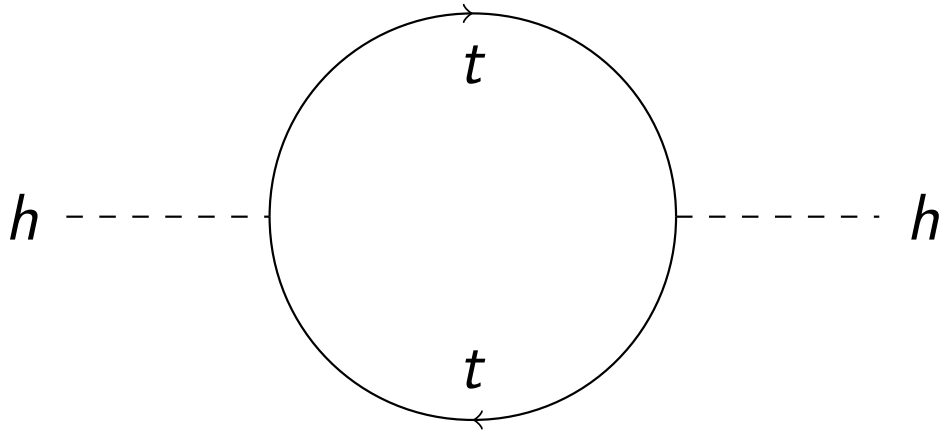
SUSY after 1 fb^{-1}

Joshua Berger

11/11/11

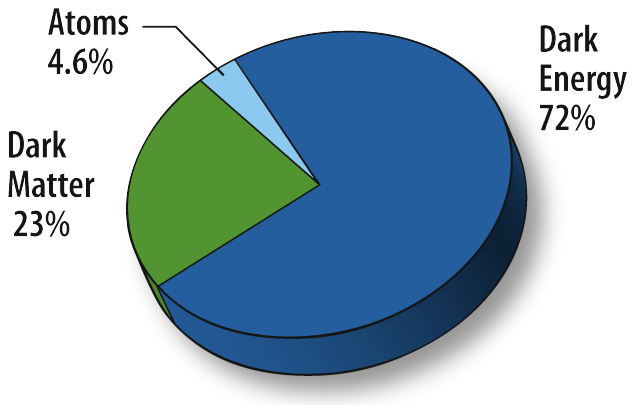
The SM's got issues: Hierarchy



$$\sim \frac{y_t^2}{16\pi^2}\Lambda^2$$

$$m_h^2 = m_{h,0}^2 + c\frac{y_t^2}{16\pi^2}\Lambda^2 + \dots$$

The SM's got issues: Dark matter



- No strong or EM interactions
- Cold $\rightarrow$ Massive
- $\langle \sigma v \rangle \approx 0.1$ pb $\rightarrow$ WIMP miracle

SUSY has the answers

- Chiral symmetry $\rightarrow$ Spartners cancel Λ^2 divergence
- R-parity $\rightarrow$ DM candidate
- Unification, beauty, string theory, etc.

Seeing SUSY: The traditional lore

$\gtrsim$ 100 GeV mass sparticles

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Hard jets/leptons

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R-parity + Cosmology

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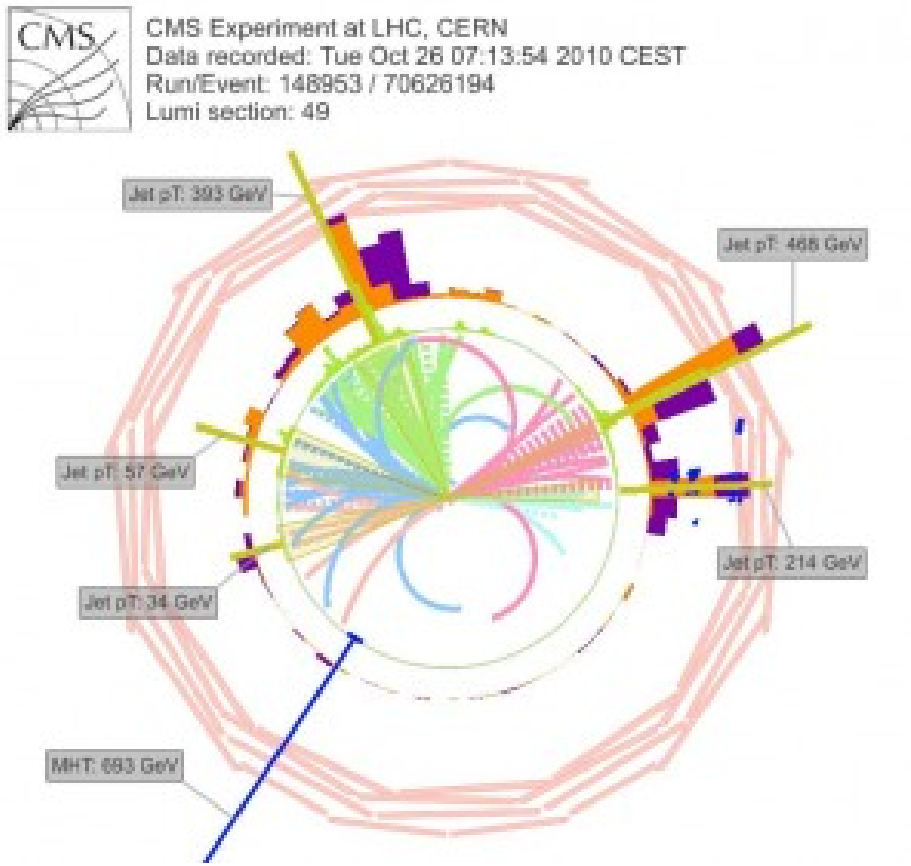
Large $\not{E}_T$



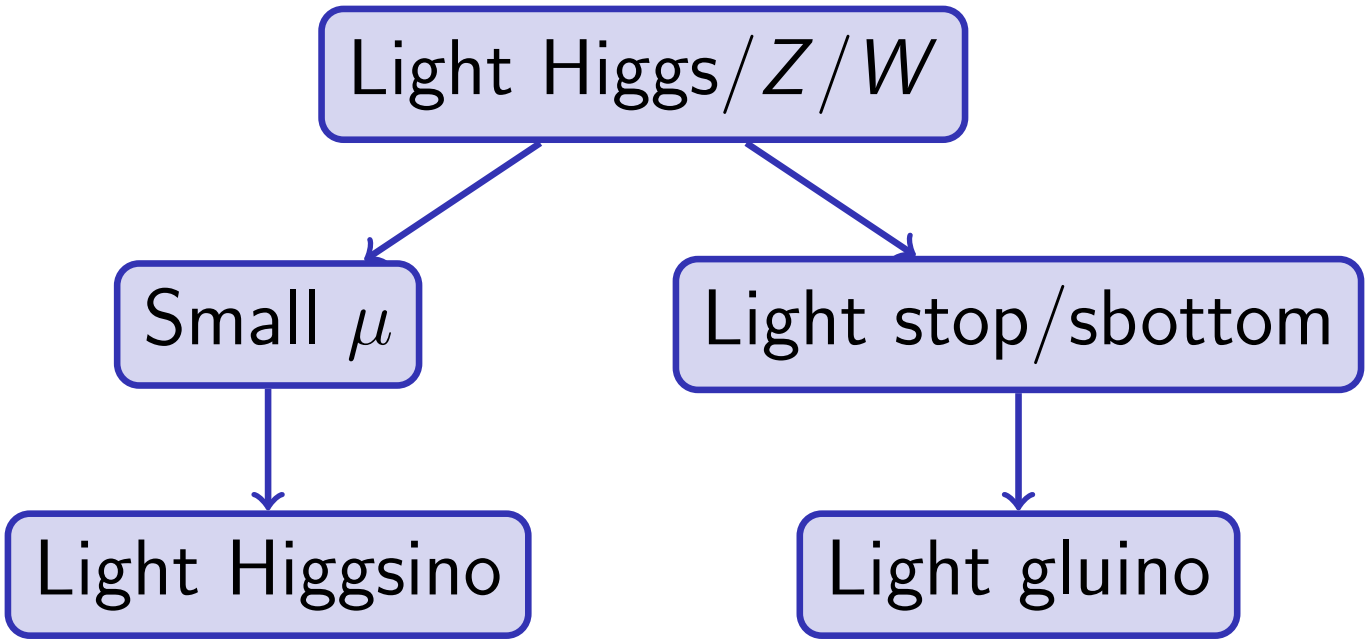
SUSY Doo, where are you?

Many explanations

1. The first two generation squarks are decoupled
2. R-parity is violated
3. Some other reason: Stealth/squashed/split SUSY

Decoupling some squarks

- What is really required to avoid fine-tuning?



- Idea: light $\tilde{f}_{1,2}$ not required

(Brust et. al., Delgado & Quiros, Essig et. al., Kats et. al., Papucci et. al.)

Consequences for topologies

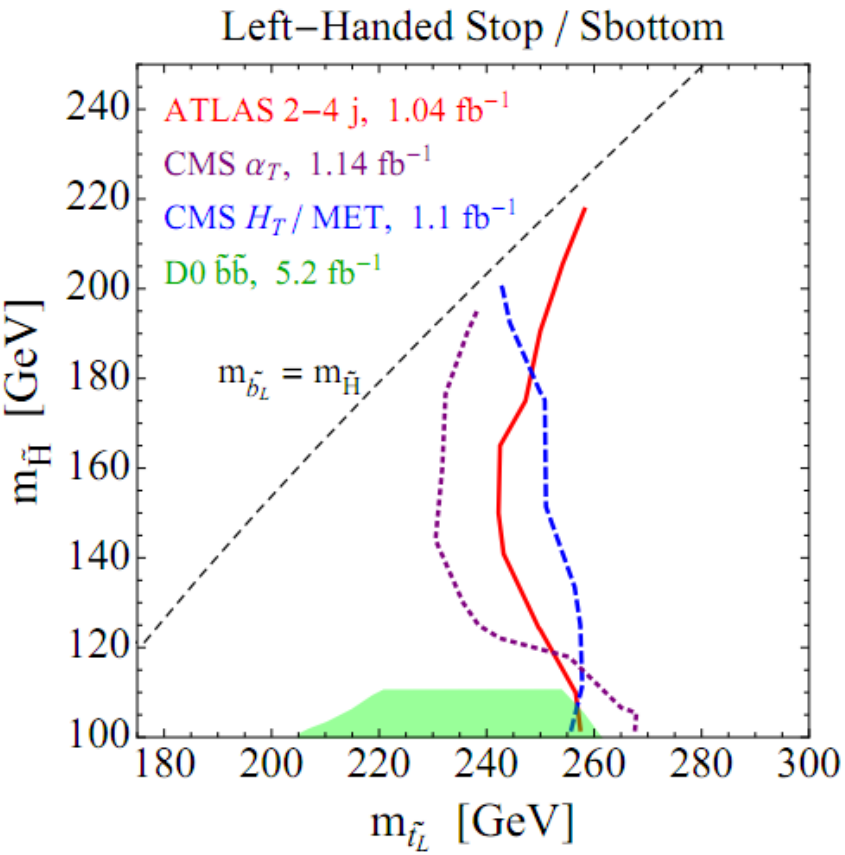
$$2\tilde{t} \rightarrow 2t\ 2\chi^0 \qquad 2\tilde{b} \rightarrow 2b\ 2\chi^0$$

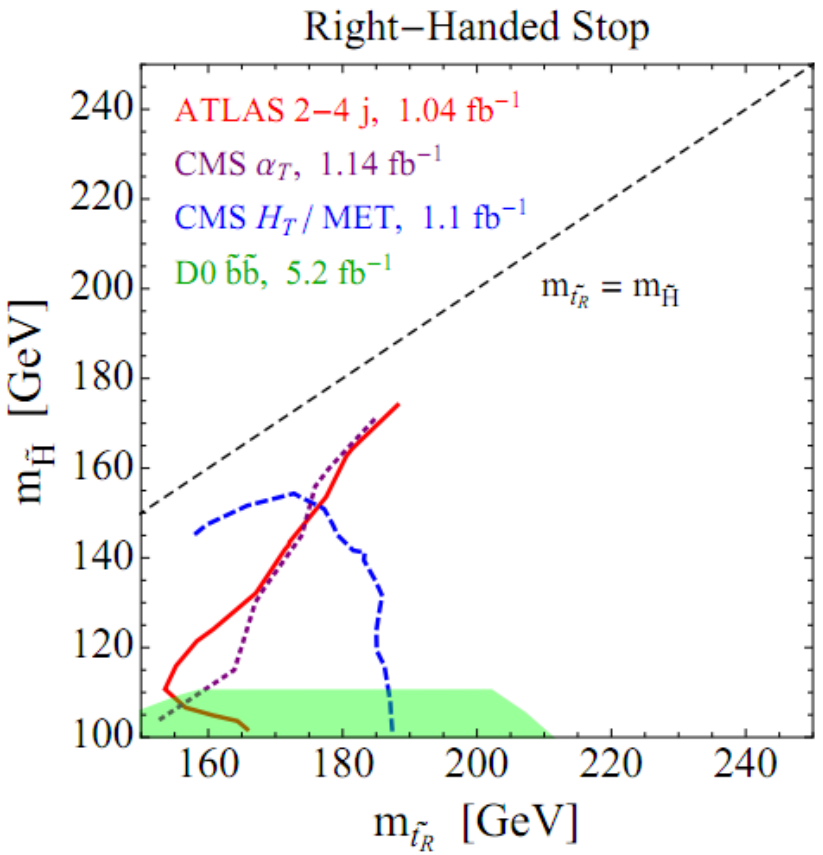
- Current limits: Jets
- Limiting factor: Direct squark production σ

$$2\tilde{g} \rightarrow 4t\ 2\chi^0 \qquad 2\tilde{g} \rightarrow 4b\ 2\chi^0$$

- Current limits: Jets, ℓ + jets, SSDL
- To be considered: $> 2b$ searches

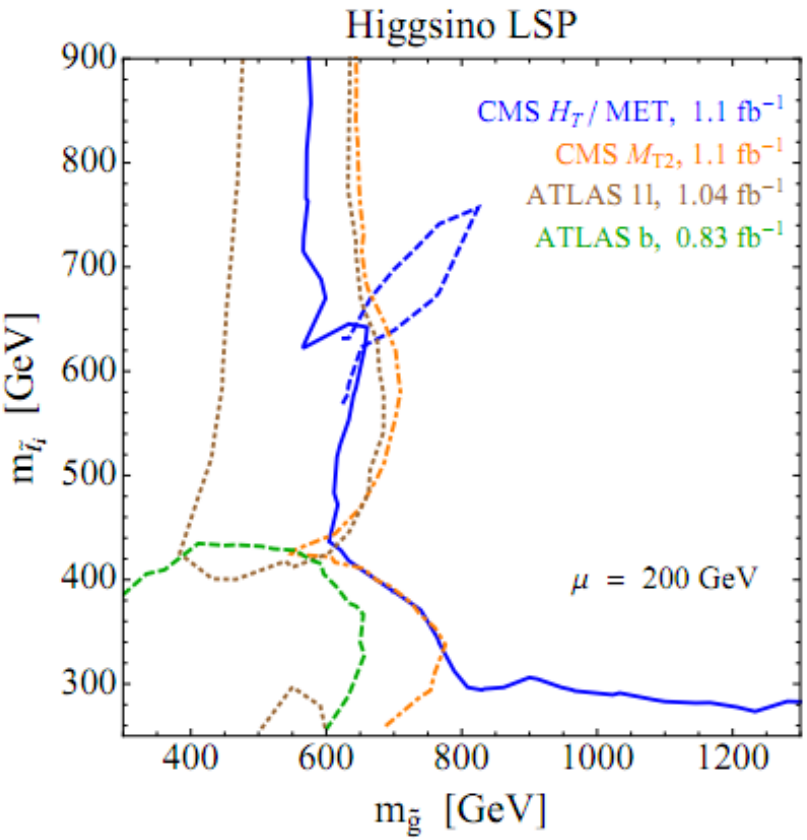
Stop search limits

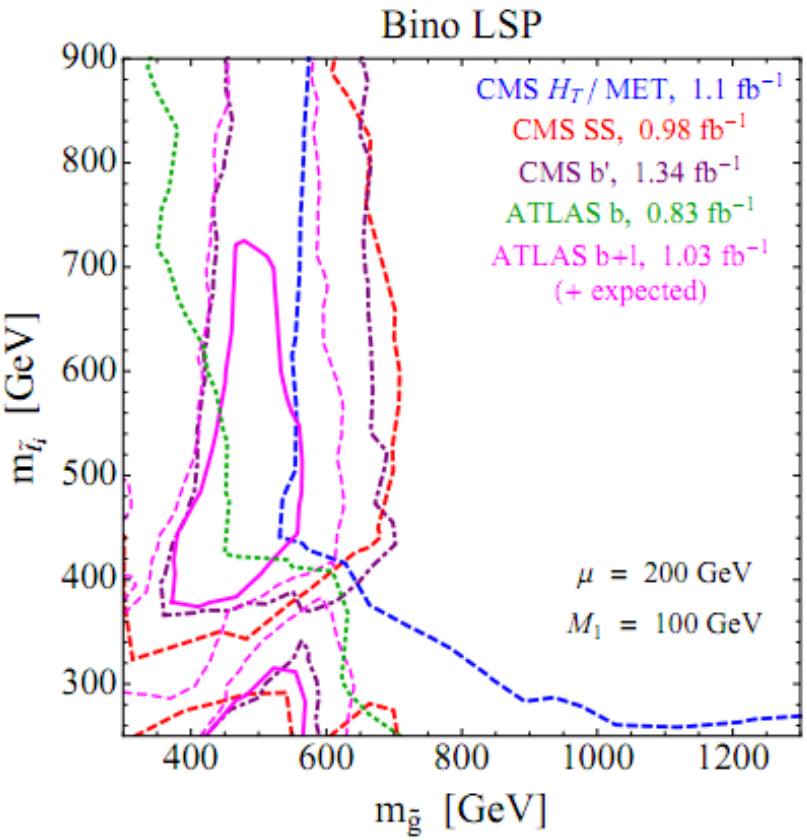




(Papucci, Ruderman, Weiler)

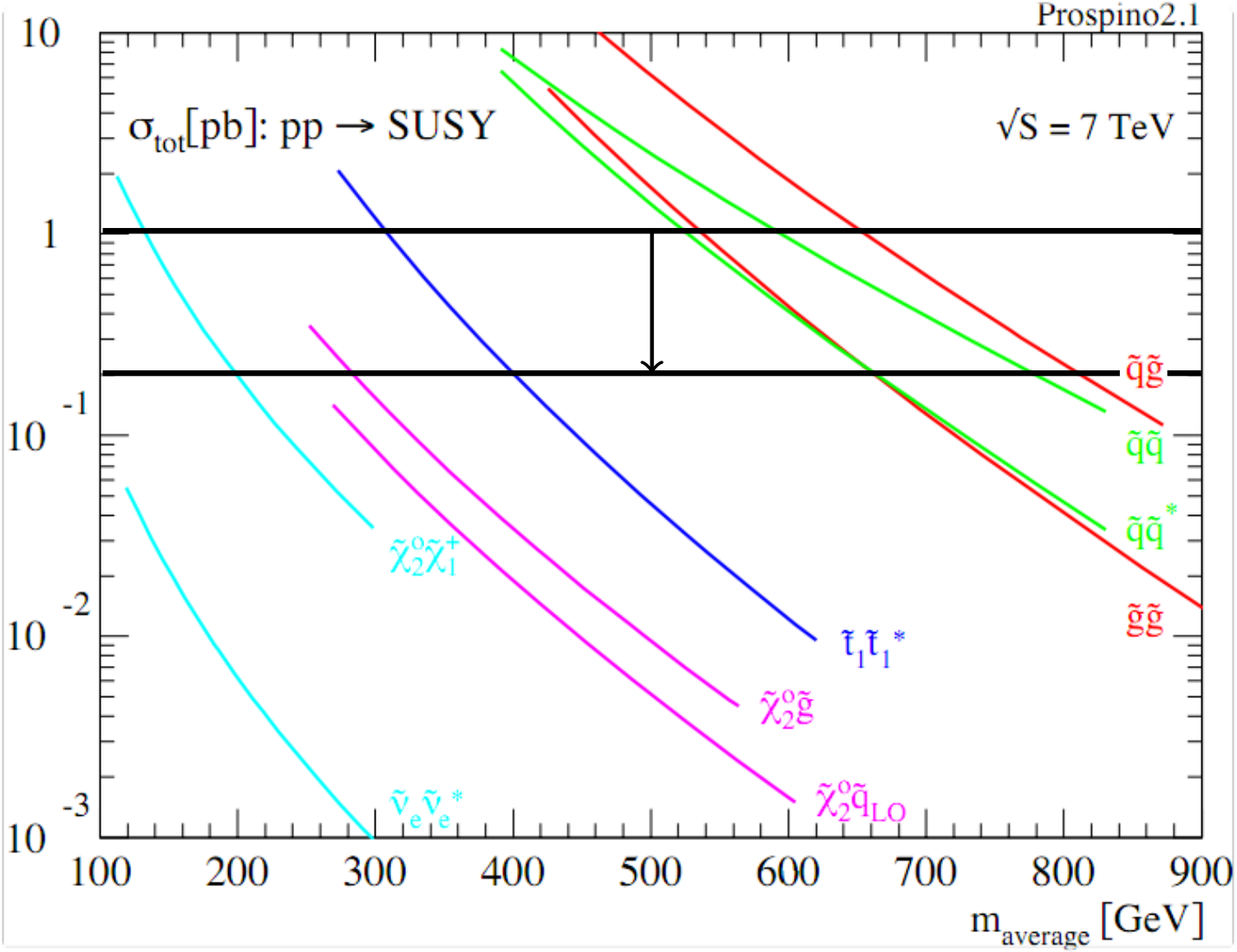
Gluino search limits





(Papucci, Ruderman, Weiler)

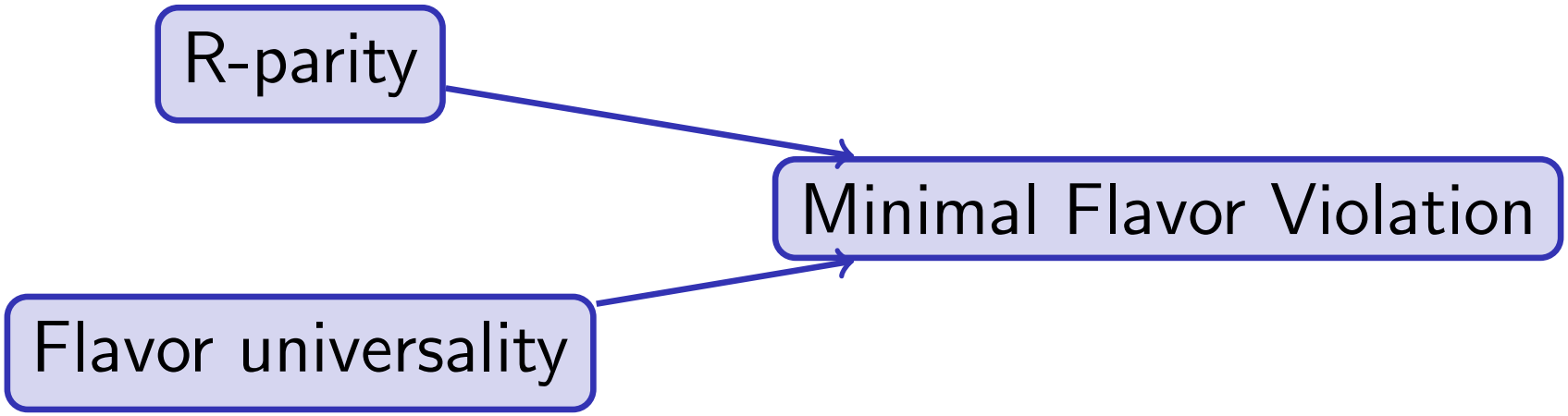
We're almost there!



(Papucci, Ruderman, Weiler)

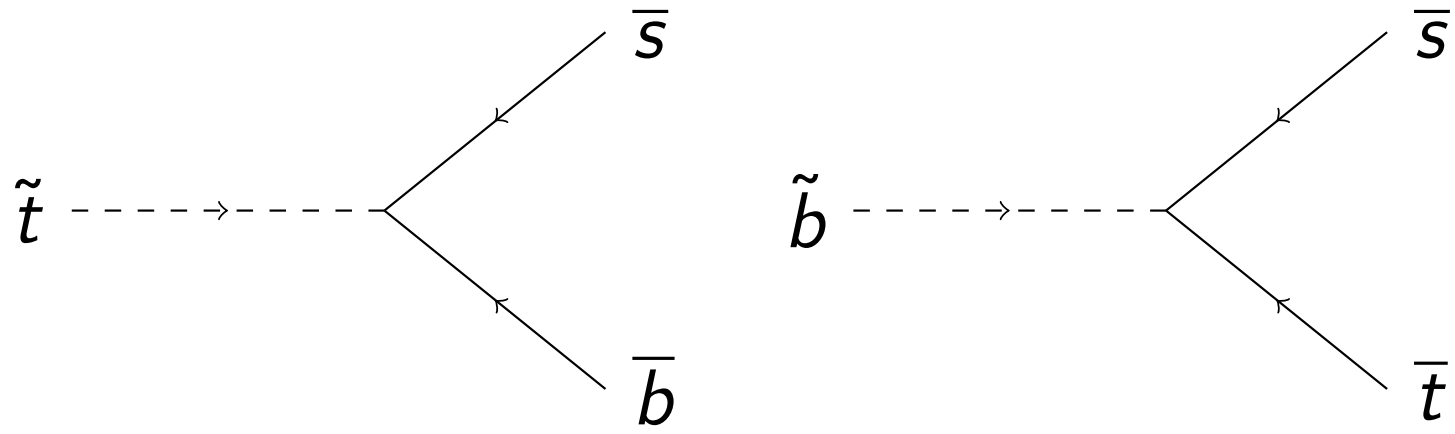
RPV with MFV: A new POV

- Can we replace 2 assumptions with 1?



- MFV: Inherit flavor structure from SM
- Prevents unwanted processes
- Possible DM candidate: gravitino

Collider signatures



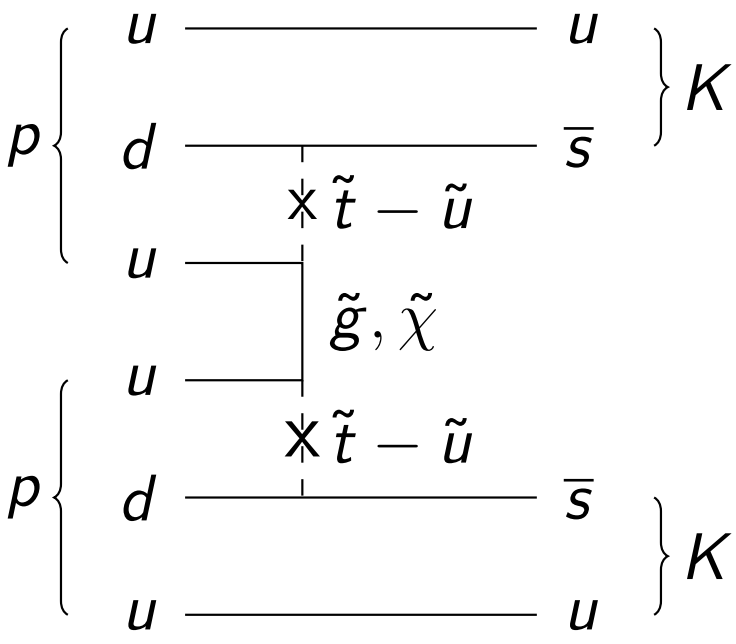
- Highly LSP dependent
- Production is still pairwise
- Baryon-number violating jet resonances
- Displaced vertices, $\not{E}_T$ possible

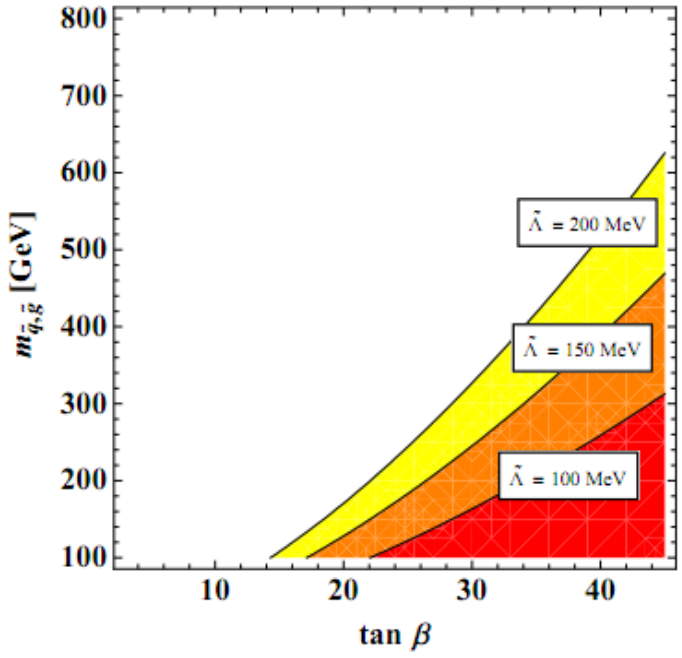
Unexplored territory

- Most restricted vertex: $\lambda' QL\overline{d}$, but $\lambda' \sim 0$
- 3 jet resonance from gluino decay (CMS)
  - $m_{\tilde{g}} \gtrsim 280\ \mathrm{GeV}$
- 4 jet resonance from stop pair production (ATLAS)
  - $m_{\tilde{f}} \gtrsim 150 - 180\mathrm{GeV}$

Bounds from low energy

- Dinucleon decay





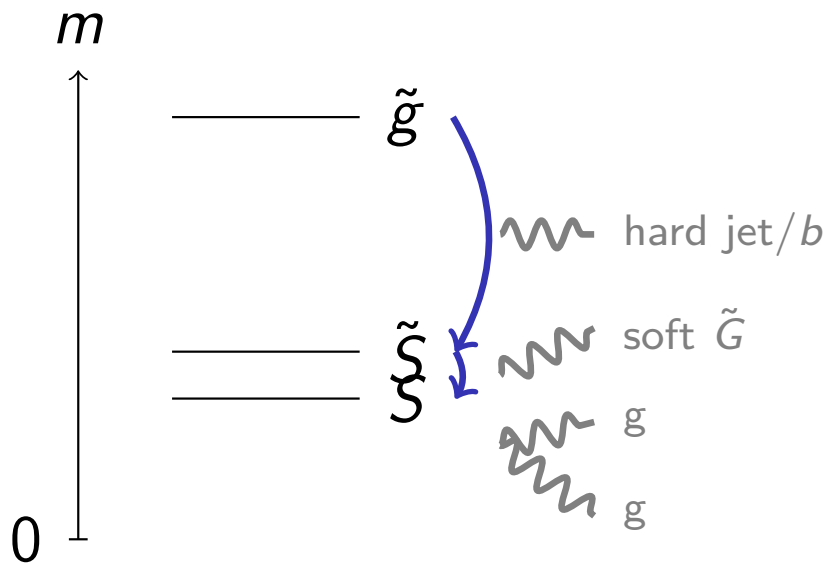
- Mild bounds: $n - \overline{n}$, proton decay

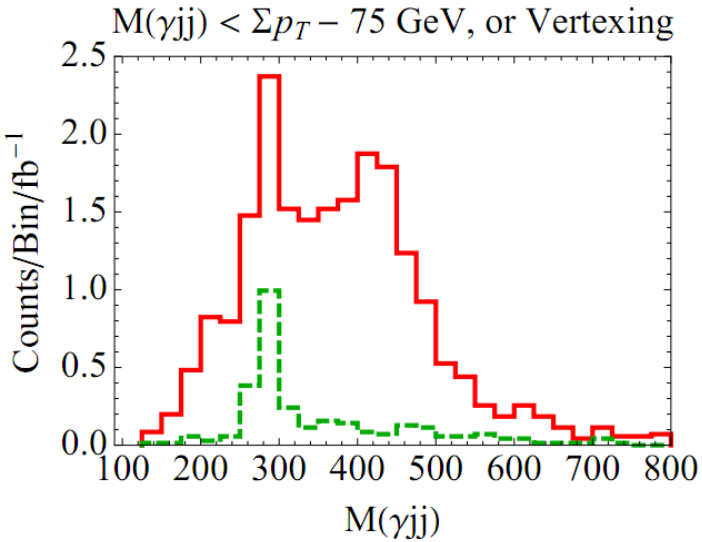
New and exciting framework

- Get SUSY with fewer assumptions
- Current searches place only mild bounds
- Wealth of new, unexplored signatures

Stealth SUSY with small $\not{E}_T$

- Idea: New particle pair with small partner splitting



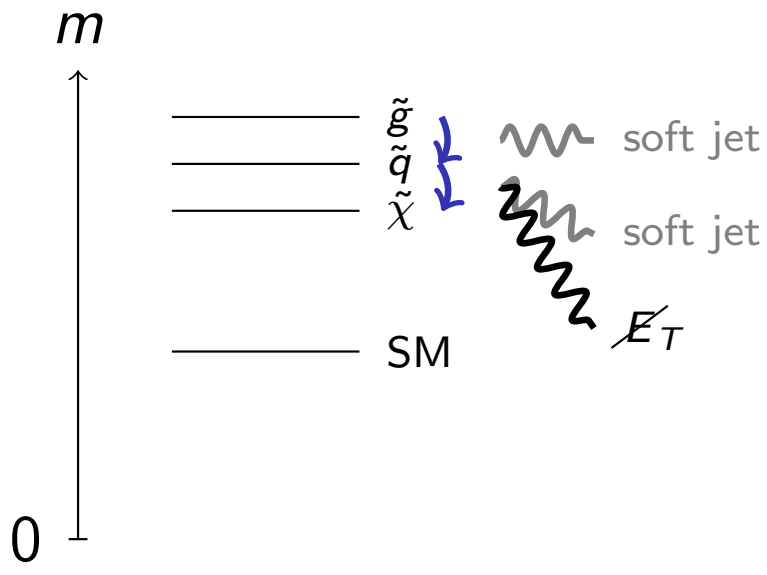


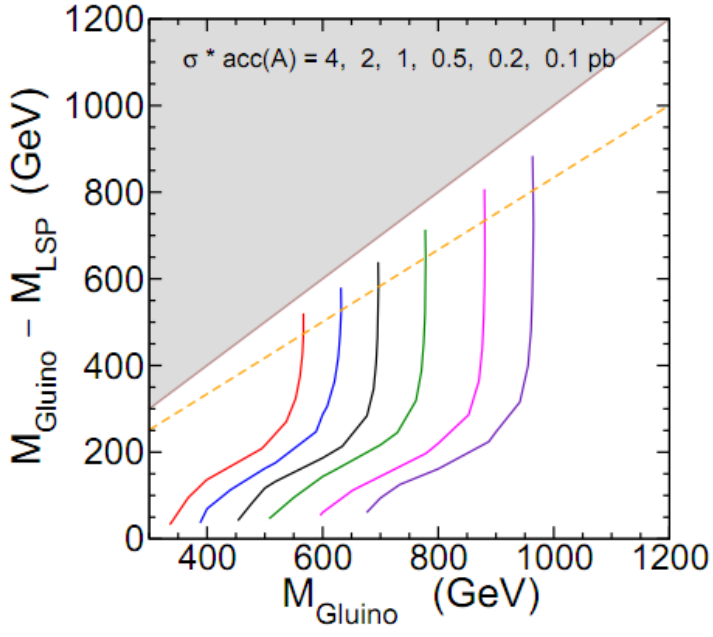
- Scenarios with lots of b's
- Looks like RPV

(Fan, Reece, Ruderman)

Squashed SUSY with no hard jets

- Idea: Degenerate spectrum of sparticles



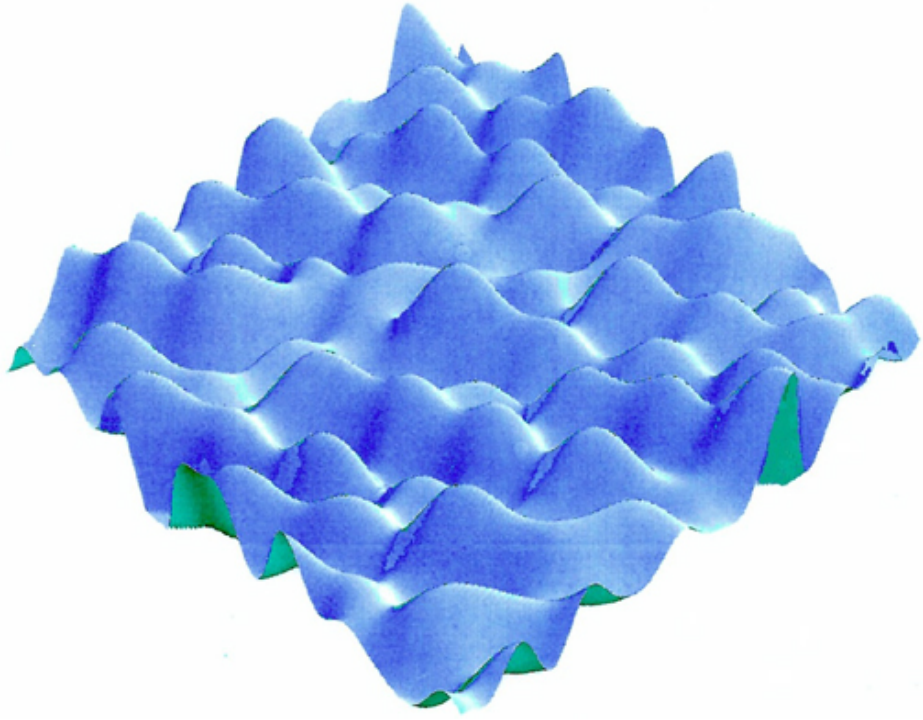


- Tough to see, tough to calculate...

There's always Split SUSY

- Idea: Forget about fine-tuning

~ 1 TeV —— $\tilde{g}$



~ 100 GeV —— $\tilde{B}, \tilde{W}, H$

- Only light scalar: Higgs
- Long-lived gluino?

(Arkani-Hamed & Dimopoulos)

Conclusions

- Naturalness of SUSY will soon be probed
- Many options remain: e.g. RPV with MFV
- Keep an open mind (and use Simplified Models)