

Thermal Relic Sterile ν DM diluted by Leptogenesis

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Introduction

3 problems of the SM can be solved by ν_R
 Production mechanism of ν_R as DM is unknown

Q. Is it possible to ...

- produce ν_R DM as a **thermal relic**?
- explain m_ν , BAU and DM **simultaneously**?

$$\mathcal{L}_\nu = -y\bar{L}\tilde{\Phi}\nu_R$$

Phenomena beyond the SM	Solution by ν_R
Neutrino Masses	Seesaw mech.
Baryon Asymmetry of the Universe	Leptogenesis
Dark Matter	small y

Model

SM+	For ...
3 ν_R	N_1 : DM, N_2 : Decay, N_3 : CP violation
Gauge Int. of ν_R	Production of $N_{1,2}$
2 Higgs	Majorana Masses

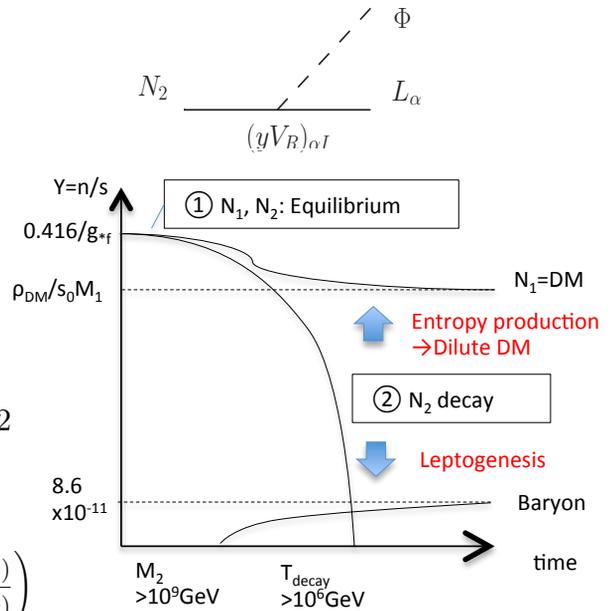
(e. g. Left Right Symmetric Model : $SU(2)_L \times SU(2)_R \times U(1)_{B-L}$)

Seesaw;
$$m_\nu = M_L - v^2 y M_R^{-1} y^T$$

DM ;
$$\Omega_{DM} h^2 = 0.12 \times 9.5 \frac{M_1}{\text{keV}} \frac{S_{\text{before}}}{S_{\text{after}}} = 0.12$$

Leptogenesis;
$$Y_B = -\frac{28}{79} \epsilon Y_{N_2}^{\text{eq}} \frac{S_{\text{before}}}{S_{\text{after}}} = 8.6 \times 10^{-11}$$

$$\left(\frac{S_{\text{after}}}{S_{\text{before}}} \propto \Gamma_{\text{decay}}^{-1/2}, \epsilon \equiv \frac{\Gamma(N_2 \rightarrow L\Phi) - \Gamma(N_2 \rightarrow \bar{L}\bar{\Phi})}{\Gamma(N_2 \rightarrow L\Phi) + \Gamma(N_2 \rightarrow \bar{L}\bar{\Phi})} \right)$$



Result

Constraints on parameters;

$$yv \equiv iV_\nu^* (X_\nu^{\text{diag}})^{1/2} R (M_R^{\text{diag}})^{1/2} V_R^\dagger$$

$$X_\nu \equiv m_\nu - M_L$$

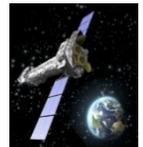
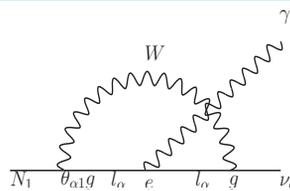
$$X_1 \lesssim 10^{-10}, X_2 \lesssim 10^{-5}, X_3 \gtrsim 0.1 \text{ (eV)}$$

$$R \simeq \begin{pmatrix} -R_{22} & 1 & -R_{32} \\ 1 & R_{22} & -R_{31} \\ R_{31} & R_{32} & 1 \end{pmatrix} \quad (\Rightarrow M_L \neq 0)$$

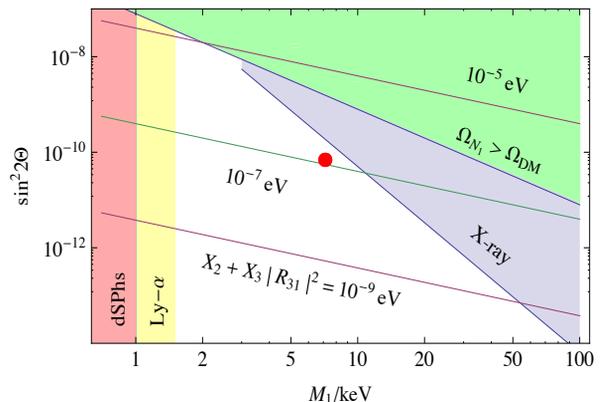
$$|R_{22,31}|^2 \lesssim 10^{-5}, |R_{32}|^2 \lesssim 10^{-10} \ll 1$$

N_1 DM can be searched by X-ray obs.

$$\Gamma_{N_1 \rightarrow \nu\gamma} = \frac{1}{1.8 \times 10^{21} \text{s}} \Theta_1^2 \left(\frac{M_1}{\text{keV}} \right)^5$$



Detection? by XMM-Newton (arXiv: 1402.2301, 1402.4119)



Summary

1. N_1 DM is produced as a thermal relic (over production 😞)

2. Decay of N_2 dilute N_1 and produce matter-anti-matter asymmetry 😊

Conclusion: ν masses, DM, asymmetry of matter can be explained **simultaneously**