

Leptons + Jets at the LHC

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Y. Bai, JB: 1407.4466

JB, J. Dror, W. H. Ng: 1506.08213

SUSY 2015

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Loopholes for Natural SUSY

- ▶ Non-minimal SSM
- ▶ Minimal flavor violation (MFV)
- ▶ Slight R-parity violation
- ▶ Dirac gauginos
- ▶ Stealth/compressed spectrum
- ▶ Twin structure

Run I Anomalies

CMS excesses in 3 searches:

1. Pair-produced leptoquarks to $(ej)(ej)$
2. Pair-produced leptoquarks to $(ej)(\nu j)$
3. W_R resonance to $eejj$

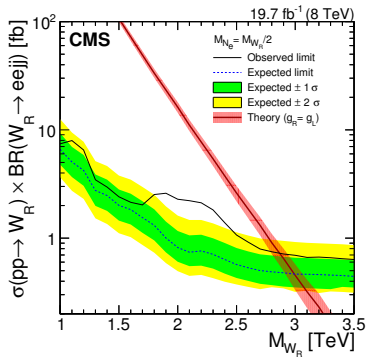
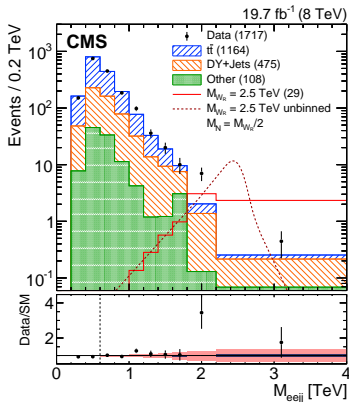
$$m_{LQ} \sim 650 \text{ GeV} \quad m_{eejj} \sim 2.1 \text{ TeV}$$

Nothing in analogous μ or τ channels

Also: $Z + \text{jets} + \text{MET}$, VV resonance, $h \rightarrow \mu\tau$, etc.

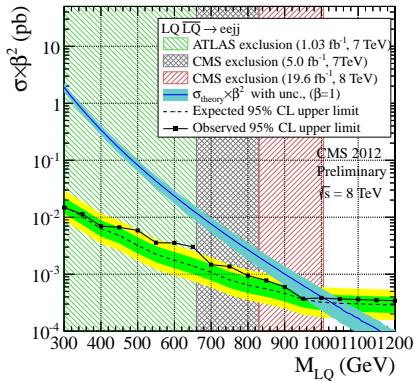
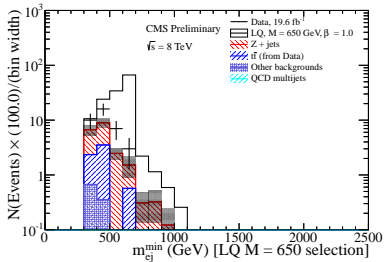
$W_R \rightarrow eejj$ Resonance

$\sim 2.8\sigma$



$eejj$ Leptoquark

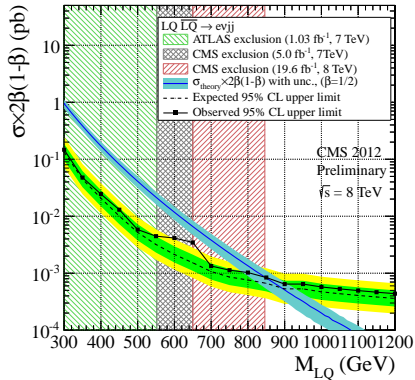
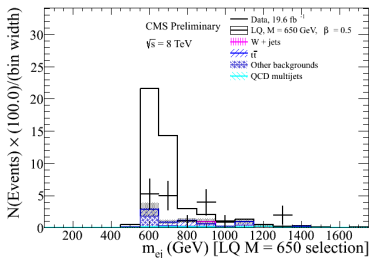
2.4σ



CMS-PAS-12041

$e\nu jj$ Leptoquark

2.6σ

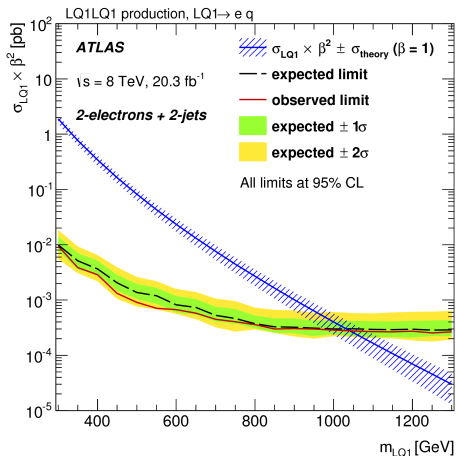


CMS-PAS-12041

What does it mean?

- ▶ Comparable rates to e_j and $\nu_j \rightarrow SU(2)_L$ symmetry
- ▶ First generation only \rightarrow Non-universality
- ▶ Naive leptoquark cross-section \times Br \rightarrow
Br $\sim 10\%$

Spoiler from ATLAS?



arxiv:1508.04735

see also SSDL: JHEP 07 (2015) 162

Slightly Model Dependent Predictions

- ▶ ATLAS should confirm...
- ▶ Bump in $e\nu jj$ @ 2.1 TeV
- ▶ Excess in jets + MET
- ▶ Dijet resonance @ 2.1 TeV

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A SUSY Model

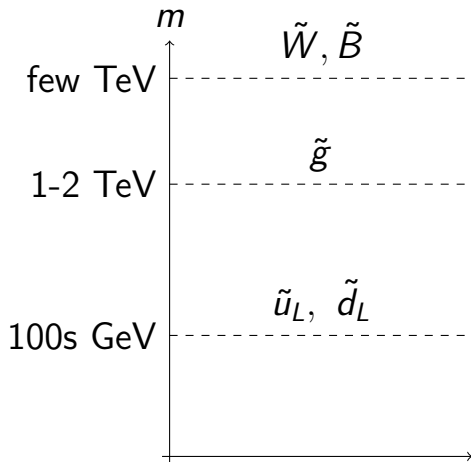
- ▶ Probably needs RPV
- ▶ Dirac gauginos helps with SSDL
- ▶ Higgs @ 125 GeV \rightarrow non-MSSM Higgs?
- ▶ Rest of the talk: Higgs as a sneutrino

Riva, Biggio, Pomarol: 1211.4526

Higgs as a Sneutrino

	$SU(3)_C \times SU(2)_L \times U(1)_Y$	$U(1)_R$
$H \equiv L_e$	$(1, 2)_{-1/2}$	0
E_e^c	$(1, 1)_1$	2
$L_{\mu,\tau}$	$(1, 2)_{-1/2}$	$1 - L$
$E_{\mu,\tau}^c$	$(1, 1)_1$	$1 + L$
$Q_{1,2,3}$	$(3, 2)_{1/6}$	$1 + B$
$U_{1,2,3}^c$	$(\bar{3}, 1)_{-2/3}$	$1 - B$
$D_{1,2,3}^c$	$(\bar{3}, 1)_{1/3}$	$1 - B$
$W^{a\alpha}$	$(8, 1)_0 + (1, 3)_0 + (1, 1)_0$	1
Φ^a	$(8, 1)_0 + (1, 3)_0 + (1, 1)_0$	0

Schematic Spectrum

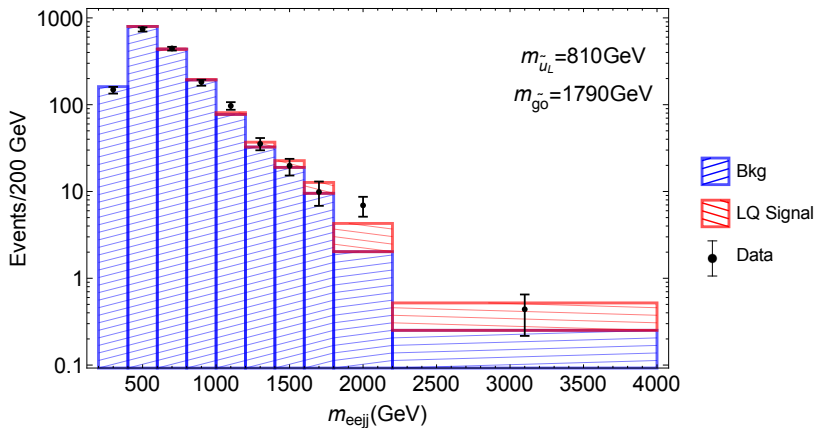


Neglect other
sparticles for now

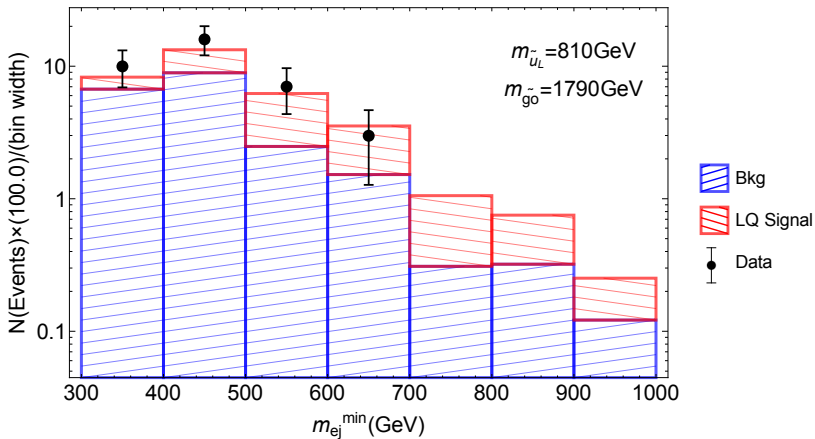
Production and Decay

- ▶ Production in $\tilde{q}\tilde{q}^*$ and $\tilde{q}\tilde{g}$
- ▶ Decay via $\tilde{q} \rightarrow q'\ell V/h$ with approximate isospin
- ▶ Final states with leptons and jets
- ▶ Features in ℓj invariant mass at $\sim m_{\tilde{q}}$
- ▶ Features in $\ell\ell jj$ invariant mass at $\sim 2m_{\tilde{q}}$ and $m_{\tilde{q}} + m_{\tilde{g}}$

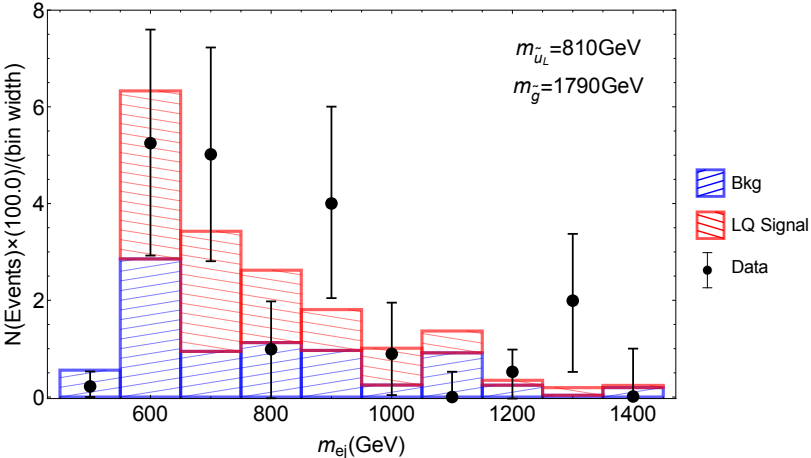
Results: $W_R eejj$



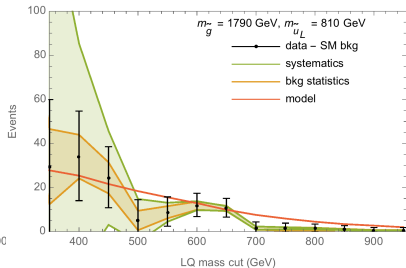
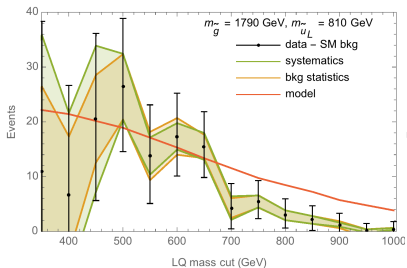
Results: Leptoquark $eejj$



Results: Leptoquark $e\nu jj$



Results: Bin by bin



Conclusions

- ▶ Many natural SUSY models predict MET-less signals
- ▶ Resonances can have complex, multi-stage decays
- ▶ Run 2 will be a powerful probe of high mass resonance-like signals