Dark Matter Annihilating into Sterile Neutrino

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Introduction to Seesaw Mechanisms

- This slide is based on JHEP 1603 (2016) 043, Yi-Lei Tang, Shou-Hua Zhu, and arXiv:1609.07841.

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- For linear see-saw or inverse see-saw (pseudo-Dirac sterile neutrino), y_ν can be as large as 10^{-3}.

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- 2) MSSM+(B-L)Z', R. Allahverdi, et.al., 0907.1486, etc.,
- In this model, there are some parameter space that DM+DM→ $N + N$ can dominate.

Current fittings on the galactic center excess of the γ-ray

- DM $\rightarrow b\bar{b}$ fits the **g**alactic **c**enter **e**xcess (GCE) well. W^+W^-, ZZ, $t\bar{t}$ do not.

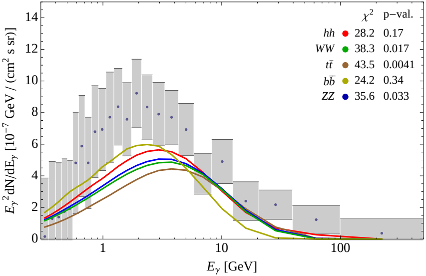

Figure : From arXiv:1411.2592, by Prateek Agrawal, Brian Batell, Patrick J. Fox, and Roni Harnik. Data from F. Calore, et.al., 1409.0042.

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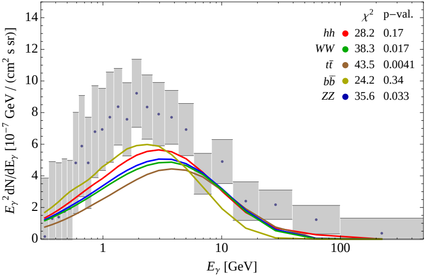

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- The key is the position of the peak and the length of the tail! $W/Z/t$ is too heavy for a lighter peak.

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- The best-fitted points are $m_N = 32.0$ GeV, $m_\chi = 44.2$ GeV, with $\chi^2 = 24.22$ and the best-fitted $\langle \sigma v \rangle = 2.63 \times 10^{-26}\text{cm}^3/\text{s}$ for the $y_1 = y_2 = 0$, $y_3 \neq 0$ case, and $m_N = 27.0$ GeV, $m_\chi = 45.4$ GeV, with $\chi^2 = 23.81$ and the best-fitted $\langle \sigma v \rangle = 3.37 \times 10^{-26}\text{cm}^3/\text{s}$ for the $y_3 = 0$, $y_1^2 + y_2^2 \neq 0$ case.

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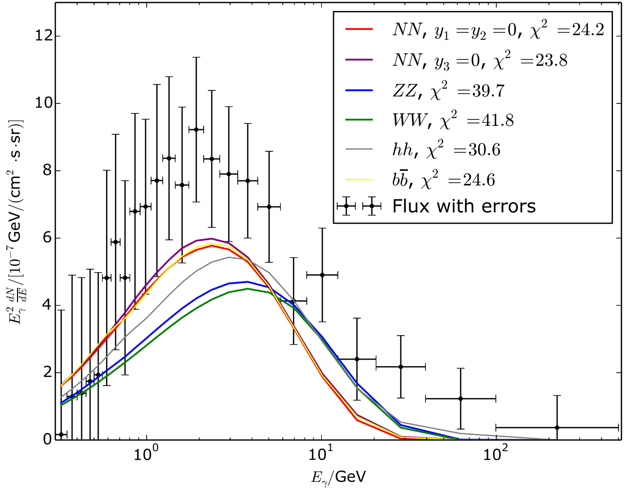

Model Independent Analysis of the GCE Originating From DM+DM→ $N + N$

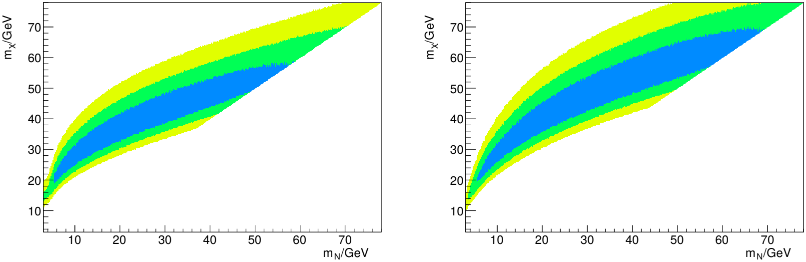

Figure : 1,2,3-σ area fitting the GCE data

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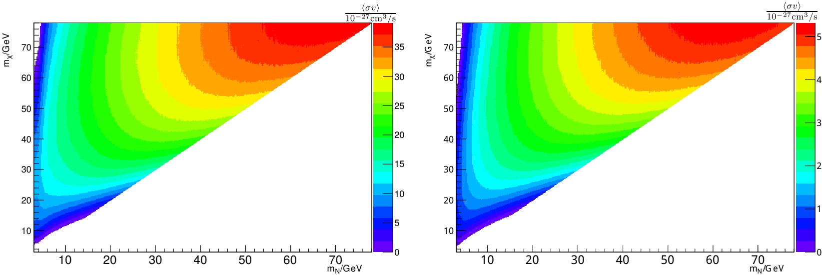

Figure : Best-fitted $\langle\sigma v\rangle$ for the γ-ray GCE

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- For the pseudo-Dirac sterile neutrinos, y_{N_D} can ~ 0.01, however, when $T < m_{N_D}$, the effective decay/inverse-decay rate drops rapidly.
- Secluded dark matter.

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- ϕ can interact with the Higgs boson through the $\phi \phi H^\dagger H$ terms.

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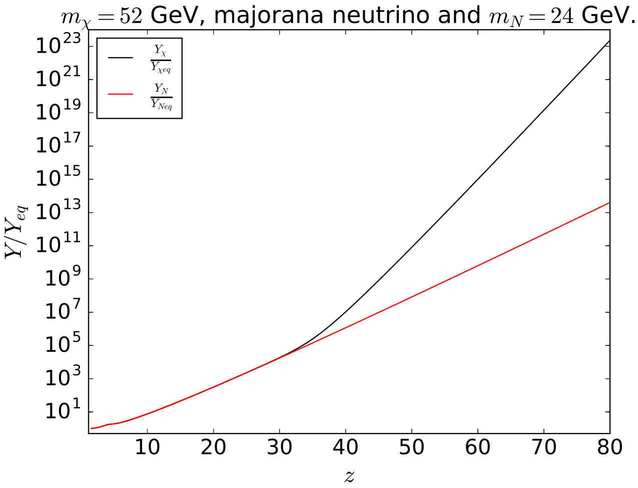
- The contribution from the $W/Z/\gamma^T$ in the thermal bath was estimated according to the method introduced in Phys.Rev.Lett. 117 (2016) no.9, 091801.

Results

- Calculate in a completed Boltzmann equation,



Results

- In order for a correct relic abundance, the interactions of the $\chi\chi \to N_{(D)}N_{(D)}$ should be stronger than the usual standard WIMP calculations!
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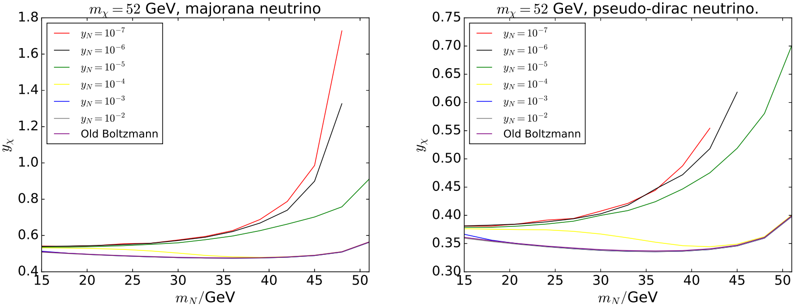

Future Plan

- Future plan: to build a complete supersymmetric/nonsupersymmetric model that dark matter $\rightarrow$ RHN. Explaining neutrino mass spectrum and mixing patterns, leptogenesis, etc....

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