

Summary of Research & Short Term Plans

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Collider Studies

- Heavy Squarks
- Light Composite Higgs

Heavy Squarks

- Work in progress with LianTao Wang.
- Given a split-SUSY scenario with heavy squarks, what's the heaviest squark you'd see at the LHC?
- The production cross section falls off rapidly with squark mass

$m_{\tilde{q}}$ [TeV]	$m_{\tilde{g}} = 600$ GeV	$m_{\tilde{g}} = 800$ GeV	$m_{\tilde{g}} = 1200$ GeV
3	$1.3 \cdot 10^1$	6.5	1.9
4	1.4	$7.3 \cdot 10^{-1}$	$2.1 \cdot 10^{-1}$
5	$1.8 \cdot 10^{-1}$	$9.2 \cdot 10^{-2}$	$2.5 \cdot 10^{-2}$

Table 1: Cross section [fb] of single squark production before cuts are applied.

- Can you see this above SM background?
- Last year when we did this study we found the answer to be yes. We thought the major SM background would be from $Z + \text{jets}$ where $Z \rightarrow \text{invisible}$. We simulated the multi-jet background in ALPGEN. A set of cuts centered on requiring a single huge jet seems to do the trick.

$m_{\tilde{q}}$ [TeV]	$m_{\tilde{g}}$ [GeV]	\cancel{E}_T	p_T^1	$ \eta^1 $	p_T^2/p_T^1	$ p_T^2 - p_T^1 $	σ_{Signal} [fb]	σ_{BG} [fb]	$N_{\text{Signal}}/\sqrt{N_{\text{BG}}}$
3	600	200	1400	0.75	-	200	2.4	4.0	12.1
	800	200	1400	1.50	0.1	800	0.61	0.45	9.1
	1200	200	1400	1.75	0.1	800	0.19	0.22	4.0
4	600	200	1800	1.0	-	200	0.37	0.80	4.1
	800	200	1800	1.0	-	200	0.19	0.42	3.0
	1200	200	1400	0.75	-	-	0.10	4.4	0.5

Table 2: Cuts chosen to optimize $N_{\text{Signal}}/\sqrt{N_{\text{BG}}}$

- However, considering the size of the jets we're looking at, the missing energy cut we used seems small.
- Need to do a more detailed study of pure QCD background accounting for detector efficiencies to quantify this effect.

Light Composite Higgs

- Just starting work with LianTao Wang on collider signatures of light composite Higgs ^a.
- A composite Higgs will have anomalous dimension-3 and dimension-6 couplings. Can we measure them, and what sensitivity will we have at the LHC? ^{b c}.

^aGiudice, G. F. and Grojean, C. and Pomarol, A. and Rattazzi, R., *The Strongly-Interacting Light Higgs*, hep-ph/0703164

^bZhang, Bin and Kuang, Yu-Ping and He, Hong-Jian and Yuan, C. P., *Testing anomalous gauge couplings of the Higgs boson via weak-boson scatterings at the LHC*, hep-ph/0303048

^cBagger, J. and others, *LHC analysis of the strongly interacting $W W$ system: Gold plated modes*, hep-ph/9504426

Model Building

- WZW Anomalies in Little Higgs Theories
- Implementation of Realistic Anomaly Free Model

WZW Anomalies in Little Higgs Theories

- Last year Hill and Hill ^a ^b showed WZW anomalies can ruin T -parity in Little Higgs theories.
- Worked with Itay Yavin to see how generically T -parity is broken in theories with condensing fermions ^c.
- Concluded that for QCD-like theories you can't implement a model free of WZW anomalies, but you can make a model with an extension of T -parity respected by the full Lagrangian including WZW terms.

^aHill, Christopher T. and Hill, Richard J., *T-parity violation by anomalies*, arXiv:0705.0697 [hep-ph]

^bHill, Christopher T. and Hill, Richard J., *Topological Physics of Little Higgs Bosons*, hep-ph/0701044

^cDK and Yavin, I., *Anomalies in Fermionic UV Completions of Little Higgs Models*, arXiv:0803.4202 [hep-ph]

Implementation of Realistic Anomaly Free Model

- We found T -parity is preserved in multi-link moose models. However, the examples we considered aren't very realistic:
 - No SM fermions
 - No mechanism to generate a Higgs quartic interaction.
- Want to add SM fermions, and use them to generate the quartic.
- Adding SM fermions complicates things: need to give these mass terms while keeping the theory free of gauge anomalies.

- Moose models with SM fermions have been constructed. We want to see if these can work with the extended version of T -parity required when working with WZW terms.
- If we can construct such a model, it would have distinct phenomenological features. Some particles protected by the old version of T -parity would be stable, others would decay through WZW terms. It might be interesting to study the phenomenology of such a model.