Where are the gluinos?
Current Limits are > 320 GeV

Color Octet, EW Singlet
R-parity conserving
Lightest colored particle
Where are the gluinos?
Current Limits are > 320 GeV

Color Octet, EW Singlet
R-parity conserving
Lightest colored particle

Can gluinos be 50 GeV?
Clean limit where signal is only jets and MET
No LEP limits
LEP Doesn’t Produce Gluinos

Best limits come from Thrust

$\tilde{m}_g \gtrsim 30 \text{ GeV}$

$\tilde{m}_g \gtrsim 50 \text{ GeV}$

Hadron Machines only way to discovering
## Jets + Missing Energy Searches at D0

85pb⁻¹ + 2fb⁻¹ analyses

<table>
<thead>
<tr>
<th></th>
<th>$Gg$</th>
<th>$\tilde{q}\tilde{q}$</th>
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<tbody>
<tr>
<td>$E_T j_1$</td>
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<tr>
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<td>$&lt; 35$</td>
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<td>$E_T j_3$</td>
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</tr>
<tr>
<td>$E_T j_4$</td>
<td></td>
<td></td>
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(Not exclusive searches)
Jets + Missing Energy Searches at D0

85pb\(^{-1}\) + 2fb\(^{-1}\) analyses

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<td>(3j + \not{E}_T)</td>
<td>(4j + \not{E}_T)</td>
</tr>
<tr>
<td>(E_{T,j_1})</td>
<td>(\geq 150)</td>
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<tr>
<td>(E_{T,j_2})</td>
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</tr>
<tr>
<td>(E_{T,j_3})</td>
<td>(\geq 150)</td>
<td>(\geq 225)</td>
<td>(\geq 150)</td>
<td>(\geq 100)</td>
</tr>
<tr>
<td>(E_{T,j_4})</td>
<td>(\geq 150)</td>
<td>(\geq 300)</td>
<td>(\geq 400)</td>
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\[H_T = \sum E_{T,j}\] (Not exclusive searches)

Will these discover anything visible in these channels?
What we know about gluino limits

DØ Preliminary, 0.96 fb⁻¹

Gluino Mass (GeV)

Slepton & Chargino limits

\[ \tan \beta = 3, \ A_0 = 0, \ \mu < 0 \]

no mSUGRA solution

UA1, UA2, DØ IB, CDF I, CDF II
mSugra is not representative of the MSSM

\[ m_{\tilde{g}} : m_{\tilde{B}} = 6 : 1 \]

Anomaly Mediation
Mirage Mediation
non-Minimal Gauge Mediation

(never mind: UED, RS/LH with T-parity)

Never varies decay kinematics

Are there visible signals that could be missed?

Backgrounds are challenging
Examining $\tilde{g}\tilde{g}$ more carefully

The “gluino” module

Turn on one decay mode $\tilde{g} \rightarrow q\bar{q}\tilde{\chi}^0$

Keep masses and total cross section free

$m_{\tilde{g}} \quad m_{\tilde{\chi}} \quad \sigma(p\bar{p} \rightarrow \tilde{g}\tilde{g}X)$

Captures many models (MSSM, UED, etc)

Misses heavy flavor and cascades
Searches useful in gluino searches

\[ Q = 0 \]

\[ Q = m_{\tilde{\chi}} \]

**mSugra**

\[ m_{\tilde{\chi}} = m_{\tilde{g}} \]
Searches useful in gluino searches

\[ Q = 0 \]

\[ Q = m_{\tilde{\chi}} \]

\[ n j + E_T \]

\[ m_{\tilde{\chi}} = m_{\tilde{\chi}} \]

\[ m_{\tilde{g}} = m_{\tilde{g}} \]

\[ m_{\text{sugra}} \]
Searches useful in gluino searches

\[ m_{\tilde{g}} = m_{\tilde{\chi}} \]

\[ j^{\text{ISR}} + E_T \]

\[ Q = m_{\tilde{\chi}} \]

\[ Q = 0 \]

\[ n j + E_T \]

\[ m_{\tilde{\chi}} \]

\[ m_{\tilde{g}} \]

mSugra
Producing Degenerate Gluinos

Need additional hard jets
Want the spectrum as well

**D0**
- $P_T^{j_1} > 150$ GeV
- $P_T^{j_2} < 50$ GeV
- $P_T^{j_3} < 20$ GeV
- $E_T > 150$ GeV
- $\Delta \Phi^{jE_T} > 30^\circ$

**CDF**
- $P_T^{j_1} > 150$ GeV
- $P_T^{j_2} < 60$ GeV
- $P_T^{j_3} < 20$ GeV
- $E_T > 120$ GeV
- $\Delta \Phi^{j_2E_T} > 0.3$
Calculating Additional Jets

Parton Showering
- QCD Bremstrahlung
- Soft/Collinear Approximation
- Resums large logs
- Computationally Cheap
- Unlimited number of partons

Matrix Elements
- Necessary for well-separated jets
- Includes quantum interference
- Fixed order calculation
- Computationally expensive
- Limited number of partons

Matching merges best of both worlds
Necessary to avoid double counting

Need it for the BSM Signal!

See. J. Alwall’s Presentation
Comparison between Matching and Showering

Ptjet1 in pp→gogo+jets by MadGraph/Pythia

Madgraph

Pythia
**Exclusive Jets + MET Search**

4 Separate Searches, Individually Optimized

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<td>$\not{E}_T$</td>
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<tr>
<td>$H_T$</td>
<td></td>
<td></td>
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Maximize significance for each $m_{\tilde{g}}$, $m_{\tilde{\chi}}$

Limit on S/B for exclusion
Sensitivity plot for 2fb$^{-1}$

$S/B > 1$

$m\tilde{\chi}$ vs. $m\tilde{g}$

$m_3/m_1 \sim 3$

$m_3/m_1 \sim 6$

130 GeV
Have only focused on $\tilde{g}$ module

<table>
<thead>
<tr>
<th>Other modules</th>
<th>3 parameters</th>
<th>4 parameters</th>
<th>5 parameters</th>
<th>7 parameters</th>
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<tbody>
<tr>
<td>$\tilde{q}$</td>
<td>$\tilde{q} \rightarrow q\chi$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\tilde{q}\tilde{g}$</td>
<td>$\tilde{q} \rightarrow q\chi$, $\tilde{g} \rightarrow q\bar{q}\chi$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\tilde{g}$</td>
<td>$\tilde{g} \rightarrow q\bar{q}\chi'$, $\chi' \rightarrow q\bar{q}\chi$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\tilde{g}$</td>
<td>$\tilde{g} \rightarrow q\bar{q}\chi''$, $\chi'' \rightarrow q\bar{q}\chi'$, $\chi' \rightarrow q\bar{q}\chi$</td>
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<td></td>
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<tr>
<td></td>
<td>$\cdots$</td>
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Model Independent Search

For each jet multiplicity

Set a limit on \( \frac{d^2 \sigma}{dH_T d \slashed{E}_T} \) \( \Delta H_T \) \( \Delta \slashed{E}_T \)

e.g.

<table>
<thead>
<tr>
<th>( H_T )</th>
<th>( \slashed{E}_T )</th>
<th>4 jets</th>
</tr>
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<tbody>
<tr>
<td>200</td>
<td>100</td>
<td>10^{-8}_8 fb</td>
</tr>
<tr>
<td>400</td>
<td>200</td>
<td>10^{+8}_8 fb</td>
</tr>
<tr>
<td>600</td>
<td>300</td>
<td>10^{+3}_3 fb</td>
</tr>
<tr>
<td>800</td>
<td>400</td>
<td>5^{+2}_2 fb</td>
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Tevatron is a proving ground for LHC

Improvement on existing searches

Need model-independent searches

Important orthogonal directions to mSugra

Possible to not discover a visible signal

\[ m_{\tilde{g}} = 210 \text{ GeV} \quad m_{\tilde{B}} = 100 \text{ GeV} \]

\[ H_T \geq 225 \text{ GeV} \quad E_T \geq 300 \text{ GeV} \quad H_T \geq 150 \text{ GeV} \quad E_T \geq 100 \text{ GeV} \]