

Neutralino Dark Matter and Other LHC Predictions from Quasi Yukawa Unification

Şükrü Hanif Tanyıldızı

Bogoliubov Laboratory of Theoretical Physics
Joint Institute for Nuclear Research

Helmholtz - DIAS International Summer School
and Workshop
20-30 July 2015

The chosen model

Determination of violated sectors on GUT scale

Scanning procedure and constraints

Expectations and results

We explore:

Pati, Salam Phys.Rev.D10,275,(1974)

1. Neutralino Dark Matter
2. LHC implications of t-b- τ quasi Yukawa Unification

$$y_t : y_b : y_\tau = |1 + C| : |1 - C| : |1 + 3C| \quad \longrightarrow \quad \text{Yukawa couplings at } M_{\text{GUT}}$$

Implications in the framework on SUSY models based on

$$G = SU(4)_c \times SU(2)_L \times SU(2)_R$$

4-2-2 model has some salient features:

King,Shafi, Phys. Lett. B 422, 135 (1998)

1. Discrete LR symmetry reduces the number of gauge couplings from three to two with $g_L = g_R$ and M of $SU(2)_L = M$ of $SU(2)_R$.
2. The matter fields of each family belongs to

$$\psi(4, 2, 1) \text{ and } \psi_c(\bar{4}, 1, 2)$$

3. The LR symmetry requires the existence of right handed neutrino.

Considered constraints:

$$m_h = (123 - 127) \text{ GeV}$$

$$m_{\tilde{g}} > 1 \text{ TeV}$$

$$0.8 \times 10^{-9} \leq \text{BR}(B_s \rightarrow \mu^+ \mu^-) \leq 6.2 \times 10^{-9} \text{ (} 2\sigma \text{)}$$

$$2.99 \times 10^{-4} \leq \text{BR}(b \rightarrow s\gamma) \leq 3.87 \times 10^{-4} \text{ (} 2\sigma \text{)}$$

$$0.15 \leq \frac{\text{BR}(B_u \rightarrow \tau\nu_\tau)_{\text{MSSM}}}{\text{BR}(B_u \rightarrow \tau\nu_\tau)_{\text{SM}}} \leq 2.41 \text{ (} 3\sigma \text{)}$$

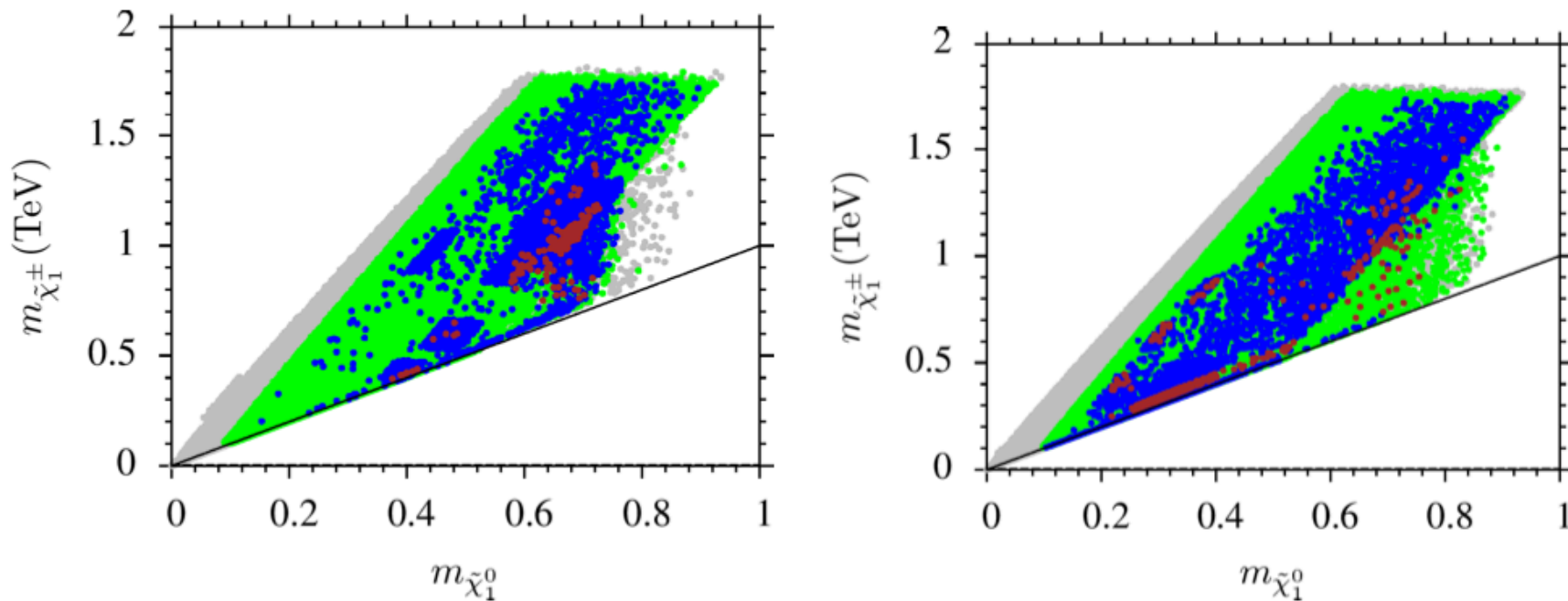
$$0.0913 \leq \Omega_{\text{CDM}} h^2 \leq 0.1363 \text{ (} 5\sigma \text{)}.$$

LSP neutralino and Coannihilation Scenarios:

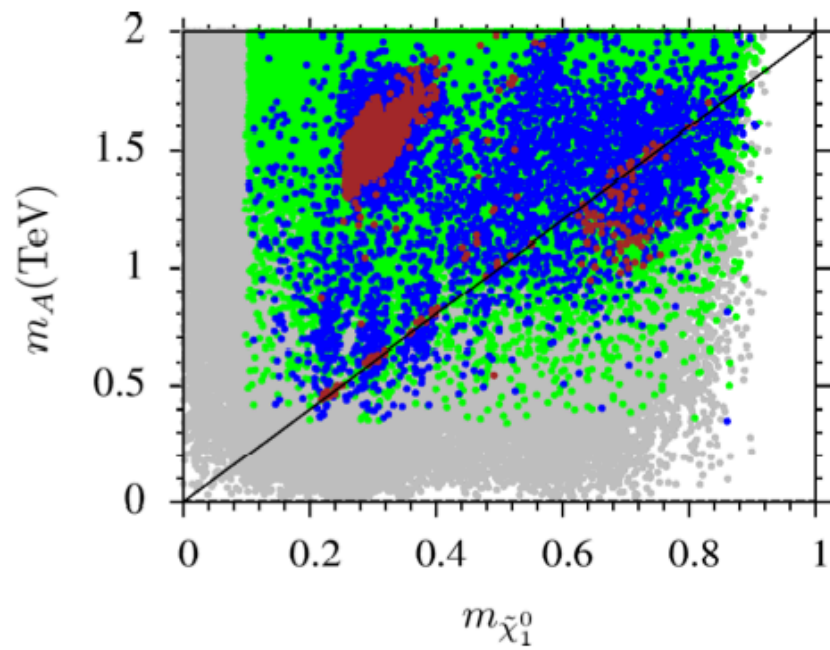
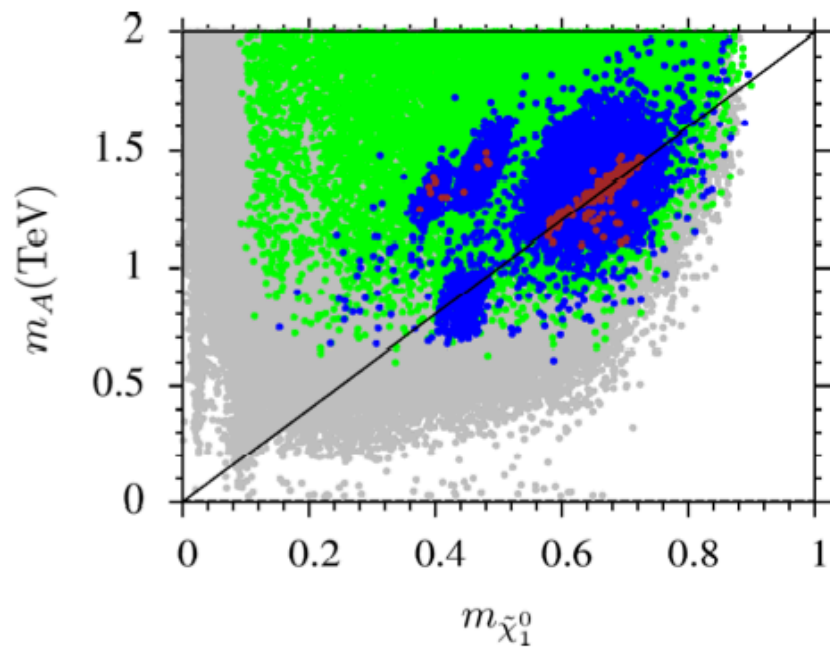
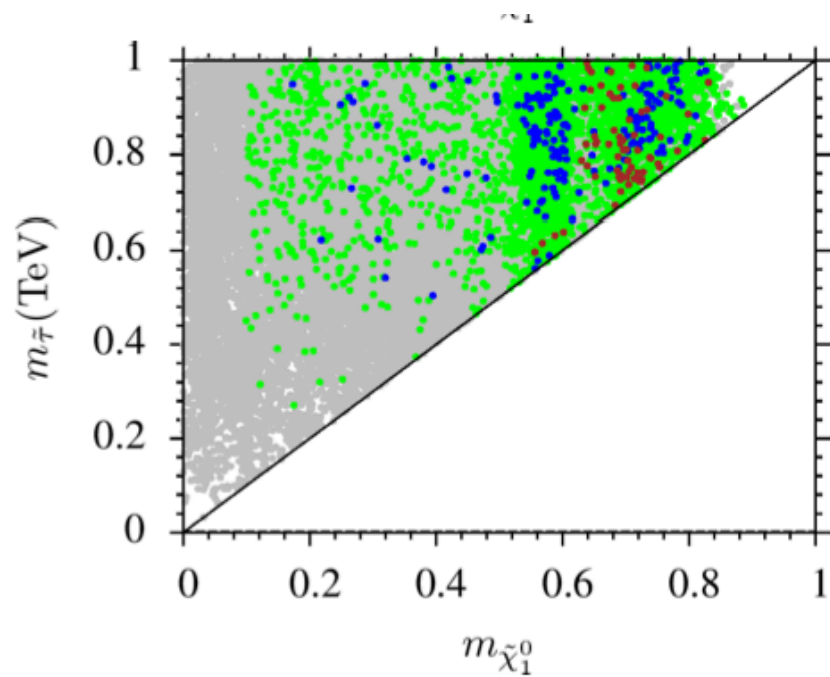
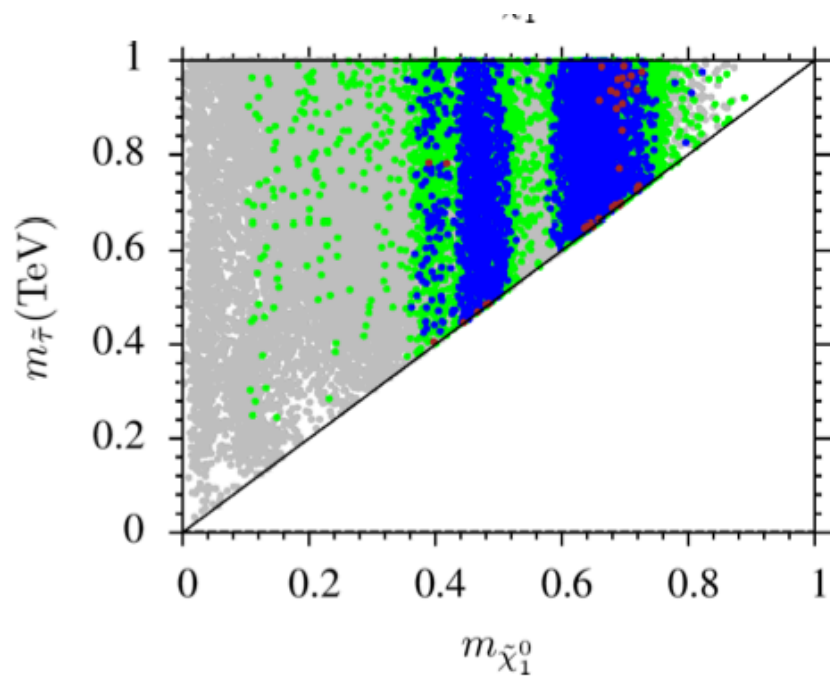
We accept only the solutions which lead to LSP neutralino, then the implications can be on the dark matter observables.

LSP neutralino \longrightarrow bino \longrightarrow relic abundance is so high \sim WMAP

Solution is coannihilation channels:



Green: ν constraints from parameter space and B-physics.
Blue: ν condition for quasi Yukawa Unification and “green”.
Red: ν Relic density for LSP neutralino and “green” and “blue”.



Higgsino(-like) LSP:

In the previous slides we identified coannihilation channels and A-resonans.

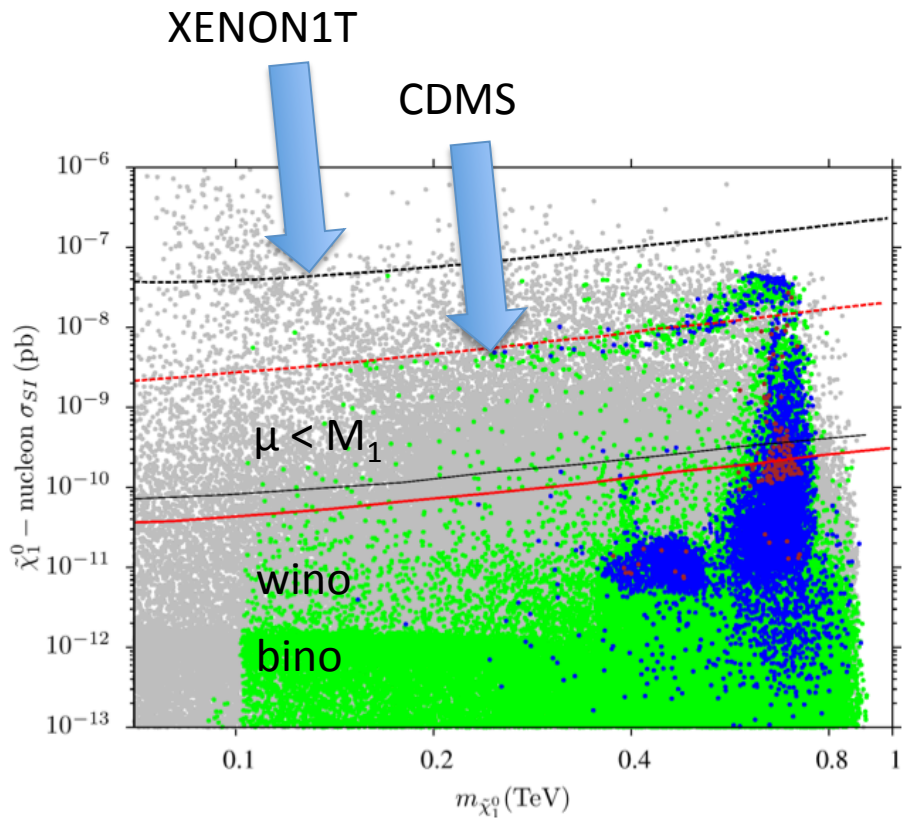
They reduce relic abundance of LSP neutralino.

Alternative scenario is Higgsino LSP.

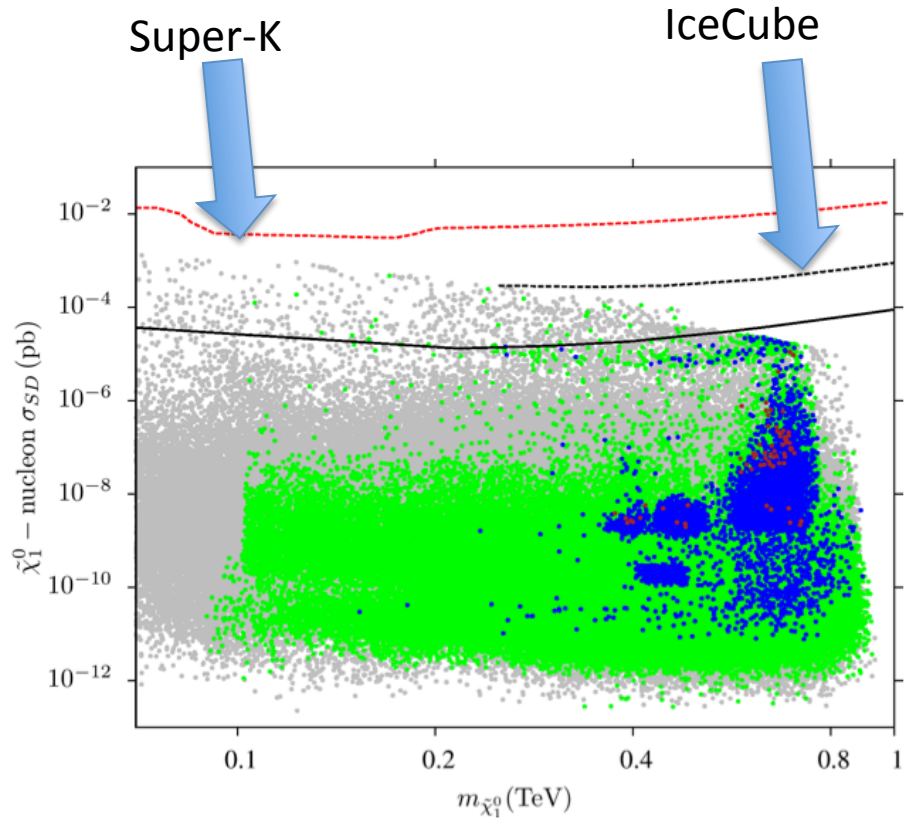
This case opens up possibilities for direct detection experiments via relic LSP neutralino scattering on nuclei.

Scattering on nuclei: $\mu < M_1$, hence $m_{\tilde{H}} < \text{bino}$ and LSP-higgsino.
 $M_2 < M_1$ hence LSP – wino.

spin independent



spin dependent



This presentation is based on the letter:

Neutralino Dark Matter and Other LHC Predictions from Quasi Yukawa Unification

Qaisar Shafi (Delaware U., Bartol Inst.)

Şükrü Hanif Tanyıldızı (BLTP, JINR)

Cem Salih Ün (Uludag U.)

e-Print: [arXiv:1503.04196](https://arxiv.org/abs/1503.04196) under review in Phys.Rev.D.