Low-scale leptogenesis and dark matter

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Model and motivations

$$L_{SS} = L_{SM} - \sum_{\alpha,i} \bar{L}_\alpha Y^{\alpha,i} \tilde{\phi} N_i - \sum_{i,j=1}^{2} \frac{1}{2} \bar{N}_i^c M_N^{i,j} N_i + h.c$$

- Explain observed neutrino masses
- Explain Matter-Antimatter asymmetry if $M_N \in [1,100] GeV$ → ARS mechanism
- Testable scenario

Is it possible to extend the model to solve other issues of the SM and, in particular, include a *Dark Matter candidate*? It is essential that at least one of the sterile neutrino does NOT equilibrate before the electroweak phase transition.

$$H(T_{EW}) = \frac{T^2{}_{EW}}{M_{Pl}} \geq \Gamma_\alpha(T_{EW})$$

Otherwise lepton asymmetry is washed out!

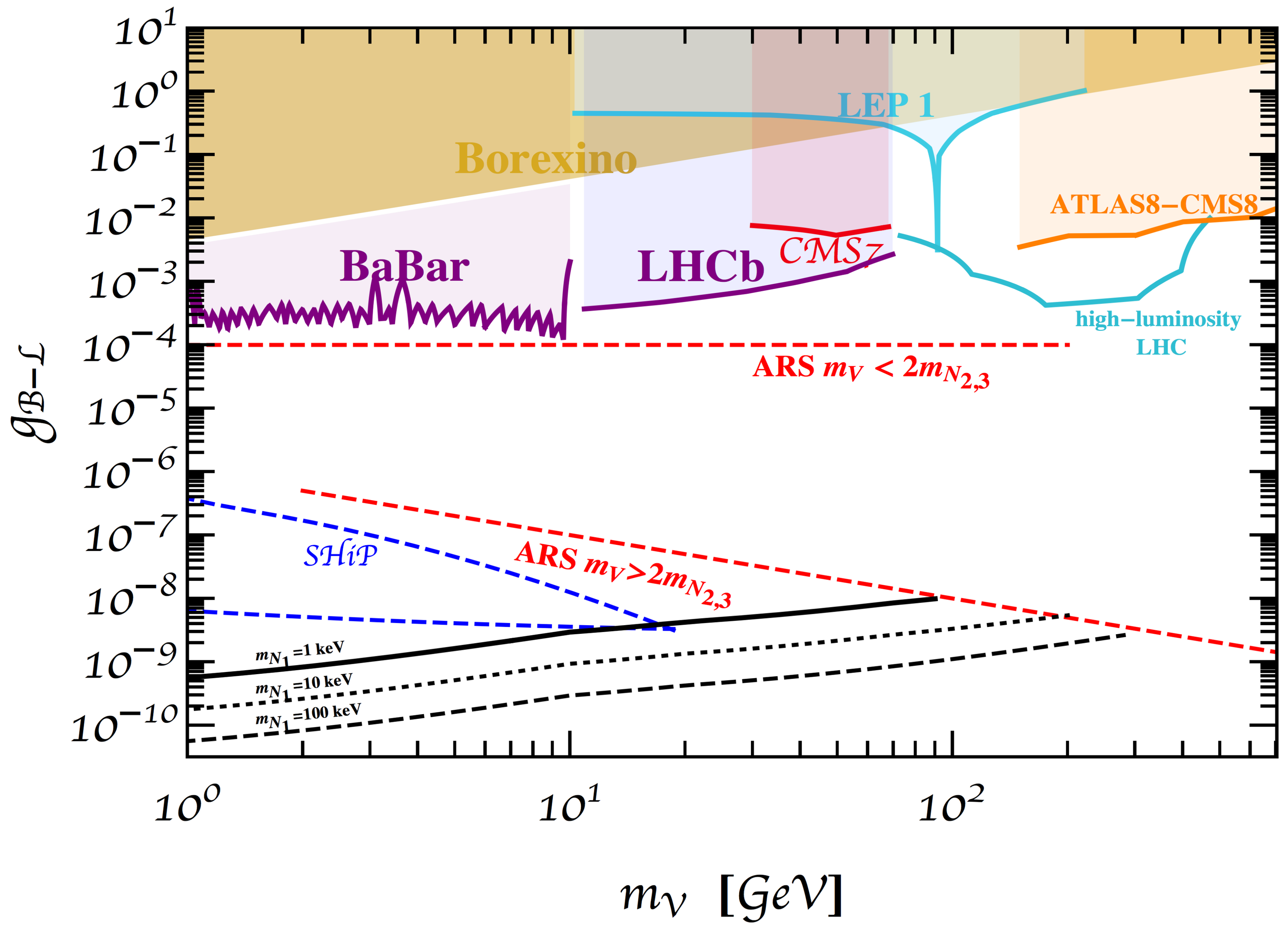
B-L gauge symmetry

$$\mathcal{L} \supset g_{B-L}\left(\sum_f Q^f_{B-L} V_\mu \bar{f}\gamma^\mu f - \sum_\alpha V_\mu \overline{N_\alpha}\gamma^\mu N_\alpha\right)$$

If one promote the B-L global symmetry of the SM to a local one, anomaly cancelation requires the introductio of three sterile neutrino. Two of them can be at the GeV scale and drive low-scale leptogenesis

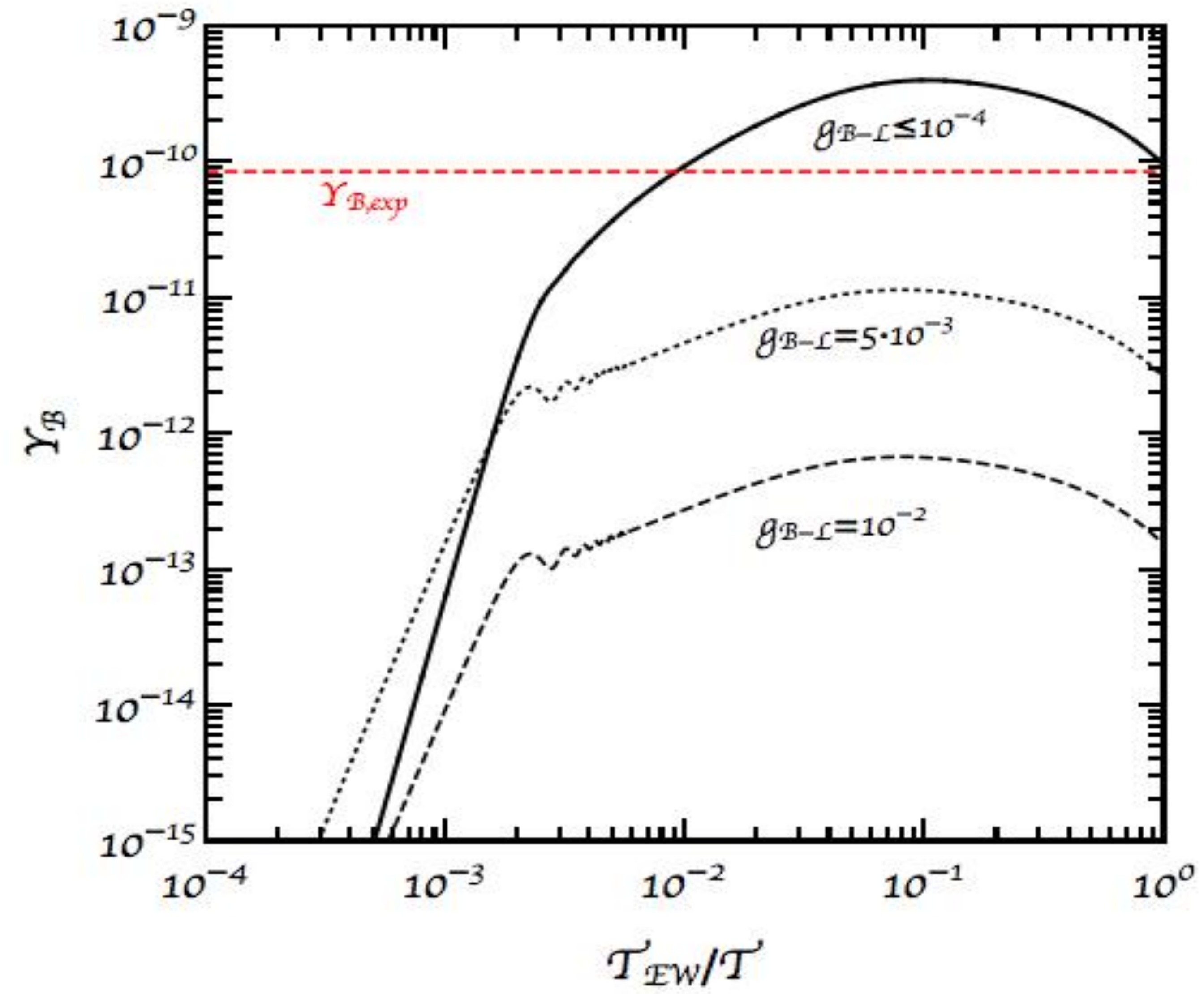
$$H(T_{EW}) > \Gamma_{EW}(f\bar{f} \to NN) \propto g^4_{B-L} T_{EW}$$

→ $g_{B-L} \leq 10^{-4}$



Baryon asymmetry

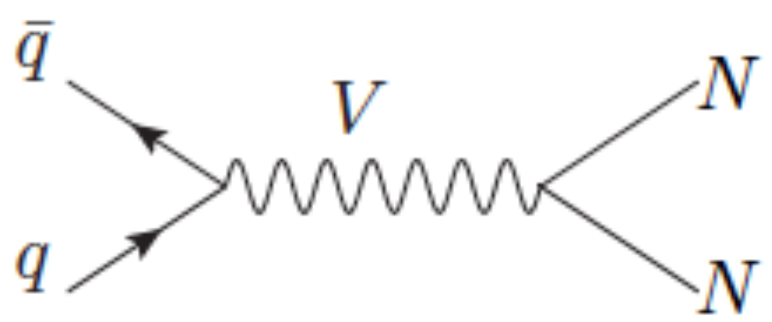
To take properly into account these new interactions one has to add new collision terms in the Raffelt-Sigl kinetic equations for neutrinos



Dark matter

Candidate: third sterile neutrino, lighter than the others

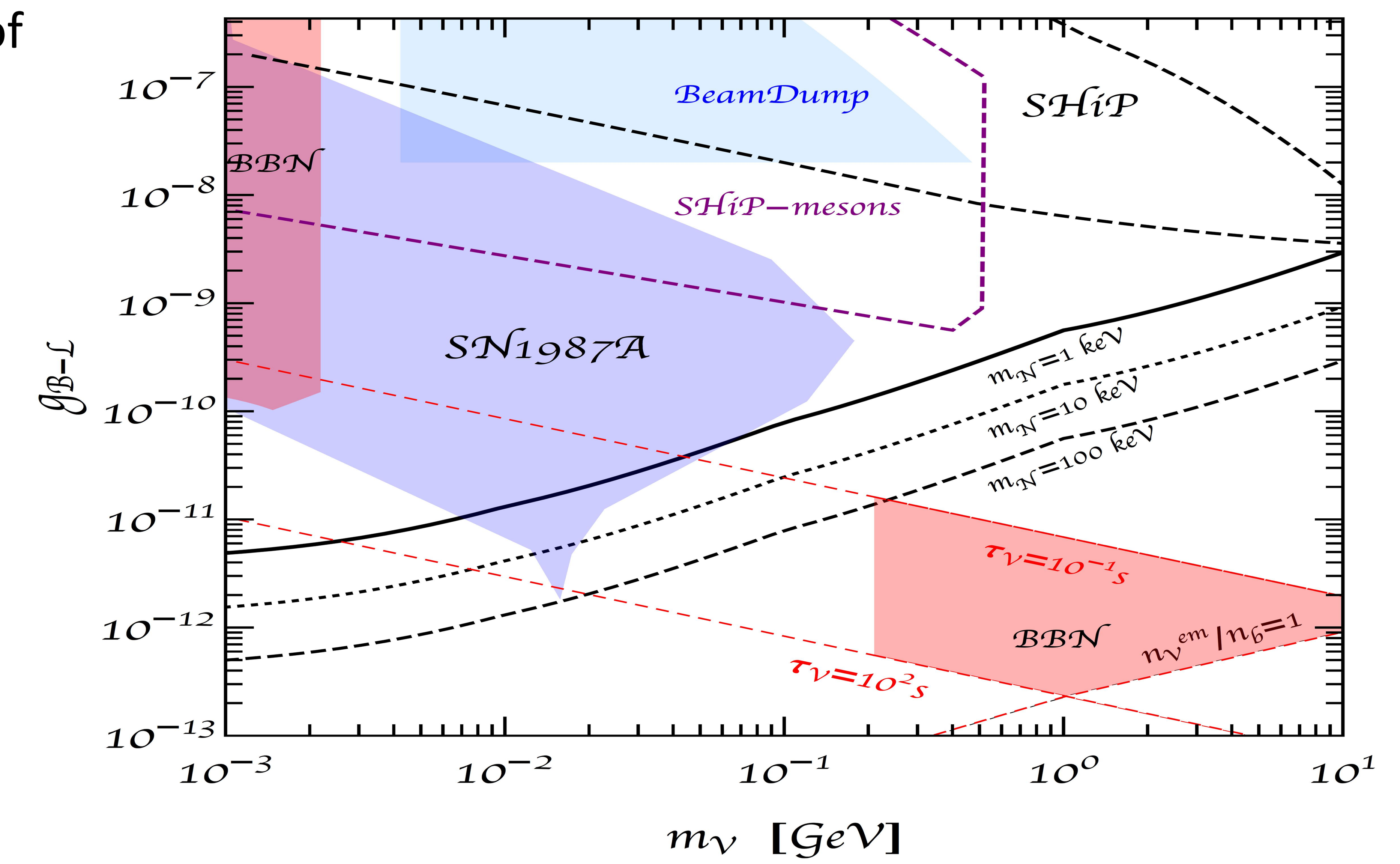
Production: freeze-in via the B-L gauge boson



$$\frac{dY_N}{dT} = -\frac{2}{HT\left[1 + \frac{T}{3g_*}\frac{dg_*}{dT}\right]} \frac{K_1(x)}{K_2(x)} \Gamma(V \to NN) Y_V$$

Produced via inverse decay of SM particles

Both N and V produced through freeze-in



Summary

ARS mechanism explains baryon asymmetry in the Universe; however the simplest model does not include a good dark matter candidate. If one wants to extend the model to explain also dark matter, has to take care that the new interactions introduced do not spoil leptogenesis. We showed that this typically leads to freez-in scenarios or to particular flavor structures; here we described in particular the case of B-L gauged.