

A (not so) light stop with flavor in quiver-like BSM extensions

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Based on work with A. Giveon, S. B. Gudnason and T. Shacham,
1112.6261, 1208.6263

Motivation

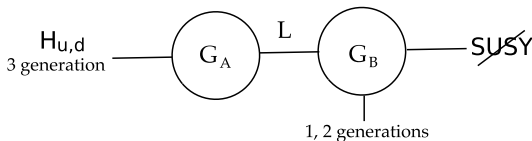
Naturalness of a 125 GeV Higgs in SUSY

Squark mass hierarchy (due to LHC bounds, which are strong especially for first and second generation squarks)

Partial explanation of Yukawa hierarchies

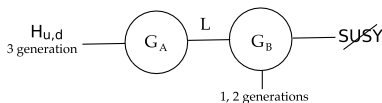
A quiver-like construction for natural SUSY

The standard model generations are charged under different nodes of a quiver-like theory (such as in N. Craig, D. Green, A. Katz, 1103.3708)



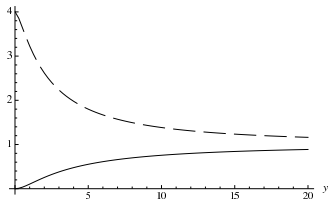
A bifundamental field Higgs $G_A \oplus G_B \rightarrow G_{SM}$
1st and 2nd generation sfermions obtain a large mass from gauge mediation; 3rd generation sfermions and Higgses obtain smaller masses from gaugino mediation

Sfermion mass² as a function of the link VEV



The gauge mediation integrand for sfermion masses is multiplied by the following factors (1110.1453):

$$f_{3\text{gen}}(p^2) = \frac{m_v^4}{(p^2 - m_v^2)^2}, \quad f_{1,2\text{gen}}(p^2) = \left(\frac{p^2(g_B^2/g_{SM}^2) - m_v^2}{p^2 - m_v^2} \right)^2.$$



Solid: 3rd generation. Dashed: 1st, 2nd generation. $y = \frac{m_v}{M}$

Higgs sector

Non-decoupling D-Terms:

$$V_D = \frac{g_2^2(1 + \Delta_2)}{8} \left| H_u^\dagger \sigma^a H_u + H_d^\dagger \sigma^a H_d \right|^2 + \frac{3}{5} \frac{g_1^2(1 + \Delta_1)}{8} \left| H_u^\dagger H_u - H_d^\dagger H_d \right|^2 ,$$

$$\Delta_k = \frac{\alpha_{Ak}}{\alpha_{B_k}} \frac{2m_{L_k}^2}{m_{\nu_k}^2 + 2m_{L_k}^2} .$$

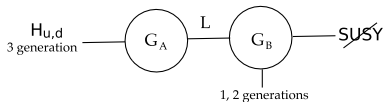
This can give a 125 GeV Higgs with a light stop

μ term:

$$\mathcal{W}_\mu \sim \frac{L\tilde{L}}{\Lambda_{\text{flavor}}} H_u H_d ,$$

which for $\Lambda_{\text{flavor}} \approx 100$ TeV can give μ at the weak scale.

Yukawa textures



Gauge invariant irrelevant operators:

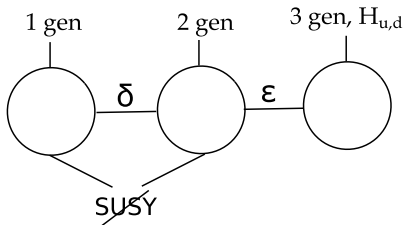
$$Q_3 \bar{u}_3 H_u, \quad \frac{Q_2 \bar{u}_2 L_2 H_u}{\Lambda}, \quad \frac{Q_2 \bar{u}_3 L_2 L_3 H_u}{\Lambda^2}, \dots$$

$$\epsilon_l = \frac{v_l}{\Lambda}, \quad \epsilon_d = \frac{v_d}{\Lambda}$$

$$y_u = \begin{pmatrix} \epsilon_l & \epsilon_l & \epsilon_l \epsilon_d \\ \epsilon_l & \epsilon_l & \epsilon_l \epsilon_d \\ \epsilon_d^2 & \epsilon_d^2 & 1 \end{pmatrix}, \quad y_d = \begin{pmatrix} \epsilon_l & \epsilon_l & \epsilon_l \epsilon_d \\ \epsilon_l & \epsilon_l & \epsilon_l \epsilon_d \\ \epsilon_d & \epsilon_d & 1 \end{pmatrix},$$

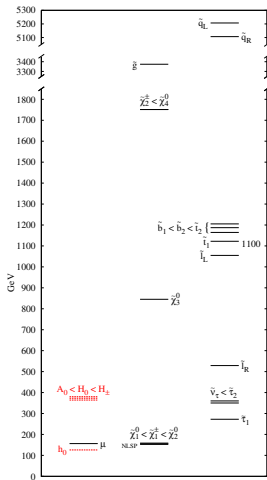
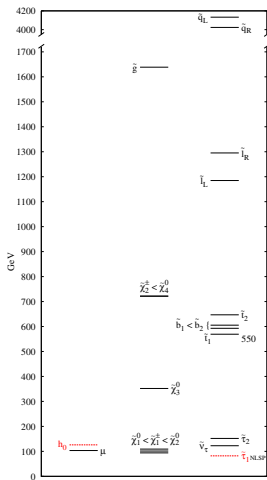
Three nodes models

Three node models can explain also the Yukawa hierarchies between 1st and 2nd generation; different link field representation can be explored (1112.6261)



$$y_u = \begin{pmatrix} \epsilon^2 \delta^2 & \epsilon^2 \delta & \epsilon \delta \\ \epsilon^2 \delta & \epsilon^2 & \epsilon \\ \epsilon \delta & \epsilon & 1 \end{pmatrix}, \quad y_d = \begin{pmatrix} \epsilon^2 \delta^2 & \epsilon^2 \delta & \epsilon \delta \\ \delta^2 \epsilon^2 & \epsilon^2 & \epsilon \\ \epsilon^2 \delta^2 & \epsilon^2 & 1 \end{pmatrix},$$

Sparticle spectrum of minimal model (1208.6263)



Conclusion

In the minimal version of these quiver-like model, (= Minimal gauge mediation messengers, and without extra dynamics in the Higgs sector), a light stop is correlated with light Higgses H^\pm , and this is constrained by $b \rightarrow s\gamma$; the stop mass should be larger than 1TeV

If extra contributions to Higgs soft masses are allowed, stop as light as 550 GeV are possible with a minimal messenger sector; the obstruction to make the stop lighter comes from too light staus or Higgsinos, (below the LEP bound)

Some tension with CP violation in ϵ_K parameter; some phases in the Yukawa matrices should be aligned with the CKM at a few per cent level