Generating A-terms at tree level

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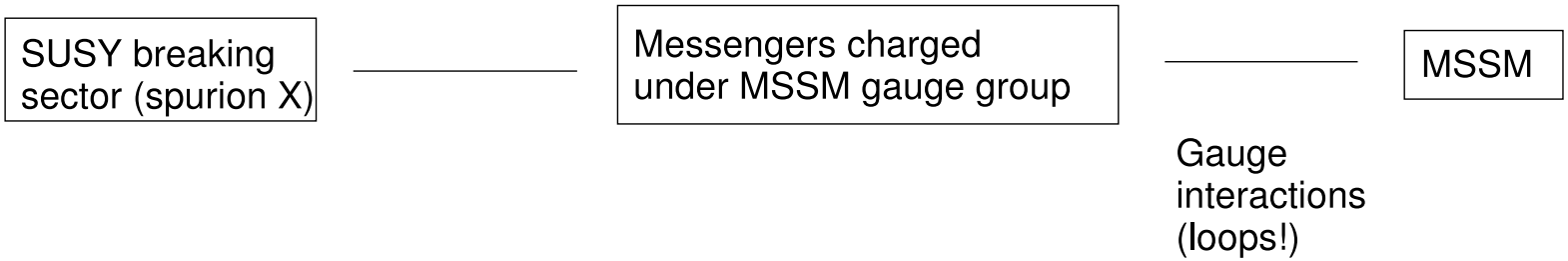
Gauge mediation and A-terms



- Flavor blind mechanism to break SUSY.
- $M_{susy} \propto \frac{1}{16\pi^2} \frac{F_x}{M} \sim TeV$
- But... no large A-terms! They show up only at 2 loops.

Minimizing tuning and maximal mixing

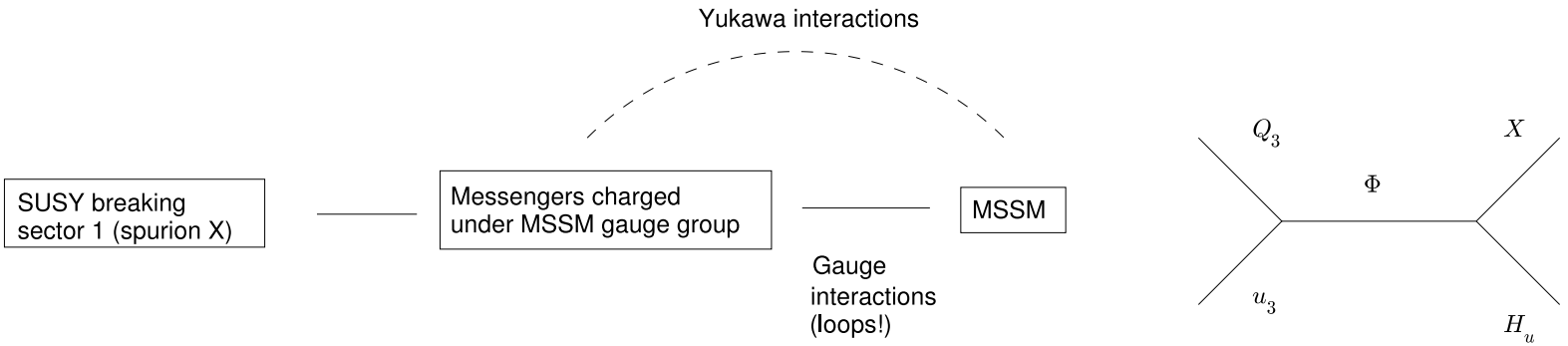
- Recall that for large tan(β) the one-loop higgs mass is

$$m_h^2 \approx m_Z^2 + \frac{3g^2 m_t^4}{8\pi^2 m_W^2}\left(\log\left(\frac{M_{SUSY}^2}{m_t^2}\right) + \boxed{\frac{A_t^2}{M_{SUSY}^2}\left(1 - \frac{A_t^2}{12M_{SUSY}^2}\right)}\right) \quad (1)$$

- To avoid large M_{SUSY} try to get *maximal mixing*, $A_t = \sqrt{6}M_{SUSY}$

$\rightarrow$ *We need large a-terms! (mixed stops)*

The objective: find the implications of changing the picture



$$W_{eff} \supset \frac{X}{M} Q_3 u_3 H_u \quad , \quad K_{eff} \supset \frac{X^\dagger X}{M^\dagger M} H_u^\dagger H_u \tag{2}$$

- Tree level A-terms *and* soft masses m_{soft} generated at the same scale, $\frac{F_X}{M}$

  $\rightarrow A/m_{H_u}$ problem (tuning problem!)

- We *would like to have* m_{soft} as small as possible.

A simple example

- Consider the following 1-messenger model.

$$W = \kappa Q_3 u_3 \tilde{\Phi}_{H_u} + X' \Phi_{H_u} \tilde{H}_u + M \Phi_{H_u} \tilde{\Phi}_{H_u} \quad , \quad X' = M_{X'} + F_{X'} \theta^2 \tag{3}$$

- Integrating out $\Phi, \tilde{\Phi}$ we get

$$W_{eff} \propto \underbrace{\kappa \frac{X'}{M}}_{y_t, A_t} Q_3 u_3 H_u \quad , \quad K_{eff} = \underbrace{\frac{X'^\dagger X'}{M^\dagger M}}_{m^2_{soft}} H_u^\dagger H_u + \ldots \tag{4}$$

$$y_t \propto \kappa \frac{M_{X'}}{M} \quad , \quad A_t \propto \kappa \frac{F_{X'}}{M} \quad , \quad m^2_{soft} = \frac{F^2_{X'}}{M^2} \tag{5}$$

$$\rightarrow \quad \frac{m^2_{soft}}{A_t^2} \propto \frac{1}{\kappa^2} \tag{6}$$

Can we solve the A/m_H problem?

- We made a comprehensive survey of models that generate A_t at tree level, and this feature is *very general* (MFV and NMFV models).
- Large $\kappa \rightarrow$ Landau pole. Sign of a strongly coupled theory in the UV (Seiberg dualize the theory).
- For $\kappa \approx 3$ and setting the top yukawa to its physical value

$$\left| \frac{\delta m_{soft}}{A_t} \right| \approx 0.5 \tag{7}$$

Can we get the right Higgs mass without large tuning?

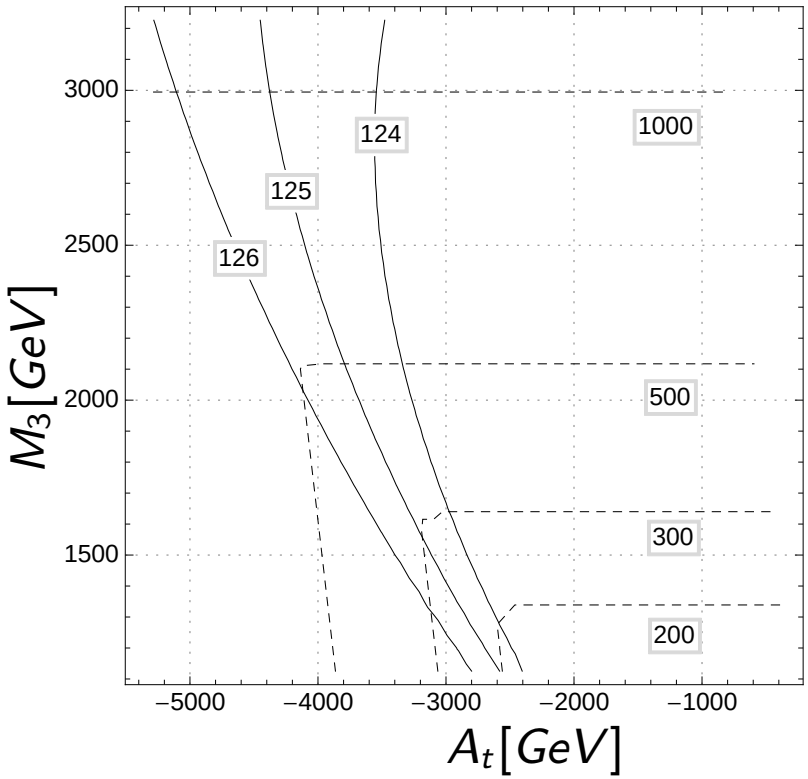


Figure : Contours of the Higgs mass and tuning.

Summary of features

- Tuning is reduced with respect to a non composite model.
- The size of the large top yukawa is explained from compositeness.
- SU(5) unification can be achieved.
- Flavor constrains are not a problem.
- The spectrum is dictated by gauge mediation.

Work in progress

- Another module is needed for the introduction of a second, loop suppressed, susy breaking sector.
- Only explains a small part of the yukawa texture.

Backup: we need a new spurion

- X cannot be the gauge mediation SUSY breaking field if we want to avoid huge soft masses.
- We need a new, loop suppressed X'.
- But still we get $m_{soft} \sim A_t$

$\rightarrow A/m_H$ problem still there (tuning problem!)