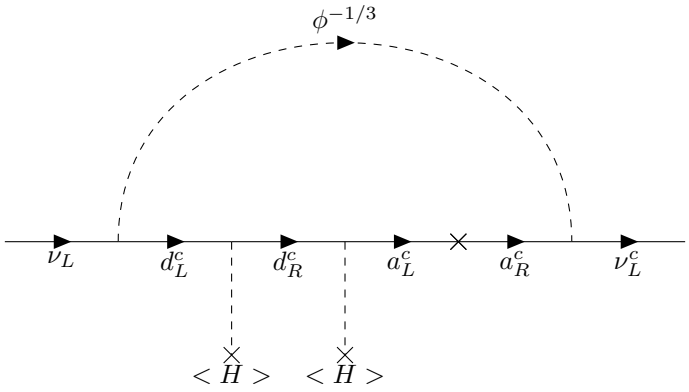


Figure 2: Neutrino Mass Diagram through d quark mixing.

Particle	$SU(3)_c$	$SU(2)_L$	$U(1)_Y$	S	Flavour
Q	3	2	1/6		3
d_R^c	3^*	1	+1/3		3
u_R^c	3^*	1	-2/3		3
L	1	2	-1/2		3
e_R^c	1	1	+1		3
$A_{R,L}$	3	2	-5/6		3
H	1	2	1/2		1
ϕ	3	1	-1/3		1

$$\begin{aligned}
\mathcal{L}^Y_{new,4D} &\subset y_1 \underbrace{\overline{Q_L^c} L}_{\left(\overline{d_L^c}\nu_L - \overline{u_L^c} e_L\right)} \phi^* + y_2 \overline{u_R^c} e_R \phi^* + y_3 \overline{A_R} L \phi + y_\epsilon \overline{d_R} A_L H + h.c. \\
\mathcal{L}_{3D} &\subset \mathcal{M}_A \overline{A} A \\
V(H,\phi) &= -m_1^2 |H|^2 + \frac{\lambda_1}{4} |H|^4 + m_2^2 |\phi|^2 + \frac{\lambda_2}{4} |\phi|^4 + \lambda_3 \left(H^\dagger H\right) |\phi|^2
\end{aligned}$$

$$\mathcal{L}_{\text{eff mix}} = \overline{\begin{pmatrix} d_L & a_L^{-1/3} \end{pmatrix}} \mathcal{M}_{\text{da}} \begin{pmatrix} d_R \\ a_R \end{pmatrix} + h.c. \,, \quad \text{where } \underbrace{\mathcal{M}_{\text{da}}}_{6\times 6} = \begin{pmatrix} y_d \nu & 0 \\ y_\epsilon \nu & M_A \end{pmatrix}$$

Potential problems:

- $d^{-1/3}\, a^{-1/3}$ mixing and its experimental bounds.
- v bound state bounds!
- $\not{CP}$ from phases in the 6×6 mixing matrix!
- ...