Revisiting mGMSB in light of a 125 GeV Higgs

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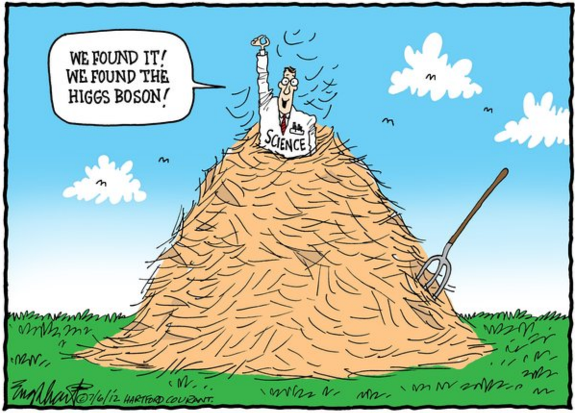
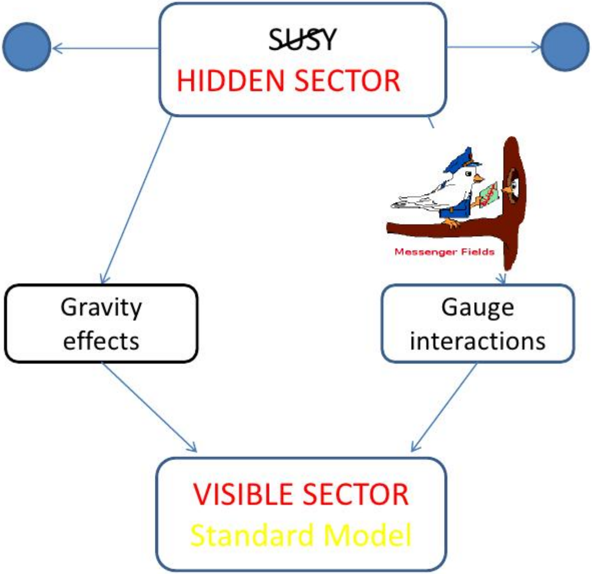
Motivation



- **Can the discovery of the Higgs shed light on the SUSY breaking mechanisms?**

SUSY Breaking



Gauge Mediated SUSY Breaking

- In mGMSB, $\not{SUSY}$ is mediated through gauge interactions.

$$
\begin{aligned}
W &\supseteq y_1 S\, \ell\, \bar{\ell} + y_2 S\, q\, \bar{q} \\
S &\rightarrow \langle S \rangle + \theta^2 \langle F \rangle
\end{aligned}
$$

- $\not{SUSY}$ transmitted through radiative corrections.

- The mGMSB spectrum is completely specified by the following parameters defined at the messenger scale:

$$M_{\rm mess}, \Lambda, \tan\beta, sign(\mu), n_5, c_{\rm grav}.$$

where $\Lambda = \langle F \rangle / \langle S \rangle$.

Some Features of mGMSB

- Gaugino masses generated at 1-loop level

$$M_i \propto n_5 \Lambda$$

- Scalar masses generated at 2-loop level

$$m \propto \sqrt{n_5} \Lambda$$

- A-terms ≈ 0 at M_{mess} and are generated at low scale through RGE running.

- In mGMSB the gravitino constitutes DM with mass

$$m_{\tilde{G}} = \frac{F}{\sqrt{3} M_P}$$

Higgs mass in the MSSM

- One loop contributions to the CP-even Higgs boson mass:

$$m_h^2 \approx M_Z^2 \cos^2 2\beta \left(1 - \frac{3}{8\pi^2}\frac{m_t^2}{v^2}t\right) + \frac{3}{4\pi^2}\frac{m_t^4}{v^2}\left[t + \frac{1}{2}X_t\right]$$

where $t = \log\left(\frac{M_S^2}{M_t^2}\right)$.

- To get the right Higgs mass ($\sim$125 GeV), the sparticle masses are pushed to higher values.

III. Results and Conclusions.

Gauge Mediated SUSY Breaking

- We perform random scans for the following range of the mGMSB parameter space:

$$\begin{aligned} 0 \leq & \quad \Lambda & \leq 10^7 \ \mathrm{GeV} \\ 1.01\Lambda \leq & \quad M_{\mathrm{mess}} & \leq 10^{16} \ \mathrm{GeV} \\ 1.5 \leq & \quad \tan\beta & \leq 60 \\ & \quad \mu & > 0. \end{aligned}$$

- We focus on the following mass range for the lightest CP-even SUSY Higgs boson:

$$124 \ \mathrm{GeV} \lesssim m_h \lesssim 126 \ \mathrm{GeV}.$$

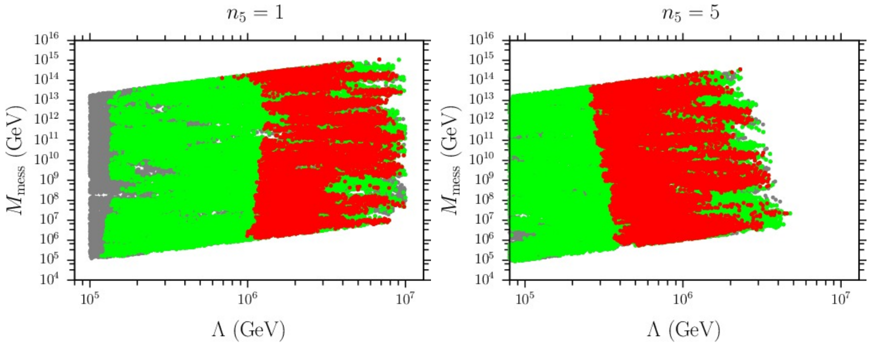


Figure: Plots in $M_{\rm mess} - \Lambda$ and $\tan\beta - \Lambda$ planes for $n_5 = 1$ and $n_5 = 5$. Gray points are consistent with REWSB. Green points satisfy particle mass bounds and constraints from B-physics. Red points belong to a subset of green points and satisfy the Higgs mass range 124 GeV $\leq m_h \leq$ 126 GeV.

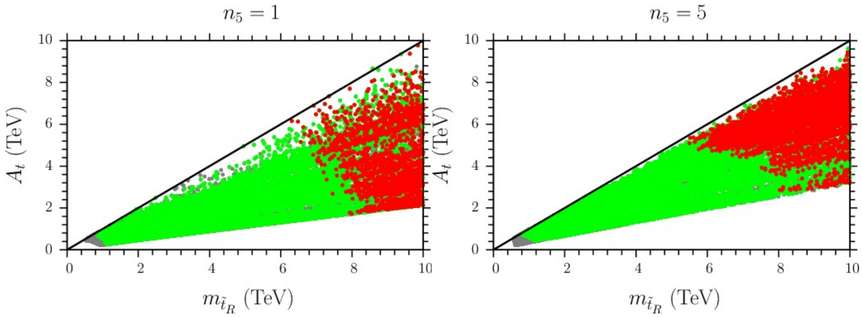
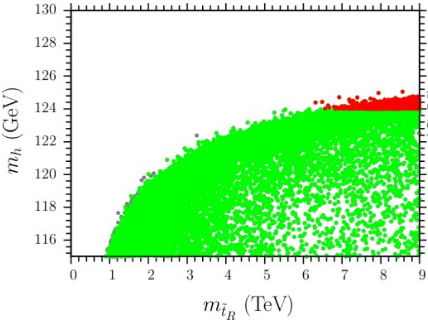


Figure: Plots in $A_t - m_{\tilde{t}_R}$ plane for $n_5 = 1$ and $n_5 = 5$. Red points belong to a subset of green points and satisfy the Higgs mass range 124 GeV $\leq m_h \leq$ 126 GeV.



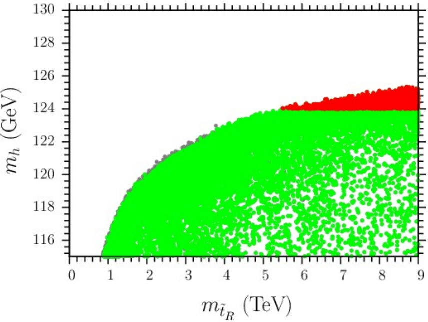
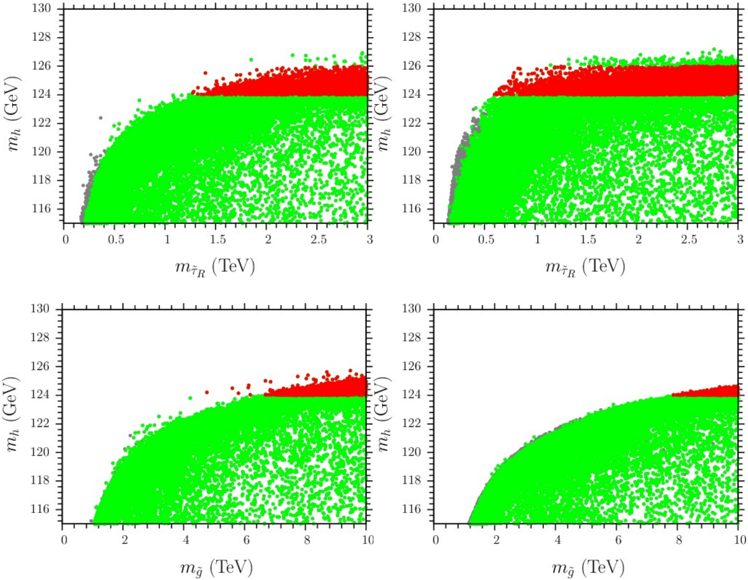
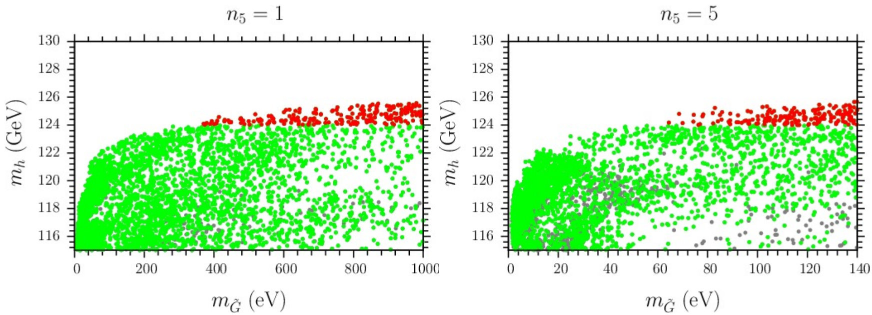


Figure: Plots in $m_h - m_{\tilde{t}_R}$ plane for $n_5 = 1$ and $n_5 = 5$. Red points belong to a subset of green points and satisfy the Higgs mass range 124 GeV $\leq m_h \leq$ 126 GeV.


m_h (GeV)
$m_{\tilde{\tau}_R}$ (TeV)
$m_{\tilde{g}}$ (TeV)
130
128
126
124
122
120
118
116
0
0.5
1
1.5
2
2.5
3
0
2
4
6
8
10



- For a single pair of $5 + \overline{5}$ SU(5) messenger multiplets, the lower limit on the gravitino mass is ~ 360 eV.
- A gravitino mass $\gtrsim 30$ eV requires non-standard scenarios in order to agree with observations [1].

[1] J. L. Feng, M. Kamionkowski and S. K. Lee, Phys.Rev. D 82, 015012 (2010).

Conclusions

- Discovery of a 125 GeV Higgs might help us pin down scenarios for physics beyond the SM.
- We found that the mGMSB scenario requires very heavy sparticle masses.
- Non-standard cosmology is required to satisfy cosmological observations