Light stop, Heavy Higgs, and Heavy Gluino in Supersymmetric Standard Models with Extra Matters

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(short introduction of the poster presentation)

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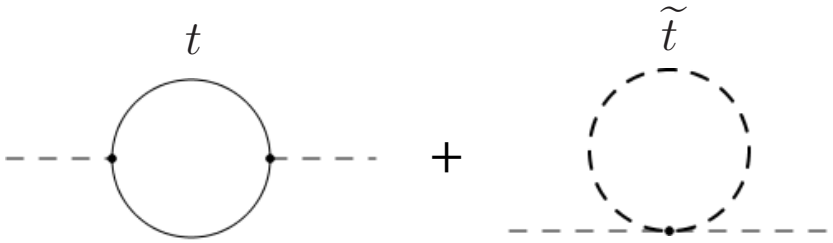
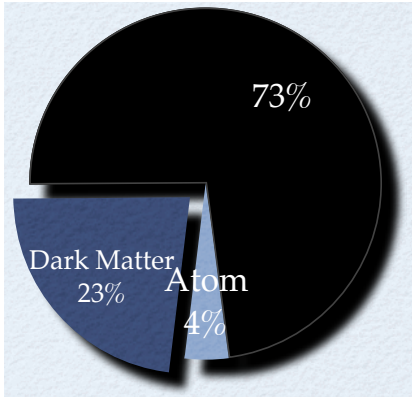
Supersymmetry

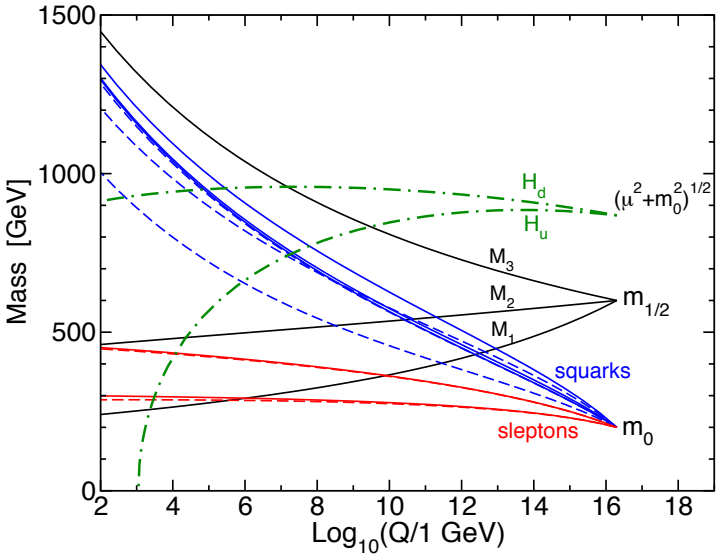
◆Cancellation of the quadratic divergence



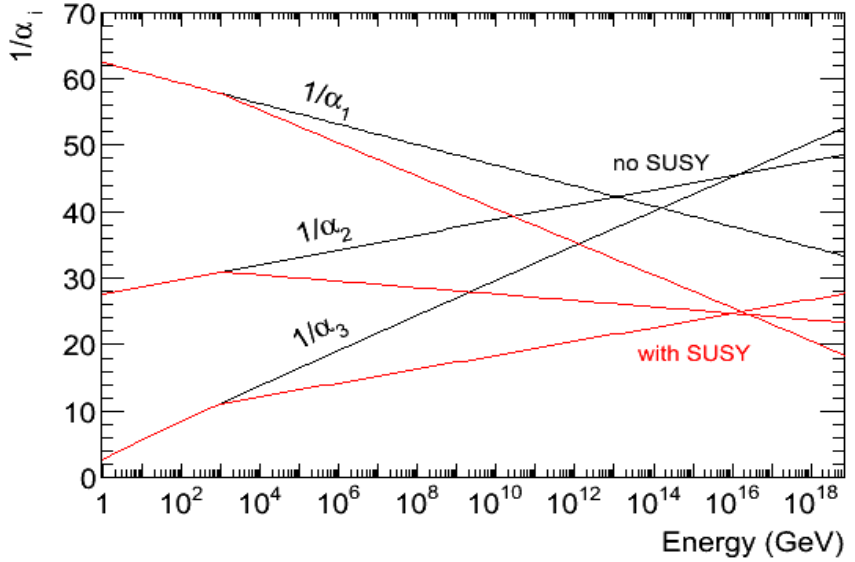
◆DM candidate



◆Origin of the EWSB



◆Unification of the gauge couplings



Supersymmetry

◆Cancellation of
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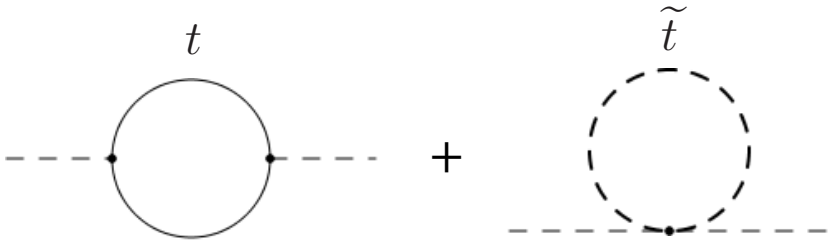

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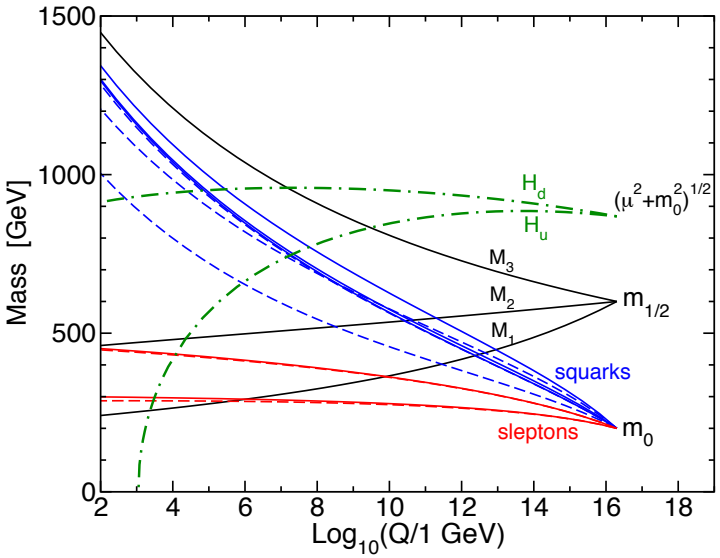


◆DM candidate

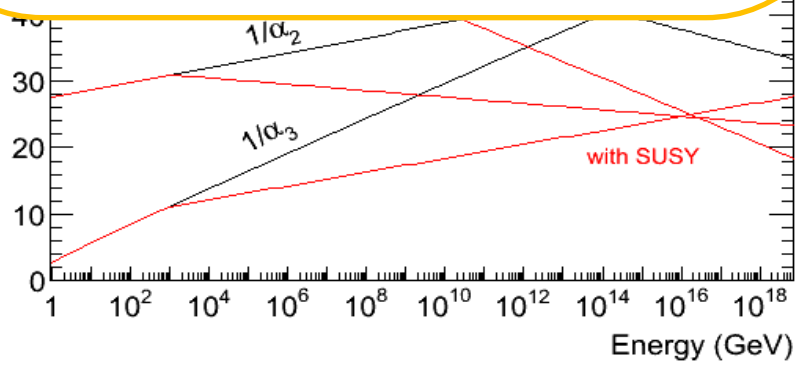
The little hierarchy problem

$$\frac{1}{2}m_Z^2 \sim -|\mu_H|^2 - m_{H_u}^2$$

$$\delta m_{H_u}^2 \sim -\frac{3y_t^2}{4\pi^2} m_{\tilde{t}}^2 \ln \frac{\Lambda}{m_{\tilde{t}}}$$

If we concern about naturalness,
$\sim$ around 1 TeV stop mass is desired.

“Light stop”



Implications from LHC

◆LHC Run 1 ···Discovery of 125 GeV Higgs "Heavy Higgs"

The MSSM predicts light Higgs at tree level. $m_h^2 \leq m_Z^2 \cos^2 2\beta$

It is important to consider the radiative correction.

$$\delta m_h^2 = \frac{3g^2 m_t^4}{8\pi^2 m_W^2}\left[\ln\left(\frac{m_{\tilde{t}}^2}{m_t^2}\right) + \frac{X_t^2}{m_{\tilde{t}}^2}\left(1 - \frac{X_t^2}{12 m_{\tilde{t}}^2}\right)\right], \qquad X_t = A_t - \frac{\mu_H}{\tan\beta}.$$

The observed Higgs mass is explained by heavy stop mass.

~~Naturalness~~

(High-scale SUSY)

This term is maximized at $X_t/m_{\tilde{t}} = \pm\sqrt{6}$.

The observed Higgs mass is explained by light stop mass and large A-term.

(Natural SUSY)

◆LHC Run 2 ··· Null result

Masses of new colored particles are severely constrained.

Implications from LHC

◆LHC

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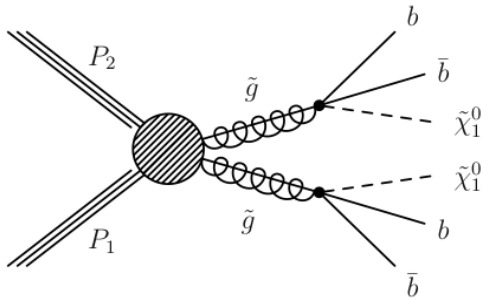

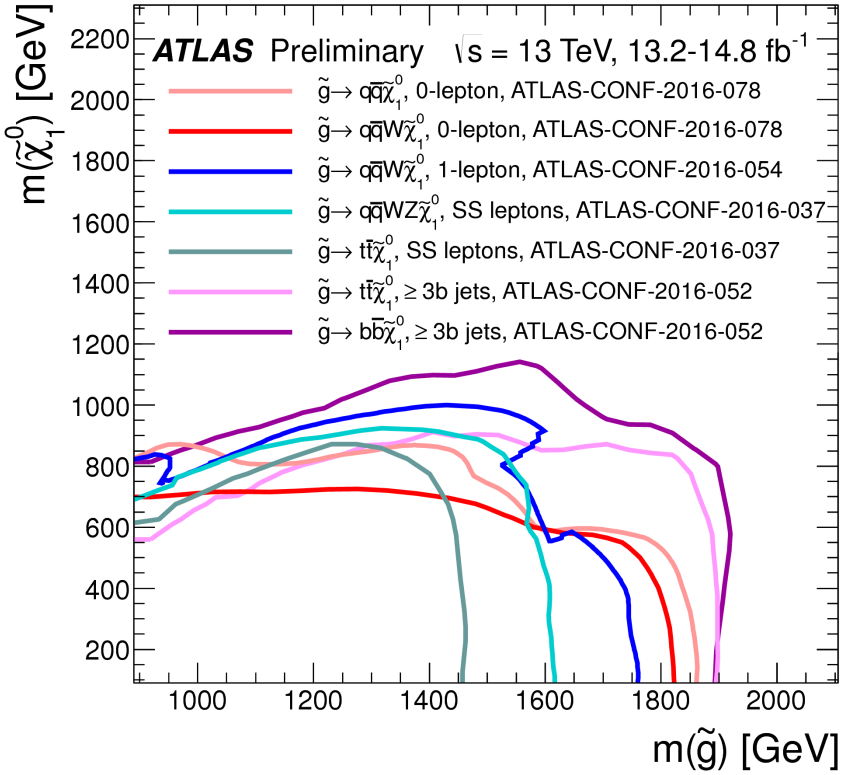

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$m_{\tilde{g}} \gtrsim 1.9$ TeV

"Heavy gluino"

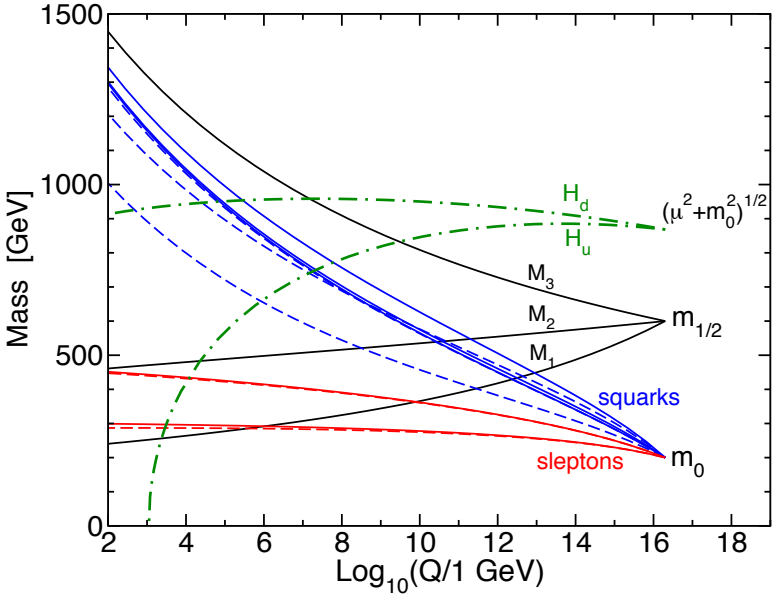
◆LHC Run 2 ··· Null result

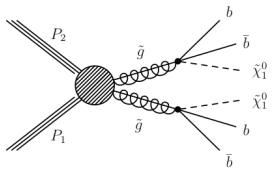
Masses of new colored particles are severely constrained.

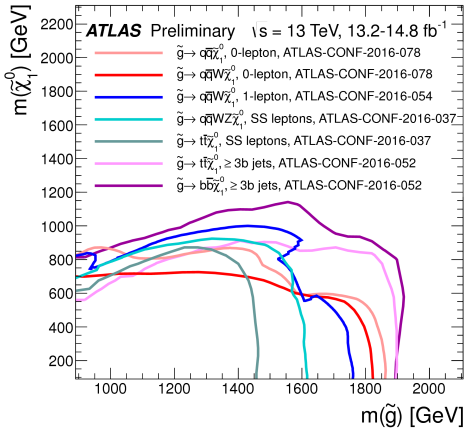
Implications from LHC

◆One-loop RGE for sfermion masses
(gaugino mass contribution)

$$\frac{dm_s^2}{d\ln\mu} = -\frac{1}{16\pi^2}\sum_{A=1,2,3} 8g_A^2 C_A(s)|M_A|^2$$







$m_{\tilde{g}} \gtrsim 1.9$ TeV "Heavy gluino"

Heavy gluino makes
stop heavy at low energy.

Natural SUSY is a critical situation.

Key concept

◆Two-loop RGE for sfermion masses

$$\frac{dm_s^2}{d\ln\mu} = \sum_{A=1,2,3}\left[-\frac{1}{16\pi^2}8g_A^2C_A(s)|M_A|^2 + \frac{1}{(16\pi^2)^2}4g_A^4C_A(s)\sum_r 2S_A(r)m_r^2\right]$$

If there are extra matters much heavier than gauginos,
one-loop contribution can be cancelled.

⇒ Light stop can be realised despite heavy gluino.

"Heavy gluino" "Light stop"

◆One-loop RGE for A-terms

$$\frac{da^{ijk}}{d\ln\mu} = \frac{1}{16\pi^2}\sum_{A=1,2,3} 4g_A^2Y^{ijk}C_A(k)M_A + (k\leftrightarrow i) + (k\leftrightarrow j).$$

Extra matters are nothing to do with A-terms.

Large A-term is realized owing to heavy gluino.

"Heavy Higgs"

⇒ The observed Higgs mass is obtained by light stop and large A-term.

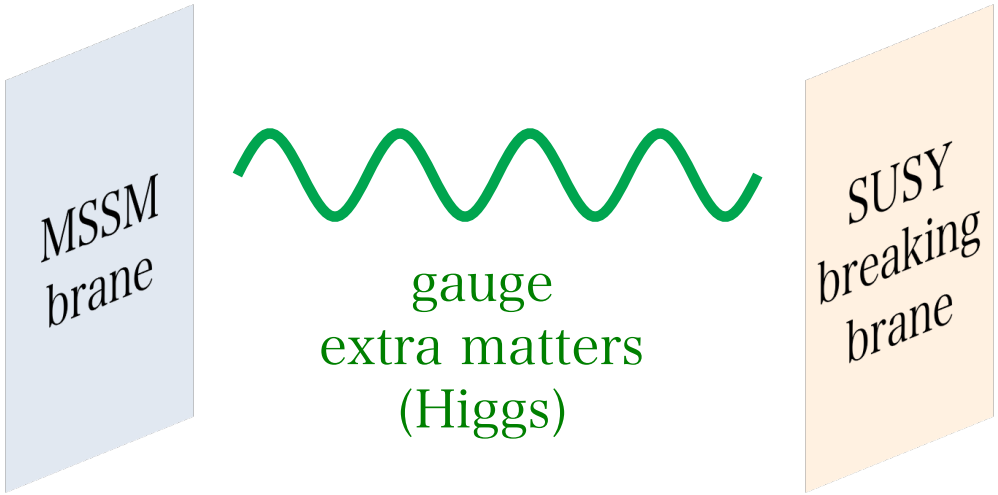
Model

We consider the model including a pair of extra $\mathbf{5} + \bar{\mathbf{5}}$ multiplets.

Supersymmetric masses: $W = M_{D'}\overline{D}'D' + M_{L'}\overline{L}'L'$

SUSY-breaking masses: $V = m_{D'}^2(|\widetilde{d}'|^2 + |\widetilde{\overline{d}}'|^2) + m_{L'}^2(|\widetilde{l}'|^2 + |\widetilde{\overline{l}}'|^2)$

◆gaugino mediation



at the input scale,

$m_{\rm vec} \gg M_{1/2}$ ⇒ realization of light stop

$m_0^2 = 0,\ A_0 = 0$ ⇒ suppression of FCNCs

Result

While stau is LSP in broad parameter space, we found that

- If Higgs soft mass parameters have non-zero value at input scale, Higgsino-like neutralino LSP is realized

- If we assume non-universal gaugino mass at input scale, wino LSP is realized

with 125 GeV Higgs and around 1 TeV stop.

Detailed spectrum and plots are shown in my poster.

Prease come to see !