A COMPARATIVE STUDY OF $0\nu\beta\beta$ DECAY IN SYMMETRIC AND ASYMMETRIC LEFT-RIGHT MODEL

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NEUTRINO 2020 XXIX INTERNATIONAL CONFERENCE ON NEUTRINO PHYSICS

LEFT-RIGHT SYMMETRIC MODEL

- Theoretical predictions of Standard Model pass the tests of almost all collider discoveries so far.
- Though some discrepencies still persist :
  - Explanation of Small neutrino mass generation.
  - Observed parity violation in low-energy weak interactions.

  ⇒ Under the umbrella of Left-Right symmetric Models (LRSMs)[1], we have a unified explanation for both of them.
- **Gauge Group** $\mathcal{G}_{LRSM}$: $SU(3)_C \otimes SU(2)_L \otimes SU(2)_R \otimes U(1)_{B-L}$.

AIM

- New physics contributions to neutrinoless double beta decay ($0\nu\beta\beta$)[2] in a TeV scale LR model with spontaneous D-parity breaking.
- Comparative study for three different cases; (i) for manifest symmetric left-right symmetric model ($g_L = g_R$), (ii) for LR model with spontaneous D parity breaking ($g_L \neq g_R$), (iii) for Pati-Salam symmetry with D parity breaking ($g_L \neq g_R$).

STANDARD $W_L - W_L$ MEDIATION

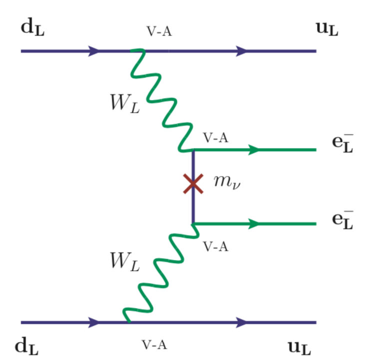

Figure 1: Standard $W_L - W_L$ mediation contribution.

- Amplitude in neutrino mass basis,

$$\mathcal{A}_{LL} \simeq G_F^2 \sum_i \left(\frac{\mathcal{V}_{ei}^{\nu\nu^2} m_i}{p^2} - \frac{\mathcal{V}_{ei}^{\nu S^2}}{M_{S_i}} - \frac{\mathcal{V}_{ei}^{\nu N^2}}{M_{N_i}} \right).$$

PURELY $W_R - W_R$ MEDIATION

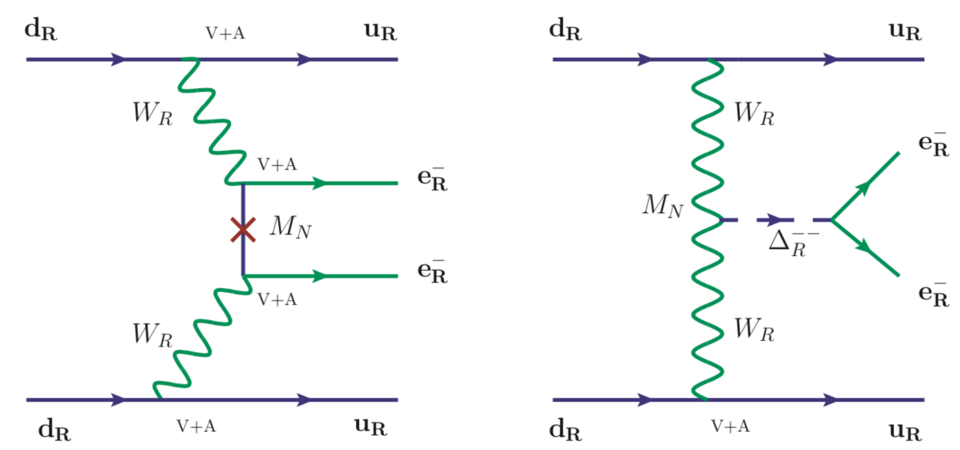

Figure 2: Left Panel : Standard $W_R - W_R$ contribution, Right Panel : Right-handed currents with doubly charged scalar exchange.

$$\mathcal{A}_{RR} \simeq G_F^2 \left(\frac{M_{W_L}}{M_{W_R}}\right)^4 \left(\frac{g_L}{g_R}\right)^4 \sum_i \left(\frac{\mathcal{V}_{ei}^{N\nu^2} m_i}{p^2} - \frac{\mathcal{V}_{ei}^{NS^2}}{M_{S_i}} - \frac{\mathcal{V}_{ei}^{NN^2}}{M_{N_i}} \right).$$

$$\mathcal{A}_{\Delta_R} \simeq G_F^2 \left(\frac{M_{W_L}}{M_{W_R}}\right)^4 \left(\frac{g_L}{g_R}\right)^4 \sum_i \frac{\mathcal{V}_{ei}^2 M_i}{m_{\Delta_R^{--}}^2}.$$

$W_L - W_R$ MIXED CONTRIBUTION

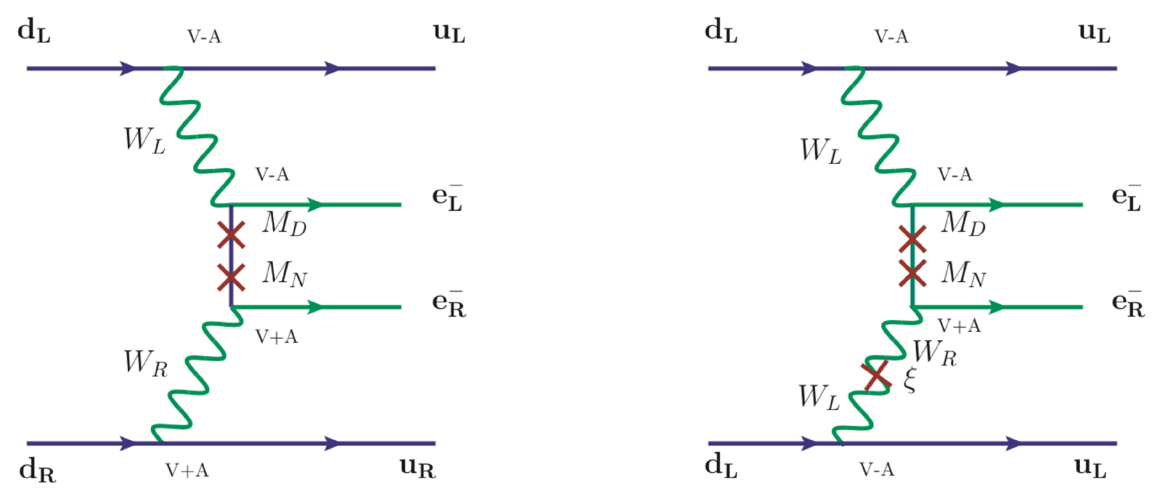

Figure 3: Mixed helicity λ and η diagrams.

$$\mathcal{A}_{LR} \simeq G_F^2 \left[\left(\frac{M_{W_L}}{M_{W_R}}\right)^2 \left(\frac{g_L}{g_R}\right)^2 (1+\tan\xi) + \tan\xi \right] \sum_i \left(\frac{\mathcal{V}_{ei}^{\nu\nu}\mathcal{V}_{ei}^{N\nu^*}}{\gamma.p} - \frac{\mathcal{V}_{ei}^{\nu S}\mathcal{V}_{ei}^{NS^*}\gamma.p}{M_{S_i}^2} - \frac{\mathcal{V}_{ei}^{\nu N}\mathcal{V}_{ei}^{NN^*}\gamma.p}{M_{N_i}^2} \right).$$

- We will consider $\left(\frac{g_R}{g_L}\right) \equiv \delta$.

DEPENDENCE OF VARIOUS PARAMETERS ON δ

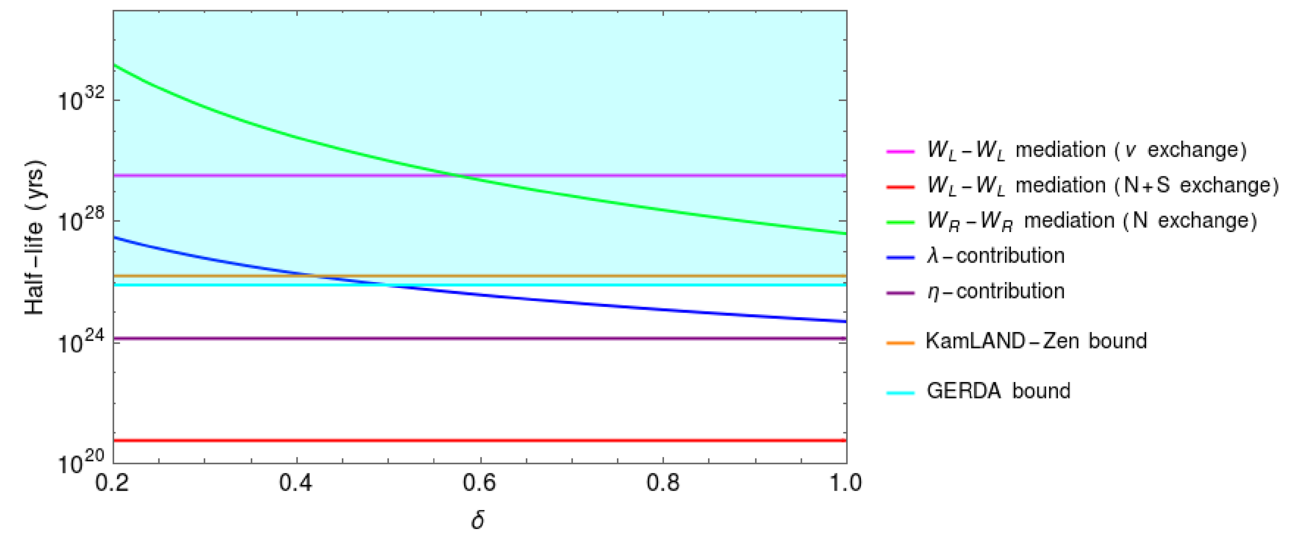

Figure 4: Dependence of half-life due to individual contribution on the ratio δ.

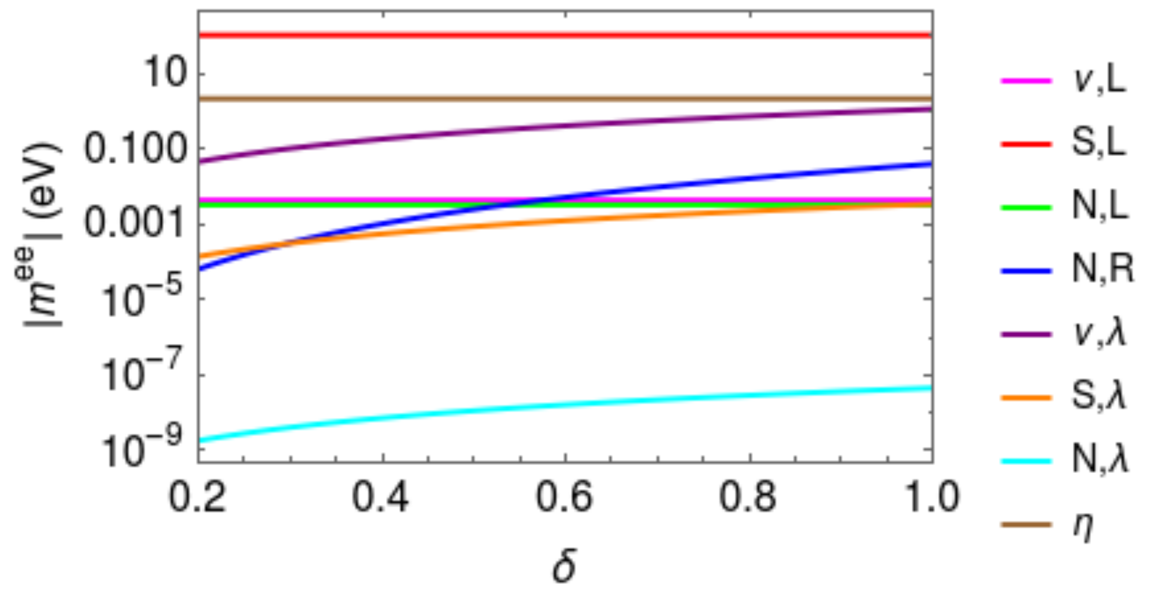

Figure 5: Dependence of effective mass parameters arising due to individual contribution on δ.

- Cyan shaded region in Fig.4 corresponds to allowed region for half-life permitted by GERDA experiment which is clearly saturating by various individual contributions within this framework.

DEPENDENCE OF VARIOUS PARAMETERS ON M_{W_R} (FOR DIFFERENT δ'S)

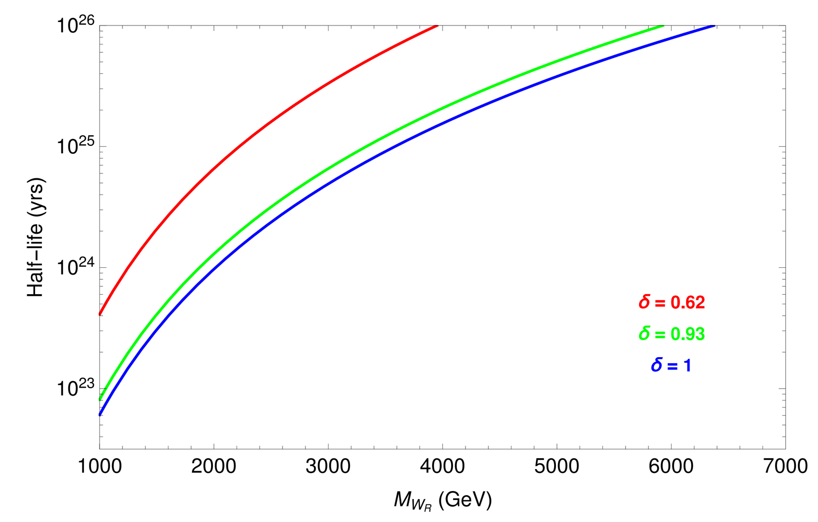

Figure 6: Dependency of half-life due to λ-contribution on M_{W_R}.

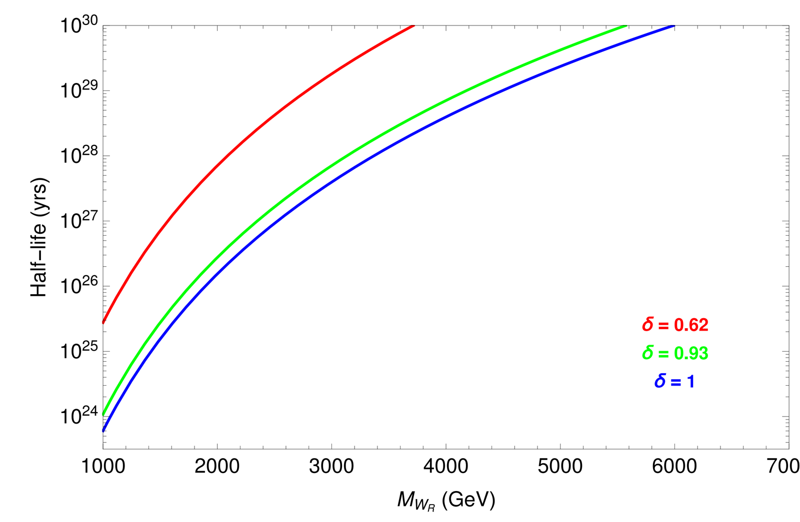

Figure 7: Dependency of half-life contribution due to RH neutrino exchange on M_{W_R}.

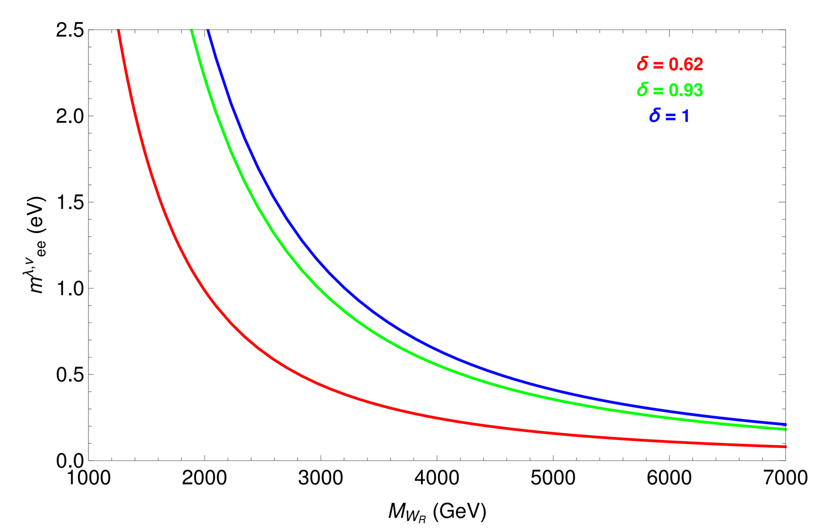

Figure 8: Plots for effective mass parameter due to λ-diagram *vs* M_{W_R}.

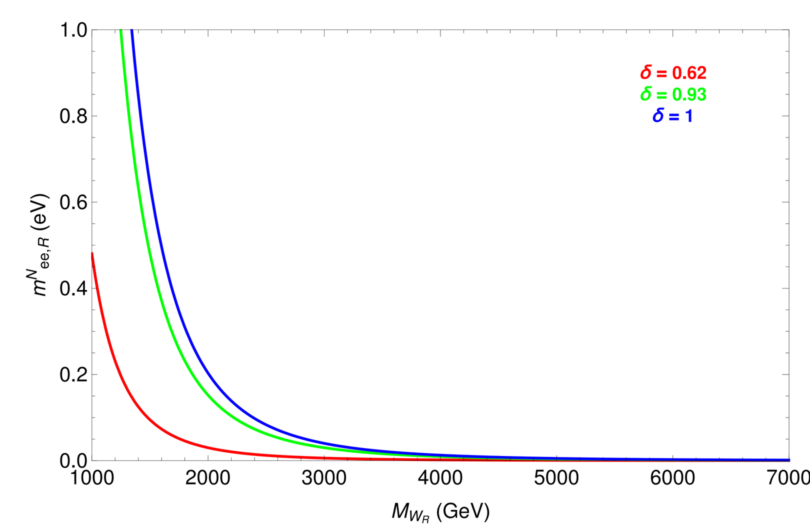

Figure 9: Plots for effective mass parameter due to RH neutrino exchange *vs* M_{W_R}.

- We have considered $\delta = 1$ for symmetric LRSM, $\delta = 0.93$ or 0.62 corresponds to asymmetric LRSM without or with Pati-Salam symmetry.
- Introducing Pati-Salam symmetry, we have found a sizeable enhancement in half-life prediction with respect to asymmetric LRSM without Pati-Salam symmetry (Details can be found in arxiv:2001.09488).

REFERENCES

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