

# Sneutrino Dark Matter in the BLSSM

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March 14, 2018



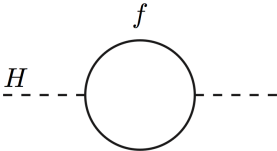
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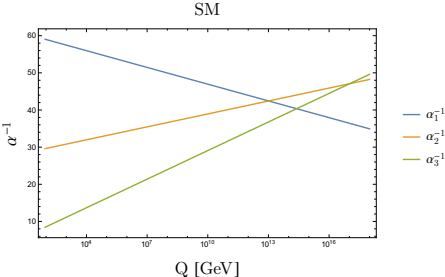
In collaboration with L. Delle Rose, S. Khalil, S. Kulkarni, C. Marzo, S. Moretti, C.S. Ün [arXiv: 1712.05232]

# Motivations

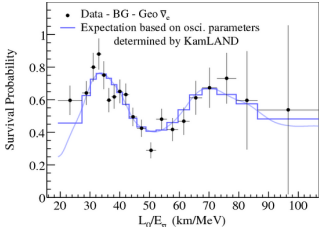
- Hierarchy Problem



- Unification



- Non-vanishing Neutrino Masses

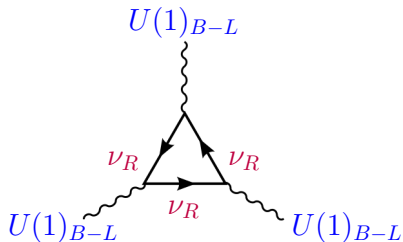


- Dark Matter



# What is the BLSSM?

- SM has **exact** B-L conservation
- Promote global symmetry to local. Gauge group now:  
 $G_{B-L} = G_{SM} \times U(1)_{B-L}$
- Require 3  $\nu_R$  for anomaly cancellation

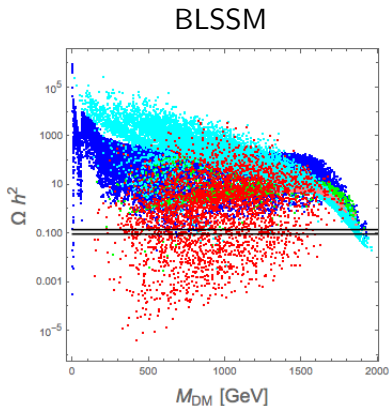
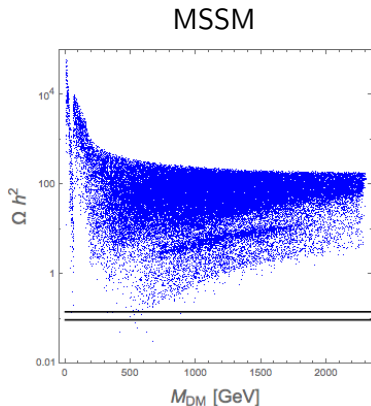


Chiral Superfield		Spin 0	Spin 1/2	$G_{B-L}$
RH Sneutrinos / Neutrinos (x3) Bileptons/Bileptinos	$\hat{\nu}$	$\tilde{\nu}_R^*$	$\bar{\nu}_R$	$(\mathbf{1}, \mathbf{1}, 0, \frac{1}{2})$
	$\hat{\eta}$	$\eta$	$\tilde{\eta}$	$(\mathbf{1}, \mathbf{1}, 0, -1)$
	$\hat{\bar{\eta}}$	$\bar{\eta}$	$\tilde{\bar{\eta}}$	$(\mathbf{1}, \mathbf{1}, 0, 1)$
Vector Superfields		Spin 1/2	Spin 1	$G_{B-L}$
BLino / B' boson		$\tilde{B}'^0$	$B'^0$	$(\mathbf{1}, \mathbf{1}, 0, 0)$

Figure: Content in addition to MSSM

# DM Review: MSSM vs BLSSM

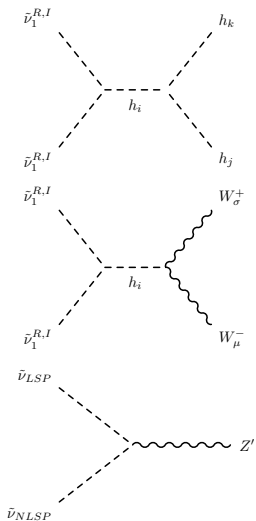
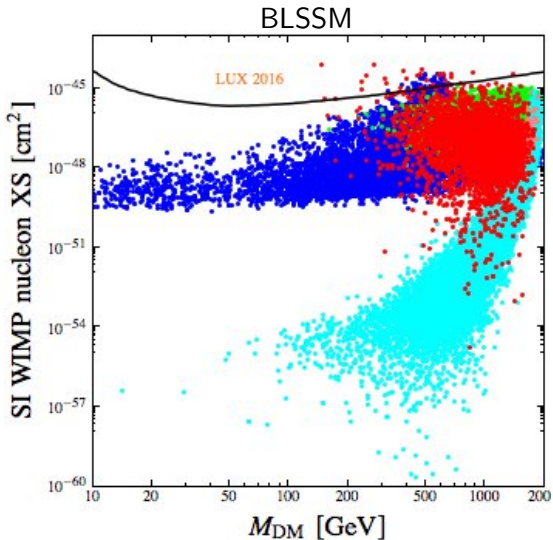
- R-parity: ad hoc in MSSM. **Natural** in BLSSM:  $R = (-1)^{3(B-L)+2S}$



Candidates: Bino ( $\tilde{B}^0$ ), **Sneutrino ( $\tilde{\nu}_R^*$ )**, Bileptino ( $\tilde{\eta}, \tilde{\bar{\eta}}$ ), BLino ( $\tilde{B}'^0$ )

# Direct Detection

- **RH Sneutrino** interact through heavy Higgs &  $Z'$  interactions  $\rightarrow$  not too constrained

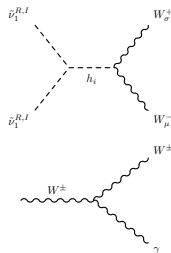
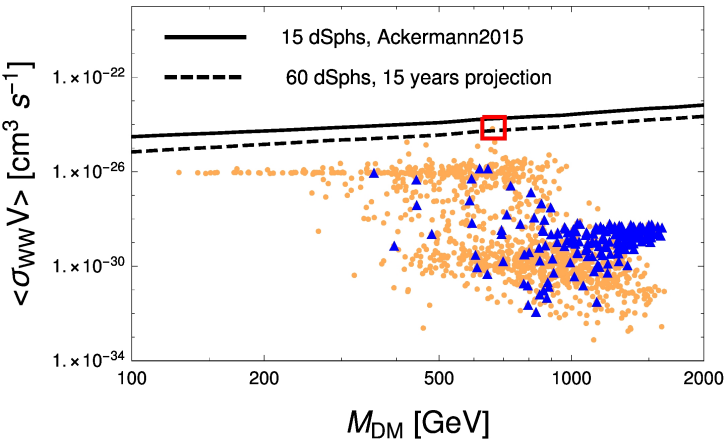


# Indirect Detection

- Fermi-LAT data beginning to probe parameter space!

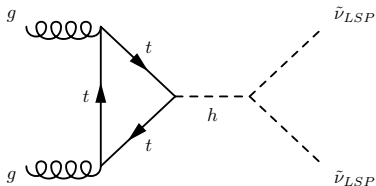
CP-odd CP-even

BLSSM

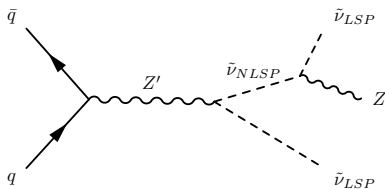


# LHC Signatures I

- No  $SU(2)_L$  quantum numbers, interactions via  $(Z, W^\pm) \propto Y_\nu \approx 0$
- Direct production: **Higgs**. Problem - only **MET** signal (mono-jet, VBF with invisible Higgs decay)

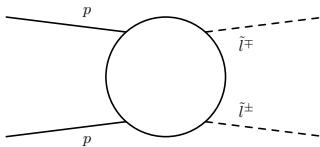


- Direct production:  $Z'$ . Dilepton signal, but  $Z'$  heavy (4 TeV), so low cross section -  $\sigma = 0.025 \text{ fb}$

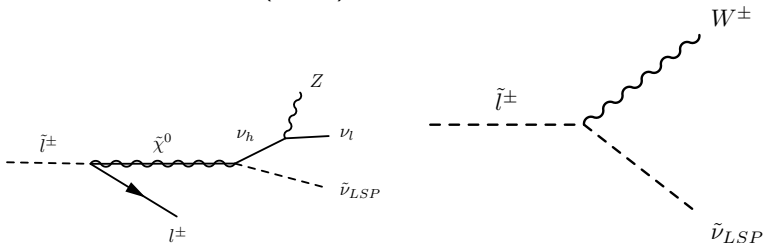


## LHC Signatures II

- Indirect production: **Slepton pair production!**  $\sigma \sim 0.1\text{fb}$



- Decay path of slepton:  $\tilde{l}^{\pm} \rightarrow l^{\pm} \tilde{\chi}^0$
- May also have  $\tilde{l}^{\pm} \rightarrow W^{\pm} \tilde{\nu}_{LSP}$  for points where  $M_{\tilde{\chi}^0} > M_{\tilde{l}}$ , despite small vertex coupling ( $\propto Y_{\nu}$ ).





# Conclusions

- The BLSSM ...
  - Solves the hierarchy problem
  - predicts light, non-vanishing left-handed neutrino masses
  - offers much larger parameter space than the MSSM
- RH Sneutrino DM...
  - Perfectly matches relic density limits
  - Evades direct-detection limits
  - May be probed by future indirect-detection experiments
  - Offers interesting collider signatures, which will be accessible during run-II

For more details, see:  
arXiv: 1712.05232