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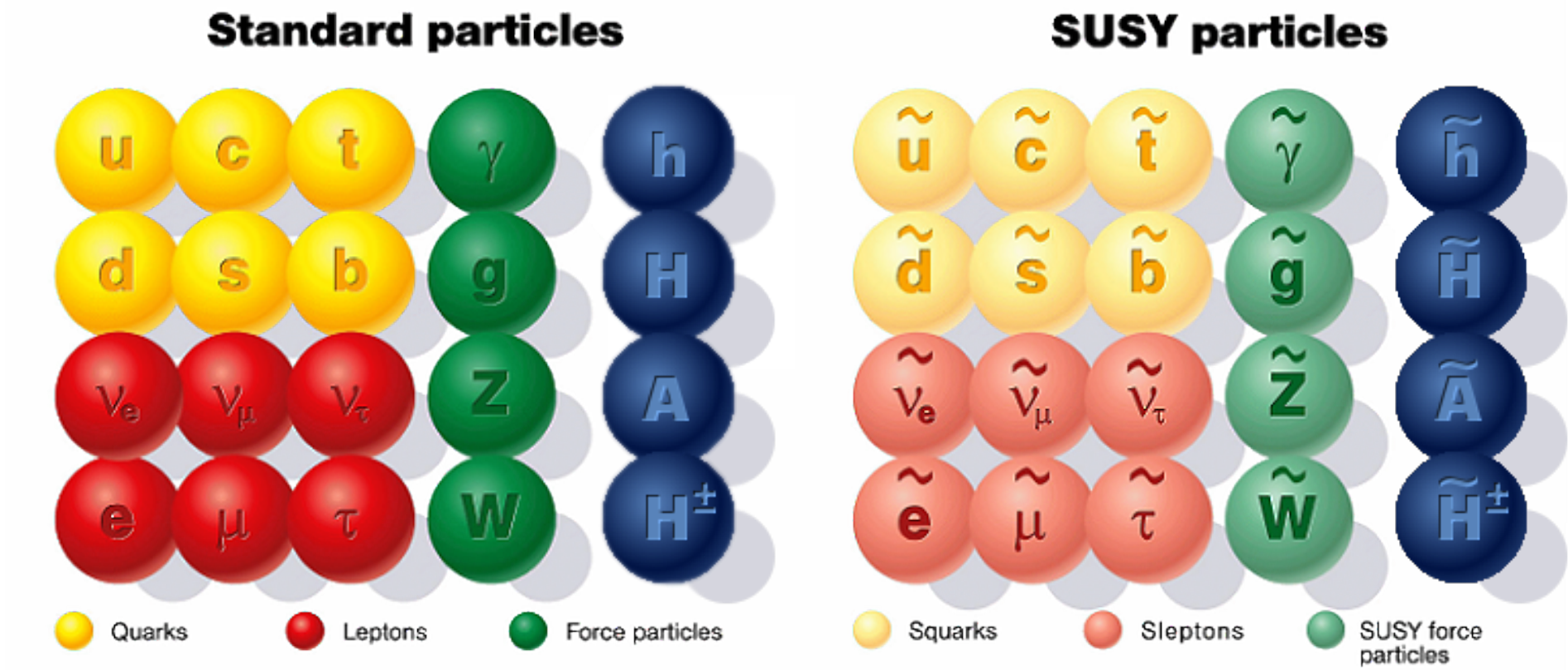
MSSM: Status & Forecast Part I

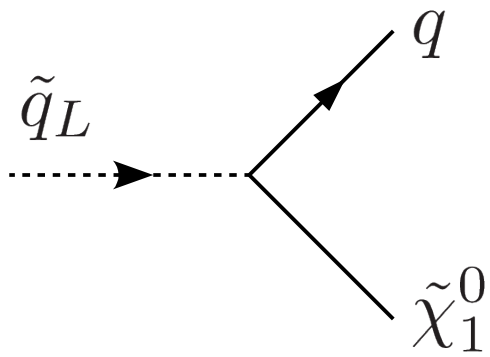
Young Scientists Workshop 2011
Wildbad Kreuth

MSSM


Standard particles
u c t γ h
d s b g H
ν_e ν_μ ν_τ Z A
e μ τ W $H^\pm$
Quarks
Leptons
Force particles
SUSY particles
$\tilde{u}$ $\tilde{c}$ $\tilde{t}$ $\tilde{\gamma}$ $\tilde{h}$
$\tilde{d}$ $\tilde{s}$ $\tilde{b}$ $\tilde{g}$ $\tilde{H}$
$\tilde{\nu}_e$ $\tilde{\nu}_\mu$ $\tilde{\nu}_\tau$ $\tilde{Z}$ $\tilde{A}$
$\tilde{e}$ $\tilde{\mu}$ $\tilde{\tau}$ $\tilde{W}$ $\tilde{H}^\pm$
Squarks
Sleptons
SUSY force particles

R-Parity Conservation

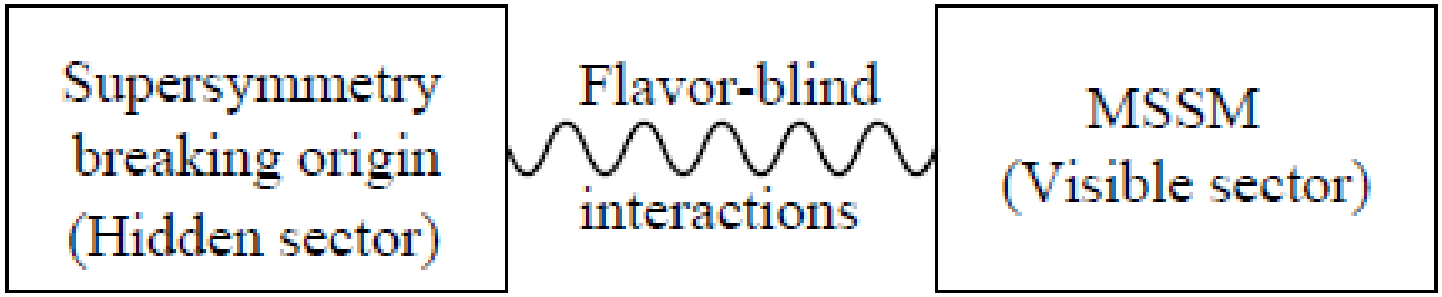
- What? Multiplicative Quantum number
  - SM & Higgs: 1, MSSM: -1
- Why? Conserve baryon and lepton number!
- Consequences



  - Lightest SUSY particle (LSP) is stable
    $\rightarrow$ dark matter candidate?

mSugra, CMSSM, GMSB, AMSB, ...

- Soft breaking → MSSM 105 (24) parameters



- Assume "simple" breaking model

  → 5 parameters $m_0,\ m_{1/2},\ \mathrm{sgn}\mu,\ A_0,\ \tan\beta$

Scalar mass

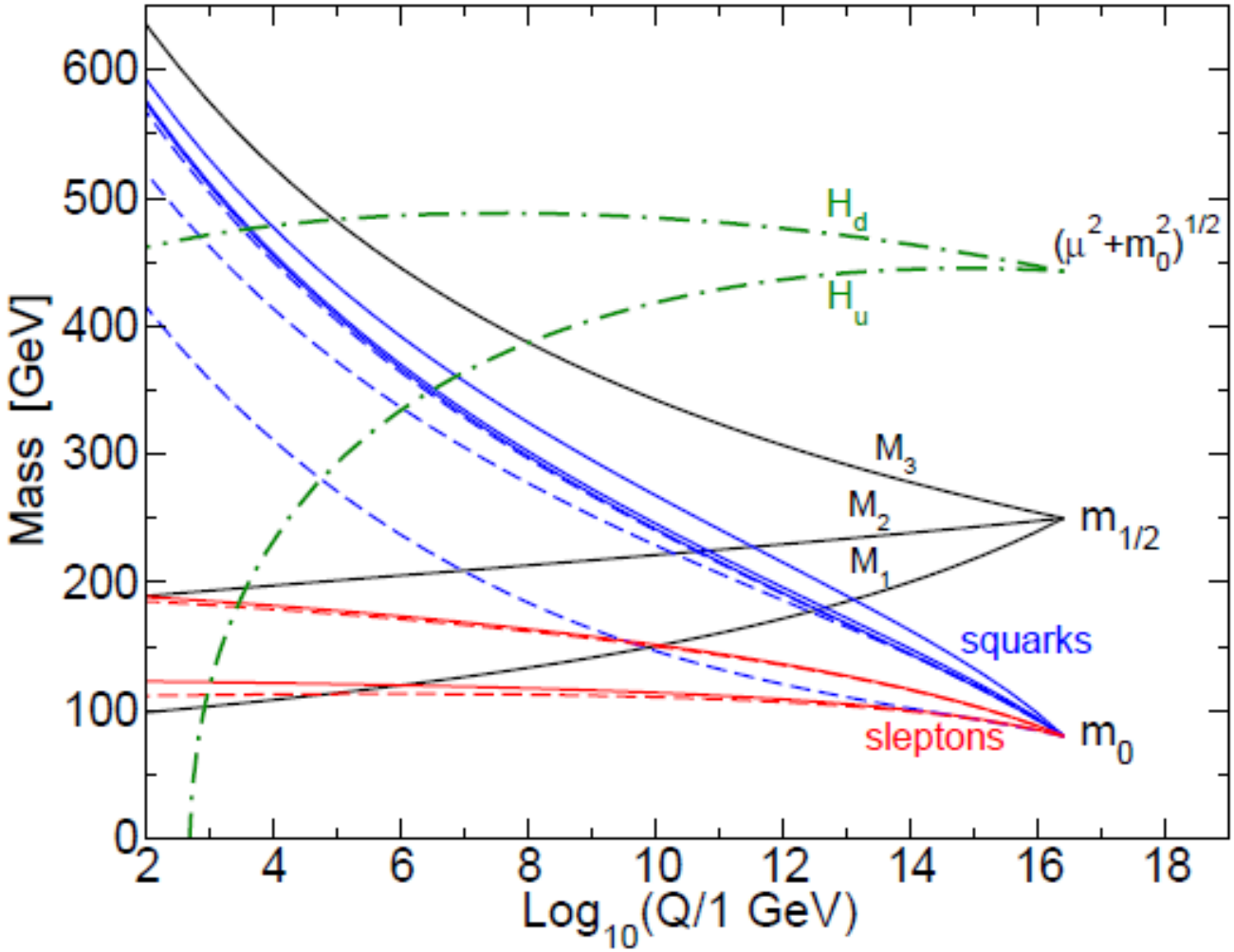
Gaugino mass

Higgsino mass parameter

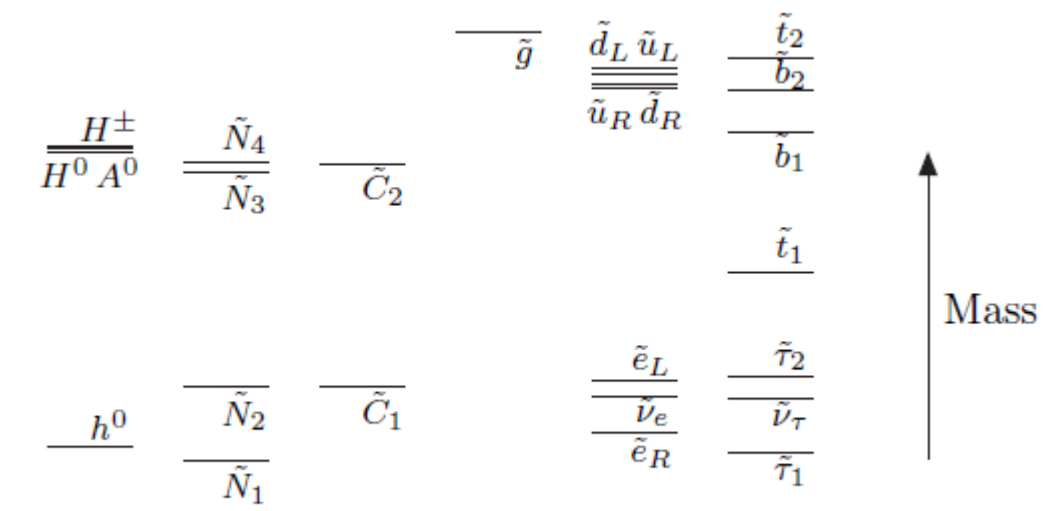
Trilinear couplings

Ratio of Higgs vevs

RG running of mSugra point

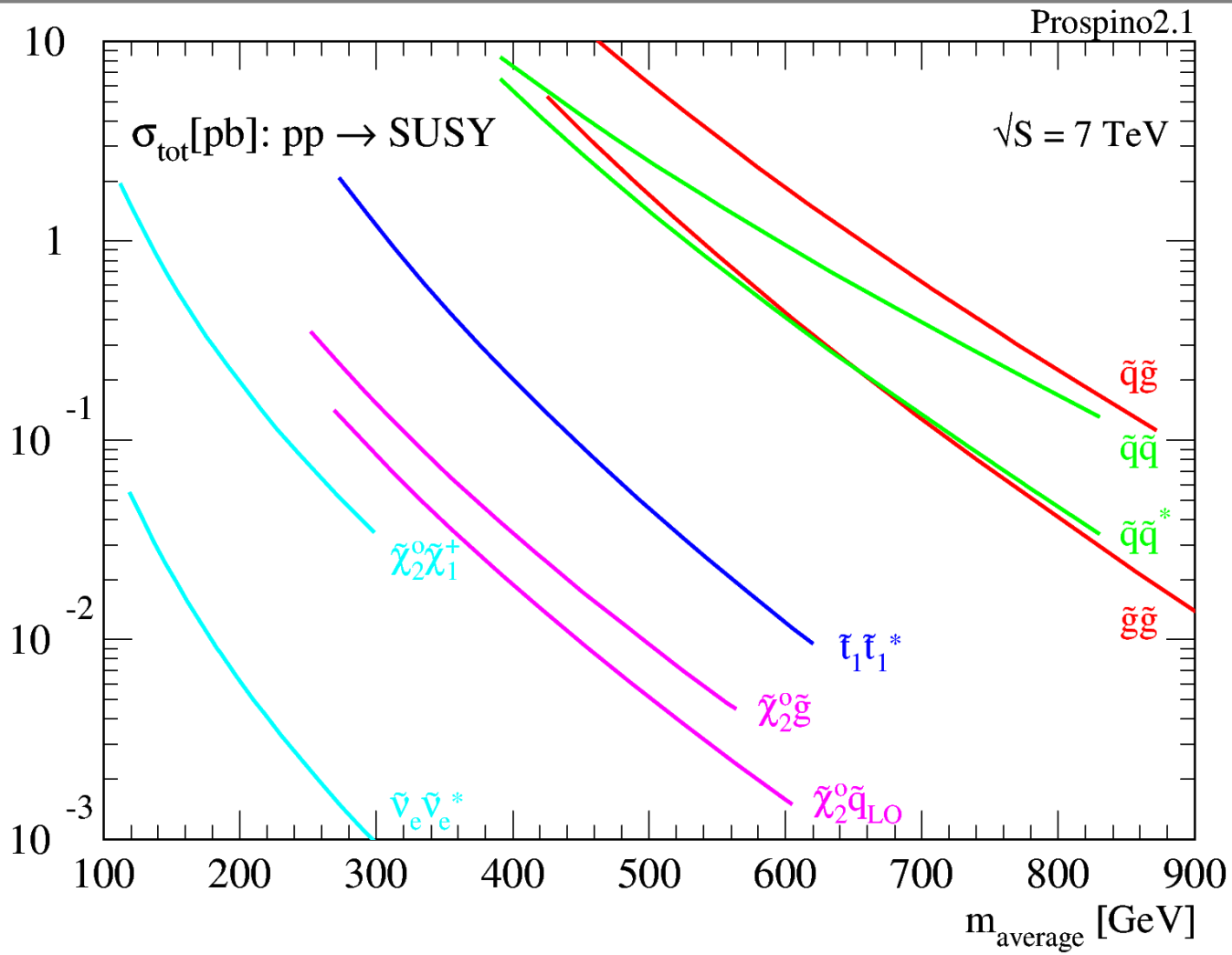


Spectrum

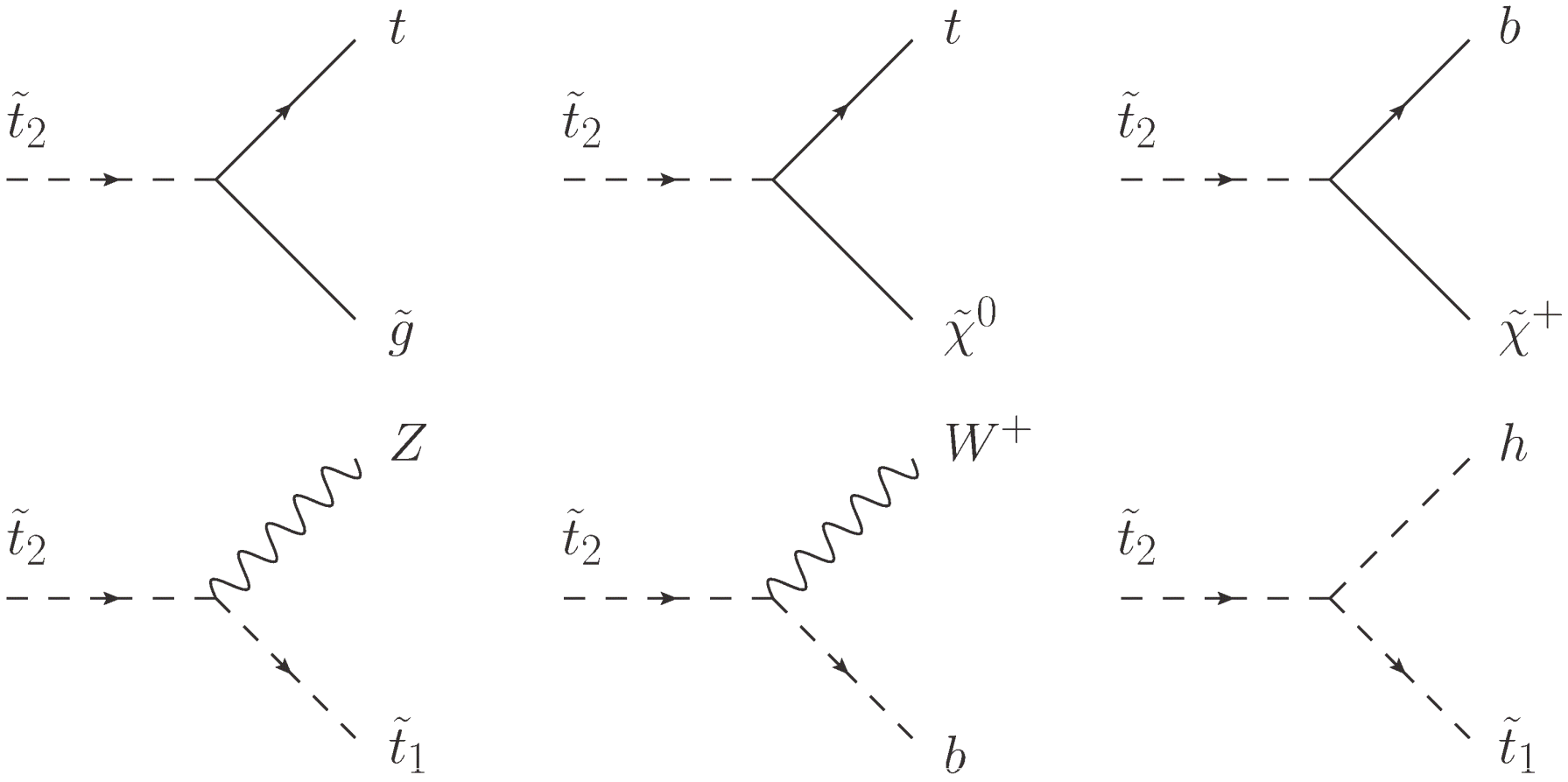


- Mass diff. $\tilde{t}_2 > \tilde{t}_1$
- $\tilde{g} > \tilde{q}$ vs. $\tilde{g} < \tilde{q}$
- mSugra: $\tilde{\chi}_1^0$ Bino

Sparticle Production

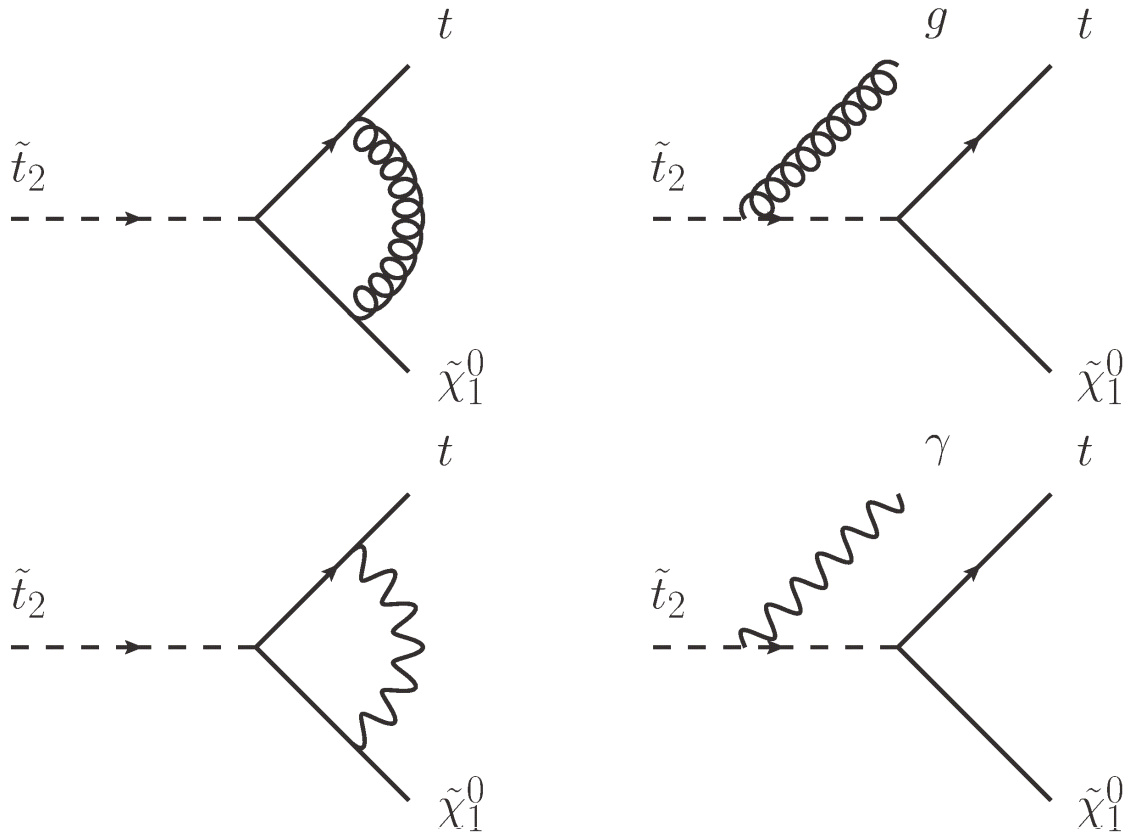


Squark decays



Corrections to squark decays

- Problem: We do not measure Γ_{part} but BR
  → Collect all decays, all corrections



SUSY Event

- Black board

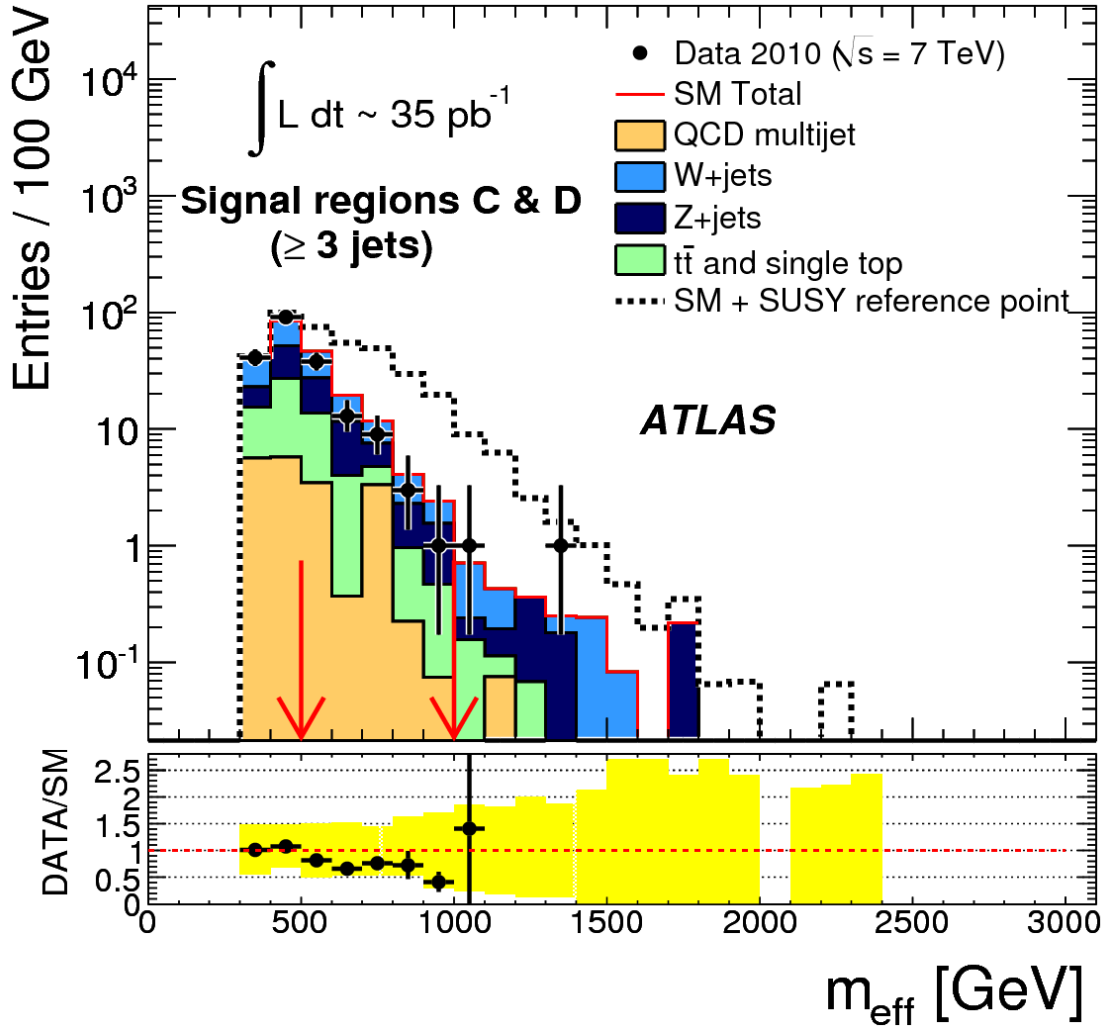
Signatures

- Missing ET + high pT jets (+ leptons, +X)
- + b-jets
- + High ET di-photonic final state (Gravitino LSP)
- Direct Neutralino/Chargino Production

  Missing ET + leptons

- Charged stable massive particles ($\tilde{\tau}_1$, $\tilde{\chi}_1^{\pm}$)
- R-Hadrons (bound state of squarks + quarks)

Example: effective mass distribution

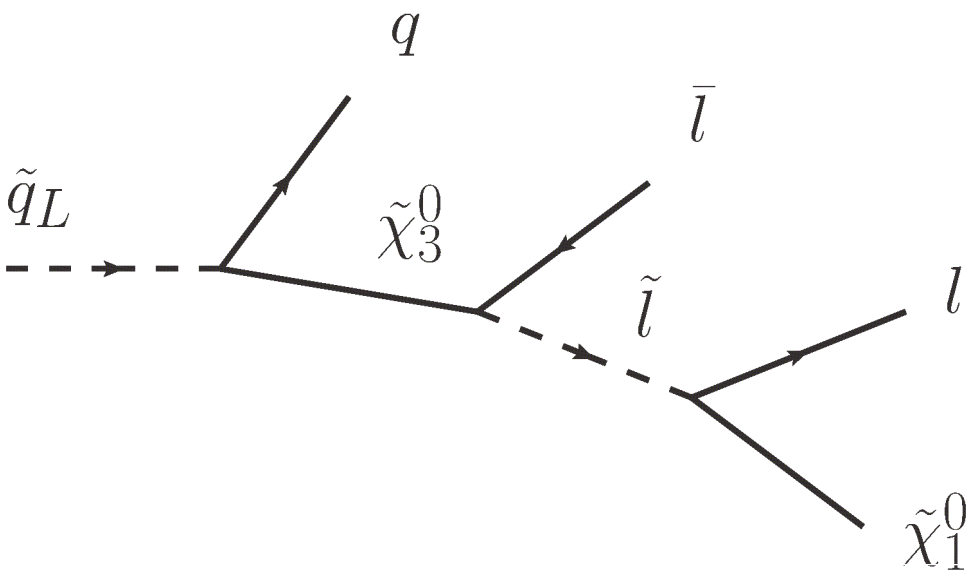


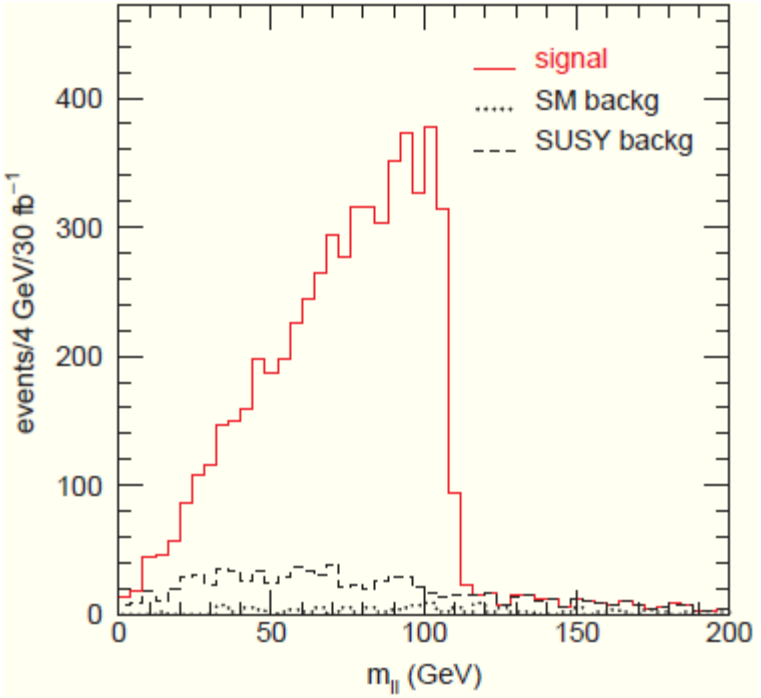
- Effective mass

$$m_{\text{eff}} = E_T^{\text{miss}} + \sum p_T$$

Parameter determination

- Masses: Endpoint method





$$(p_l + p_{\bar{l}})^2 \leq \frac{(m^2_{\chi^0_3} - m^2_{\tilde{l}})(m^2_{\tilde{l}} - m^2_{\chi^0_1})}{2m_{\tilde{l}} m_{\tilde{\chi}^0_1}}$$

Thank you!

Questions

&

Discussion