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# U(1)R as lepton number: third generation leptoquarks at the LHC

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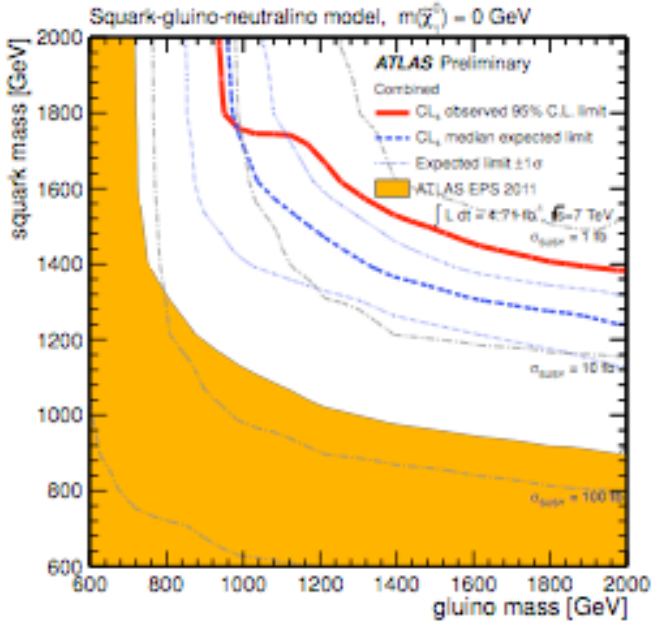
hep-ph 1107.4634
hep-ph 1203.5340

Hot topics at colliders,
27/04/12

LHC stringent bounds on first/second generation squarks and gluino.




MSSM parameter space significantly constrained

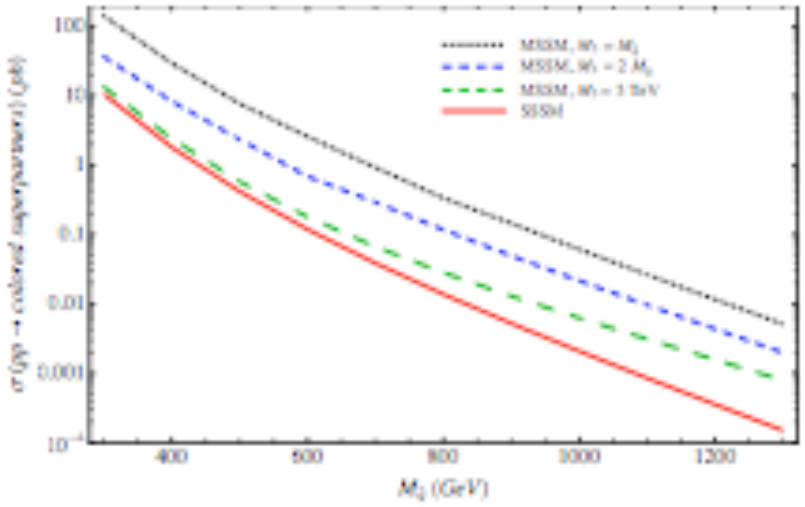
# Need to explore different SUSY scenarios/ SUSY breaking mechanism

flavorful SUSY mediation, stealth SUSY, RPV..

# Dirac gauginos

Squark production cross section lowered by heavy gluinos

MultiTeV Majorana gluinos problem for naturalness




hep ph 1203.4821

Dirac gluinos naturally heavier than scalars!

supersoft=no log divergencies, gauginos naturally heavier than scalars

(hep-ph/0206096)

# Dirac gauginos

New Adjoints superfields for each SM gauge group $\psi_{\tilde{B}}$ $\psi_{\tilde{W}}$ $\psi_{\tilde{g}}$

We can now build models with a quasi exact R symmetry

SUSY flavor problems largely ameliorate

Advantages: hep ph 0712.2039

Larger CP violation ( ew baryogenisis easier to accomodate) **hep ph 1107.1719**

# R symmetric models

- MRSSM: R symmetry contains the standard Rp as discrete symmetry. R symmetric Higgs sector contains 4 doublets. hep ph 0712.2039
- $\mathrm{U}(1)_R$ as the lepton number. Sneutrino can play the down type higgs, just two doublets required. hep-ph 1107.4634
- $\mathrm{U}(1)_R$ baryon number **hep-ph 1110.6670**

# $\mathrm{U}(1)_R$ lepton number

standard lepton number for BSM particle is violated

$$\lambda LLE^C \quad \lambda' LQD^C$$

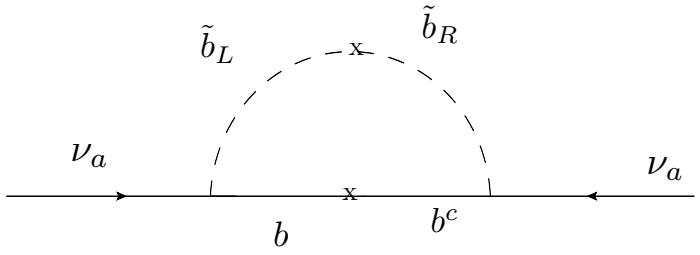
RPV couplings
no bounds from neutrino physics!

These couplings could be larger, interesting pheno consequences!

# Larger RPV couplings

## larger RPV couplings

| | | | |
|---|---|---|---|
| $\lvert\lambda'_{i11}\lambda'_{j11}\rvert$ | | bounds from neutrino physics<br>Barbier et al<br>hep ph 040639 | $5\times10^{-2}\,\tilde{d}^2\tilde{m}^{-1}$ $[m_\nu<1\text{ eV}]$ |
| $\lvert\lambda'_{i12}\lambda'_{j21}\rvert$ | | | $3\times10^{-3}\,\tilde{q}^2\tilde{m}^{-1}$ $[m_\nu<1\text{ eV}]$ |
| $\lvert\lambda'_{i13}\lambda'_{j31}\rvert$ | | | $8\times10^{-5}\,\tilde{q}^2\tilde{m}^{-1}$ $[m_\nu<1\text{ eV}]$ |
| $\lvert\lambda'_{i22}\lambda'_{j22}\rvert$ | | | $2\times10^{-4}\,\tilde{s}^2\tilde{m}^{-1}$ $[m_\nu<1\text{ eV}]$ |
| $\lvert\lambda'_{i23}\lambda'_{j32}\rvert$ | | | $5\times10^{-6}\,\tilde{q}^2\tilde{m}^{-1}$ $[m_\nu<1\text{ eV}]$ |
| $\lvert\lambda'_{i33}\lambda'_{j33}\rvert$ | | | $10^{-7}\,\tilde{b}^2\tilde{m}^{-1}$ $[m_\nu<1\text{ eV}]$<br>$(\tilde{m}^{d2}_{LR}=\tilde{m}\,M^d)$ (5.12) |

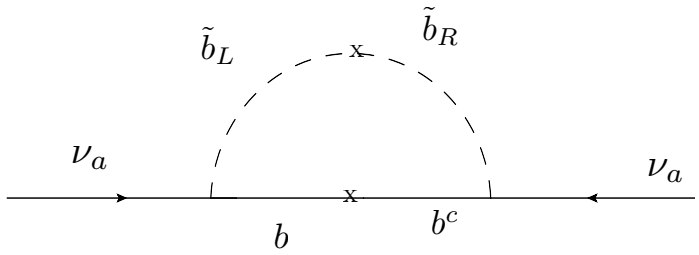



R symmetry forbids
left right mixing!

Bounds on the amount of R breaking

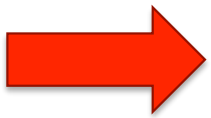
R symmetry is not exact. Broken by gravitino mass

Majorana mass for gauginos and trilinear coupling generated through anomaly or gravity mediation




Neutrino mass generated

$$m_{\nu_a} < 1eV$$



Bounds on gravitino mass

$$\mathrm{m}_{3/2} < 100\ MeV$$

interesting implications for neutrino physics, hep-ph 1203.5340

connection with DM, work in progress

work in progress

# Third generation quarks and leptons

R symmetry
lepton number

$\lambda'_{i33} \sim 1$

RPV MSSM $\lambda'_{i33} \sim 10^{-3}$

$\tilde{t}_L \to b\tau \qquad \tilde{t}_L \to bl$

$\tilde{b}_L \to b\nu$

$\tilde{b}_R \to tt \qquad \tilde{b}_R \to tl$

sizable branching ratio in the our framework, shorter decay chain!

RPV decays of lightest neutralinos and charginos

tops, bottom and taus copiously produced at the LHC

# Summarizing..

- Dirac gauginos interesting possibility to interpret LHC bounds
- R symmetry - R symmetry as lepton number
- The sneutrino is the down type Higgs
- Distinctive LHC phenomenology (copious leptoquark signatures)
- Interesting model building for neutrinos