Neutrino phenomenology, (g-2)$_{\mu,e}$ with U(1) gauge symmetries in inverse seesaw framework

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1. Introduction

- We have taken two anomaly-free gauge symmetries $(U(1)_{B-L} \times U(1)_{L_e-L_\mu}$ in the framework of inverse seesaw mechanism to study neutrino phenomenology.
- As the extra particles over Standard Model particles, three right-handed neutrinos, three left-handed neutral fermions and two scalar singlets are taken.
- In addition to neutrino phenomenology, we have studied electron and muon (g-2), non-unitarity, neutrinoless double beta decay to complete the neutrino physics study.

2. Model Description

- Particles present in the proposed model are grouped in following table:

	Particles	$SU(2)_L \times U(1)_Y$	$U(1)_{B-L}$	$U(1)_{L_e-L_\mu}$
Fermions	l_L	$(\mathbf{2}, -1)$	-1	$1, -1, 0$
	l_R	$(\mathbf{1}, -2)$	-1	$1, -1, 0$
	$N_{iR}(i = 1, 2, 3)$	$(\mathbf{1}, 0)$	-1	$1, -1, 0$
	$S_{iL}(i = 1, 2, 3)$	$(\mathbf{1}, 0)$	0	0
Scalars	H	$(\mathbf{2}, 1)$	0	0
	χ_1	$(\mathbf{1}, 0)$	-1	1
	χ_2	$(\mathbf{1}, 0)$	1	0

- The Lagrangian for lepton sector is,

$$\begin{aligned}\mathcal{L}_{lepton} \supset\ & \mathcal{L}_{SM} + [y_D^e \bar{\ell}_{eL} \tilde{H} N_{1R} + y_D^\mu \bar{\ell}_{\mu L} \tilde{H} N_{2R} + y_D^\tau \bar{\ell}_{\tau L} \tilde{H} N_{3R}] \\ + & [y_{NS}^{11} \bar{N}_{1R} S_{1L} \chi_1 + y_{NS}^{12} \bar{N}_{1R} S_{2L} \chi_1 + y_{NS}^{13} \bar{N}_{1R} S_{3L} \chi_1 + y_{NS}^{33} \bar{N}_{3R} S_{3L} \chi_2^*] \\ + & [\mu_1 \bar{S}_{1L}^C S_{1L} + \mu_2 \bar{S}_{2L}^C S_{2L} + \mu_3 \bar{S}_{3L}^C S_{3L}] + h.c. \end{aligned} \tag{1}$$

- Active neutrino mass matrix in inverse seesaw mechanism framework can be written as:

$$m_\nu = M_D^T (M_{NS}^{-1})^T M_\mu M_{NS}^{-1} M_D \ . \tag{2}$$

3. $0\nu\beta\beta$ effective mass

- Neutrinoless double beta decay (NDBD) is one of the experiment to know the nature of neutrinos (is it Dirac or Majorana).
- The expression for NDBD is:

$$(A, Z) \to (A, Z + 2) + 2e^+ \ , \tag{3}$$

- In our work, we have found the bound on effective mass of NDBD is [0.005-0.02] meV.

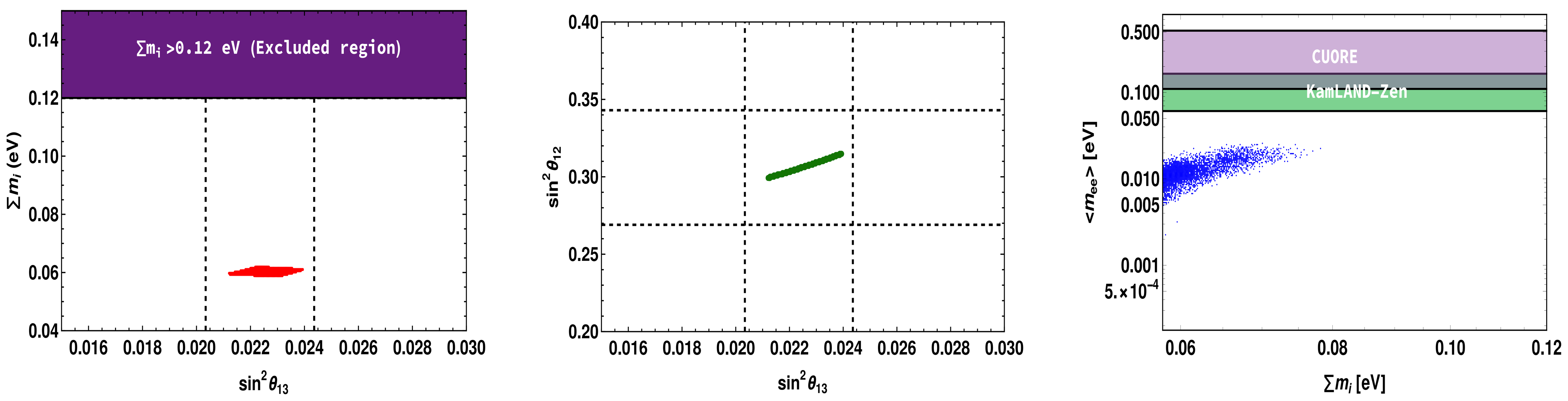
4. Non-unitarity

- The expression for non-unitarity mixing matrix is:

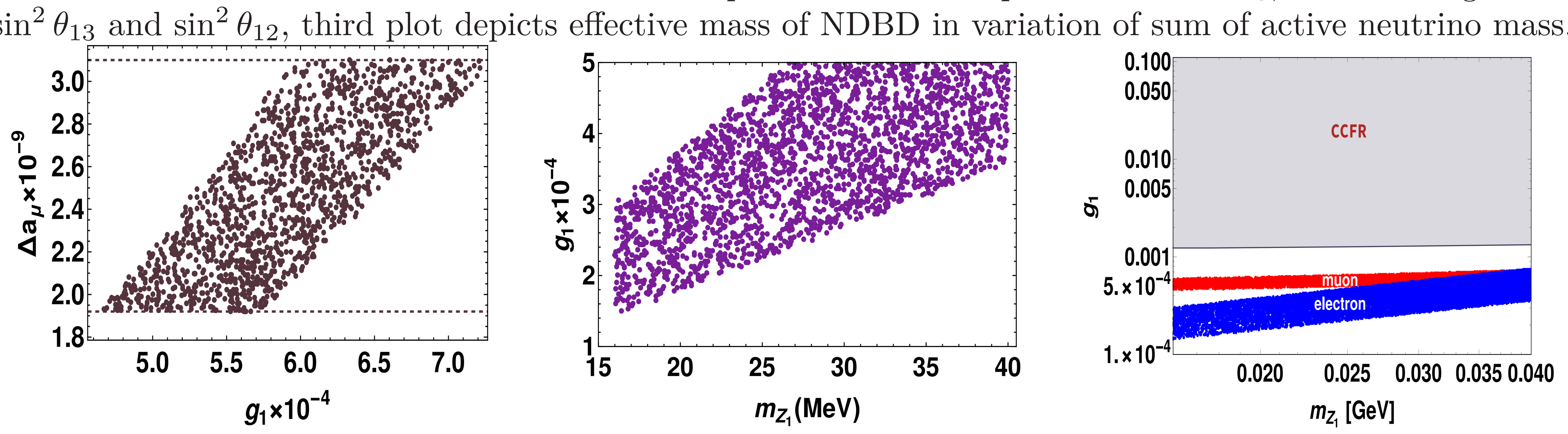
$$N = (1 - \eta)\ U_{\text{PMNS}} \tag{4}$$

- We have calculated the non-unitary parameter η which is well below to the experimental upper limit.

5. Results



First plot shows the variation of sum of active neutrino mass with respect to oscillation parameter $\sin^2\theta_{13}$, second one gives the correlation plot of $\sin^2\theta_{13}$ and $\sin^2\theta_{12}$, third plot depicts effective mass of NDBD in variation of sum of active neutrino mass.



Leftmost plot shows the variation of muon anomalous magnetic moment with the variation of gauge coupling g_1, middle one gives the allowed range of gauge coupling g_1 with the appropriate range of m_{Z_1}, rightmost plot depicts the variation of coupling with mass of gauge boson with CCFR bound.

6. Conclusions

- Inverse seesaw mechanism is a very strong method for giving eV scale mass to active neutrinos.
- Two anomaly free gauge symmetries (over SM symmetry) successfully explain neutrino phenomenology, non-unitarity, effective mass of neutrinoless double beta decay, electron and muon anomalous magnetic moment.
- Two MeV scale singlet are present in the proposed model which can also be traced in recent and future experiments.

7. Reference

- P. Panda, P. Mishra, M. K. Behera, R. Mohanta, arXiv:2203.14536 [hep-ph].

8. Acknowledgement

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