Here α and G_F, respectively, are the fine-structure constant and the Fermi constant, θ_i^2 is the mixing angle defined by

$$\theta_i^2 = \frac{\left(m_D^\dagger m_D\right)_{ii}}{m_{\chi_i}^2} = \mathcal{O}\left[\left(\frac{M_N^D}{M_N^M}\right)^2\right]\frac{v_L^2}{v_R^2}\,. \tag{43}$$

With the previous parameter choice, we can determine the mixing angle to be $\theta_i^2 \simeq 10^{-22}$. Therefore the decay into the electron-positron pairs (42b) can [26] provide a natural explanation for the flux of 511 keV photons from the galactic bulge observed by INTEGRAL [27] satellite,

$$\frac{\Phi_{511\gamma}}{\Phi_{\rm exp}} \simeq \Sigma_i \frac{\theta_i^2}{10^{-22}}\left(\frac{m_{\chi_i}}{1.3\,\mathrm{MeV}}\right)^4 \frac{\Omega_{\chi_i}}{\Omega_\chi}\,. \tag{44}$$

It is easy to check that our scenario is consistent with other astrophysical and cosmological constraints [28]. Alternatively, we may explain the observed cosmic positron/electron excess [29–33], which is probably from continuum distribution of pulsars [34, 35], by fine tuning the parameters.

V. CONCLUSION

In summary we have shown the dark matter can be well determined by the neutrino masses and the baryon asymmetry in the left-right symmetric model with doublet and singlet fields. In this model, the SM fermions obtain masses by integrating out charged singlet fermions. In the neutrino sector, the right(left)-handed neutral fermions, associated with the left(right)-handed Higgs doublet, can generate the left(right)-handed neutrino masses through the seesaw. The mass matrices of the left- and right-handed neutrinos have a same structure as a result of the left-right symmetry. The neutral singlets are also responsible for the baryon asymmetry and the dark matter. Specifically their 2-body decays can produce a desired lepton asymmetry in the left-handed leptons and then the observed baryon asymmetry can be realized by the sphaleron induced lepton-to-baryon conversion. At the same time, the right-handed neutrinos can serve as the dark matter as they have a right relic density from the 3-body decays of the neutral singlets. The decays of these non-thermally produced right-handed neutrinos can easily induce the observed fluxes of 511 keV photons from the Galactic bulge. The attractive feature of our scenario is that the left-right symmetry can connect the properties of the dark matter to the neutrino masses and the baryon asymmetry.

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