DISCOVERING SUPERSYMMETRY
WITH LIKE-SIGN DILEPTONS

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Abstract

Supersymmetry may be discovered at hadron colliders by searching for events similar to the top quark signal of two isolated leptons. In the case of gluino production, the most distinguishing feature is that in half the events the two leading leptons have the same sign. We demonstrate the remarkable sensitivity of this gluino signature at both the Fermilab Tevatron Collider and at the Superconducting Super Collider. Techniques for approximately determining the gluino mass are discussed.

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1. Introduction

A hallmark in the search for supersymmetry would be the discovery of the gluino or the squarks, the supersymmetric partners of the gluon and the quarks\cite{1}. Many previous discussions of supersymmetry phenomenology at hadron colliders have centered on the “classic” signature for gluino or squark production: clusters of hadrons (“jets”) and large missing transverse energy with no associated hard leptons. The missing-energy signature arises from events in which gluinos and/or squarks are produced and subsequently decay into jets and the lightest supersymmetric particle (LSP). The LSP, like the neutrino, will escape collider detectors.

In this Letter, we focus on the striking experimental signature of two isolated leptons which can arise from gluino pair production. Half of the events of this type will have leptons with the same sign of electric charge. This signature, which is analogous to the opposite-sign lepton signal for the top quark, may yield sensitivity much superior to the missing-energy gluino signature at the Fermilab Tevatron Collider or at the Superconducting Super Collider (SSC), depending on the parameters of the supersymmetric model. Moreover, the same-sign lepton signature can also be utilized to provide an estimate of the gluino mass. A preliminary version of the results contained here appeared in Refs. 2-3. Complementary work that also considered the like-sign dilepton signature can be found in Refs. 4-7.

2. Gluino Decays and the Dilepton Signature

In this Letter, we examine gluino searches at hadron colliders in the context of the minimal supersymmetric extension of the Standard Model (MSSM). We
concentrate on $\tilde{g}\tilde{g}$ production under the assumption that $M_{\tilde{g}} < M_{\tilde{q}}$ (otherwise, $\tilde{g} \to q\tilde{q}$ would be the dominant gluino decay mode, and the phenomenology of squarks would be our primary concern). Gluino signatures depend in detail on the gluino branching ratios into neutralino and chargino * final states *8–10*. The masses and couplings of the neutralinos and charginos are determined by the MSSM parameters $\mu$, $\tan \beta$ and the gaugino mass parameters, $M_1$ and $M_2$. Furthermore, under a unification assumption for the gaugino mass parameters, it follows that: $M_2 \equiv (g^2/g_s^2)M_{\tilde{g}}$ and $M_1 \equiv (5g'^2/3g_s^2)M_{\tilde{g}}$.

In gluino pair production, the most prominent missing-energy signature arises from $\tilde{g} \to q\bar{q}\tilde{\chi}^0_1$ decays, when $\tilde{\chi}^0_1$, the lightest neutralino, is assumed to be the LSP. However, substantial suppression of the $\tilde{g} \to q\bar{q}\tilde{\chi}^0_1$ decays is found; e.g. for $M_{\tilde{g}} = 180$ GeV, $B(\tilde{g} \to q\bar{q}\tilde{\chi}^0_1) < 0.4$ (and possibly much smaller, depending upon $\mu$ and $\tan \beta$). The suppression is even more dramatic for heavier gluinos ($M_{\tilde{g}} \gtrsim 500$ GeV), where $B(\tilde{g} \to q\bar{q}\tilde{\chi}^0_1)$ is no greater than $0.14^{[9,10]}$. The dominant gluino decays are those into chargino and heavier neutralino states which in turn decay into lighter neutralinos and/or charginos. Although in a cascade decay chain the LSP is ultimately emitted and escapes detection, the missing-energy signature is significantly degraded as compared to gluino decays in which the LSP is emitted in the initial decay. Fortunately, the leptons frequently produced in typical decay chains provide a viable signal for $\tilde{g}\tilde{g}$ production.

Over a large range of supersymmetric parameter space, the dominant gluino decay mode is $\tilde{g} \to q\bar{q}\tilde{\chi}^\pm_1$, where $\tilde{\chi}^\pm_1$ is the lightest chargino. Leptons can result from decays such as $\tilde{\chi}^\pm_1 \to W^\pm\tilde{\chi}^0_1 \to \ell^\pm \nu \tilde{\chi}^0_1$, where the $W^\pm$ is either on-shell (if

* The neutralinos and charginos are mixtures of the supersymmetric partners of the $\gamma$, $Z$, and $H^0$ bosons and of the $W^\pm$ and $H^\pm$ bosons respectively.
kinematics allow) or off-shell. If the sleptons are lighter than the chargino, then the two-body decays $\tilde{\chi}_1^{\pm} \rightarrow \tilde{\ell}^{\pm} \nu \rightarrow \ell^{\pm} \nu \tilde{\chi}_1^0$ and $\tilde{\chi}_1^{\pm} \rightarrow \tilde{\nu} \ell^{\pm} \rightarrow \ell^{\pm} \nu \tilde{\chi}_1^0$ are allowed and may dominate.\(^\dagger\) Since the gluino is a Majorana fermion,\(^\ddagger\) it has the distinctive property of decaying with equal probability into fermions and antifermions. Thus, an excellent signature for pair production of gluinos results from events in which both gluinos decay to a chargino of the same sign, yielding like-sign dileptons ($\ell^+ \ell^+$ or $\ell^- \ell^-$) in the final state. The probability for the production of like-sign and opposite-sign leptons is equal, and the characteristics of the two classes of final states are identical. Observation of this distinctive result would be extremely helpful in identifying the origin of the events. It should also be noted that the like-sign dilepton signature remains viable in models with explicit $R$-parity breaking in which the LSP decays and does not produce a missing-energy signature.\(^{[12]}\)

Of course, like-sign dilepton events can arise in events involving primary squark production. If $M_{\tilde{q}} < M_{\tilde{g}}$, dilepton signatures from $\tilde{q} \tilde{q}$ events could contain both like-sign and opposite-sign components, depending on the relative squark decay branching ratios to produce final state neutralinos and charginos. (If $\tilde{t} \rightarrow t \tilde{\chi}_1^0$ decays occur, the additional isolated leptons from $t$ decay would need to be included in the analysis.) Since the parameters of the squark and the $\tilde{g}/\tilde{\chi}^+/\tilde{\chi}_1^0$ sectors are independent, the specific squark branching fractions are model dependent. As a result, we focus in this paper on the case of $M_{\tilde{q}} > M_{\tilde{g}}$. It then follows that $B(\tilde{q} \rightarrow q \tilde{g}) \sim 100\%$ so that $\tilde{q} \tilde{q}$ and $\tilde{q} \tilde{g}$ production yield $\tilde{g} \tilde{g}$ events with two or one extra quark jet, respectively. But, the direct $\tilde{g} \tilde{g}$ cross section is by far the largest

\(^\dagger\) In many models of supersymmetry the $\tilde{\ell}$ and $\tilde{\nu}$ are significantly lighter than the squarks. Thus, such decays are not incompatible with the heavy squark assumption of this paper.

\(^\ddagger\) Here, we use a broader definition of Majorana to include neutral particles that transform under real representations of the underlying Standard Model gauge group.
and yields the dominant contribution to the like-sign dilepton signal.

In the numerical work in this paper, we have taken the branching ratio for gluino decay to the lightest chargino to be $B(\tilde{g} \rightarrow q\tilde{q}^\pm \tilde{\chi}_1^\mp) = 0.58$, a result which holds to good accuracy for all $|\mu| > M_\tilde{g}/3, m_Z$. Moreover, this value for the branching ratio is approximately valid for nearly all MSSM parameters of relevance to the Tevatron gluino search. If the $\tilde{\ell}$ and $\tilde{\nu}$ are heavier than the chargino, the chargino decays dominantly into the LSP plus a real (or virtual) $W^\pm$, which then decays 22% of the time into electrons and muons. Thus the branching ratio for the decay chain $\tilde{g} \rightarrow q\tilde{q}^\pm \nu \tilde{\chi}_1^0$ is likely to be as large as 13%, with equal probability to produce a lepton of either sign. (For simplicity, the $\tau$-lepton will be neglected from our considerations.) Since gluinos are produced in pairs, the number of dilepton final states resulting from the decay of the two gluinos would be about 1.6% of all $\tilde{g} \tilde{g}$ events, of which half would have a pair of like-sign leptons. However, if $M_{\tilde{\ell}}$ and/or $M_{\tilde{\nu}} < M_{\tilde{\chi}_1^\pm}$, and $M_{\tilde{\chi}_1^\pm} < m_W + M_{\tilde{\chi}_1^0}$, then the two-body decays of the $\tilde{\chi}_1^\pm$ to $\tilde{\ell}\nu$ and/or $\tilde{\nu}\tilde{\ell}$ will have $\sim 100\%$ branching ratio into leptonic final states (including the $\tau$-lepton). If we neglect $\tau$-leptons, we find $B(\tilde{g} \rightarrow q\tilde{q}^\pm \nu \tilde{\chi}_1^0)$ close to 40%. A remarkable 15% of all $\tilde{g} \tilde{g}$ events would yield a dilepton final state.

Given the large cross-sections for gluino pair production at the Tevatron Collider and the SSC, there would exist a potentially large and interesting sample of events. These events would have hadronic jets (two from each gluino), missing energy due to the LSP and neutrinos in the final state, and a dilepton pair which can come in one of the following like-sign combinations: $e^\pm e^\pm$, $e^\pm \mu^\pm$, $\mu^\pm \mu^\pm$, and the corresponding opposite-sign combinations. The events would be very similar

\footnote{For example, when $M_{\tilde{g}} \lesssim 200$ GeV and $\tan \beta > 4$, $B(\tilde{g} \rightarrow q\tilde{q}^\pm \tilde{\chi}_1^\mp)$ varies between about 45% and 65% as $\mu$ is varied.}
to those arising from $t\bar{t}$ production in which the leptons come from primary decays of the $t$ and $\bar{t}$. Thus, distinguishing the source of opposite-sign events might be difficult. Because the efficiency for tagging $b$-jets is low and because some fraction of $\tilde{g}\tilde{g}$ events will contain $b$-jets from a hard radiated gluon, $b$-jets may not be a useful tool for separating $t\bar{t}$ from $\tilde{g}\tilde{g}$ events. For this reason we will focus on like-sign dilepton final states for which $t\bar{t}$ production yields a background only through $\tilde{t} \to \bar{b}\ell^−\nu$ and $t \to bX$, $b \to c\ell^−\nu$ (or the corresponding charge-conjugated decay chain). This background would be quite small since the lepton from the $b$ decay would very rarely be isolated.

3. Gluino Search at the Tevatron and SSC

We have evaluated the rates for the dilepton signal in gluino pair production at both the Tevatron and SSC energies. In order to roughly account for realistic experimental conditions, we have employed a parton-level Monte Carlo, which included resolution smearing but no fragmentation, to model the $\tilde{g}\tilde{g}$ events. We also examined the impact of the higher-order process $\tilde{g}\tilde{g}g$ on our results. In examining the latter process, we have placed a transverse momentum cut on the extra $g$ such that the $\tilde{g}\tilde{g}g$ cross section is approximately the same as the $\tilde{g}\tilde{g}$ cross section. A more precise treatment would incorporate a full one-loop analysis, but is unlikely to affect our basic conclusions. We find that the only impact of the extra radiated gluon is upon the size of the cross section even when cuts are imposed. The shapes of the distributions we have examined (described below) are essentially unaltered at both Tevatron and SSC energies.

† A description of a similar program to analyze the characteristics of supersymmetric events at the CERN $\sqrt{s}$ collider can be found in ref. 15.
We first present our analysis for Tevatron energies. The surprisingly large potential for gluino discovery at the Tevatron becomes apparent by giving the number of dilepton (opposite- plus like-sign) events obtained in a 25 pb\(^{-1}\) year. For the case where the \(\tilde{\chi}_1^\pm\) decays to \(\tilde{\ell}\nu\) or \(\ell\tilde{\nu}\), the net branching ratio of 15\% quoted above yields roughly 1440, 476, 183, 79, 37, and 18 dilepton events (before cuts) for gluino masses of 100, 120, 140, 160, 180, and 200 GeV, respectively. Dilepton rates originating from \(\tilde{\chi}_1^\pm \rightarrow W^{(*)}\tilde{\chi}_1^0\) decays are a factor of roughly 9 smaller.

To estimate the rates for detectable dilepton events at the Tevatron, we assume a trigger which requires that the leading (secondary) lepton has \(E_T > 15\) (10) GeV. In addition, we require \(|\eta| < 2.5\) and isolation for both leptons. \(^\dagger\) Associated hadronic jets are not required. The probability that events pass these cuts depends in detail upon the masses of the particles involved in the decay chains, but is roughly 50\% for much of parameter space. We have explored a range of supersymmetric parameters for which the mass \(M_{\tilde{\chi}_1^\pm}\) varies between about 45 GeV (its current lower bound from LEP data\(^{[17]}\)) and 80 GeV, while letting the gluino mass vary between 100 GeV (the present experimental lower bound\(^{[18]}\)) and 200 GeV. In the corresponding range of MSSM parameter space, the mass of the LSP (\(\tilde{\chi}_1^0\)) is approximately given by \(M_{\tilde{g}}/6\).

For \(\tilde{\chi}_1^\pm \rightarrow W^{\pm*}\tilde{\chi}_1^0\), the 1.6\% net branching ratio quoted earlier yields between 70 and 1 dilepton events (of which half are like-sign) per 25 pb\(^{-1}\) at the Tevatron for \(M_{\tilde{g}}\) between 100 and 160 GeV. In contrast, if the \(\tilde{\chi}_1^\pm\) decays to \(\tilde{\ell}\nu\) and/or \(\ell\tilde{\nu}\), the larger 15\% net branching ratio can result in up to 1100 (15) dilepton events for \(M_{\tilde{g}} = 100\) (200) GeV, depending on the decay mode and the various masses.

\(^\dagger\) In this paper, we define an isolated lepton to be one that is separated by at least 0.3 units in \(\Delta R \equiv \left(\Delta\eta^2 + \Delta\phi^2\right)^{1/2}\) from any parton (or “merged parton jet” if two or more partons are within 0.7 units in \(\Delta R\) of each other).
Table 1: Number of $\ell^{\pm}\ell^{\pm}$ plus $\ell^{\pm}\ell^{\mp}$ events after lepton cuts for various $M_{\tilde{g}}$ values at the Tevatron with $\int \mathcal{L} = 25$ pb$^{-1}$. The various decay modes of the $\tilde{\chi}_1^{\pm}$ are indicated by $W$ ($W\tilde{\chi}_0^0$), $\tilde{\ell}$ ($\tilde{\ell}\nu$), $\tilde{\nu}$ ($\tilde{\nu}\ell$). These rates assume the branching ratios quoted earlier (which are, in fact, typical over a wide range of parameters).

| Mode       | $W$ | $W$ | $W$ | $\tilde{\ell}$ | $\tilde{\nu}$ | $\tilde{\nu}$ | $\tilde{\ell}$ | $\tilde{\ell}$ | $\tilde{\nu}$ | $\tilde{\nu}$ |
|------------|-----|-----|-----|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| $M(\tilde{g})$ | 140 | 140 | 140 | 160           | 160           | 180           | 180           | 180           | 180           | 200           |
| $M(\tilde{\chi}_1^{\pm})$ | 80  | 60  | 45  | 60            | 60            | 80            | 80            | 80            | 80            | 80            |
| $M(\tilde{\ell} \text{ or } \tilde{\nu})$ | −   | −   | −   | 40            | 70            | 50            | 75            | 55            | 40            | 40            |
| Events     | 9   | 6   | 3   | 22            | 9             | 12            | 30            | 22            | 9             | 28            |

To illustrate, we present in Table 1 $L = 25$ pb$^{-1}$ dilepton event rates for a sampling of cases which yield $\lesssim 30$ events. For comparison, with our cuts, 12 events are expected from $t\bar{t}$ production for $m_t = 140$ GeV, but all of these have opposite-sign leptons. Thus, for comparable gluino and top quark masses, the additional requirement of two isolated like-sign leptons would reduce the top quark rate to a level far below that from gluinos. However, a top quark significantly lighter than the gluino might require that additional cuts be made to separate the two signals.

The event rate depends strongly on the lepton cuts. The lepton spectrum itself is quite sensitive to decay modes and decay product masses. For the chargino three-body decay to $\tilde{\chi}_1^0\ell\nu$ via a virtual $W$, the lepton spectrum depends primarily on $M_{\tilde{\chi}_1^0} - M_{\tilde{\chi}_1^0}$. For chargino decays to $\tilde{\ell}\nu$ ($\tilde{\nu}\ell$), the spectrum is essentially determined by $M_{\tilde{\ell}} - M_{\tilde{\chi}_1^0}$ ($M_{\tilde{\chi}_1^0} - M_{\tilde{\ell}}$). Because of the current experimental limit of $M_{\tilde{\ell}} > 44$ GeV$^{[17]}$, most leptons from $\tilde{\ell}$ decay pass our cuts for the $M_{\tilde{\chi}_1^0}$ values employed. Thus, even for the relatively large gluino masses of 160 and 180 GeV, the $\tilde{\ell}\nu$ decay event rates illustrated are large enough to be in possible conflict with observed rates.
at the Tevatron. In contrast, as illustrated in Table 1, the event rate associated
with \( \tilde{\chi}_1^\pm \to \ell \tilde{\nu} \) decays could be very small since small values of \( M_{\tilde{\chi}_1^\pm} - M_{\tilde{\nu}} \) are
possible, leading to a soft lepton that is unlikely to pass our cuts. However, even
for \( M_{\tilde{g}} = 180 \text{ GeV} \), if the \( \tilde{\nu} \) mass is not close to \( M_{\tilde{\chi}_1^\pm} \) then the event rate for the
\( \ell \tilde{\nu} \) mode is large.

Thus, if very few or no like-sign dilepton events are found after accumulating
\( L = 25 \text{ pb}^{-1} \), then improved limits on the gluino mass (as a function of other
MSSM parameters) will be attainable. If \( \tilde{\chi}_1^\pm \to W^{\pm} \tilde{\chi}_1^0 \) is the dominant decay, a
modest improvement of \( M_{\tilde{g}} > 120 \text{ GeV} \) is possible, based on the like-sign dilepton
search. In contrast, if \( \ell \tilde{\nu} \) or \( \tilde{\ell} \nu \) decays of the \( \tilde{\chi}_1^\pm \) are dominant and the \( \ell \) spectra
are not suppressed by a small mass difference, then limits of order \( M_{\tilde{g}} \gtrsim 200 \text{ GeV} \)
will be obtained over the large region of parameter space for which \( B(\tilde{g} \to q\bar{q}\tilde{\chi}_1^\pm) \)
is substantial.

Assuming that one has succeeded in isolating gluino candidates, it is impor-
tant to ask if one can estimate the mass of the gluino, and the masses of the
decay products. We have performed detailed studies and find that the most useful
distributions (at the Tevatron) for this purpose are \( E_T^{\ell \max} \), the \( E_T \) of the most
energetic lepton and \( E_T^j \max \), the transverse energy of the jet with largest \( E_T \).
For any given decay chain, these can be used to estimate the mass differences, and the
overall event rate can then be used to determine the absolute mass scale, provided
statistics are adequate. Scenarios consistent with current Tevatron rates would
require \( L > 100 \text{ pb}^{-1} \) to achieve a \( \pm 25 \text{ GeV} \) uncertainty in the measurement of
\( M_{\tilde{g}} \). Further details will be given elsewhere.

\* The \( E_T \) spectrum of the jets is completely determined by \( M_{\tilde{g}} - M_{\tilde{\chi}_1^\pm} \).
We now turn to the gluino search via the dilepton signature at the SSC. We consider only the case of \( M_{\tilde{g}}, M_{\tilde{\nu}} > M_{\tilde{\chi}_1^\pm} \) (where event rates are lowest). Before applying cuts, a 180 GeV (2 TeV) gluino will result in roughly \( 4 \times 10^6 (50) \) dilepton events (half of which are like-sign) in an SSC year (\( 10^4 \text{ pb}^{-1} \)). We triggered on leptons with large \( E_T \) in the \( |\eta| < 2.5 \) region; either both leptons must have \( E_T > 20 \) GeV, or one lepton must have \( E_T > 15 \) GeV and the other \( E_T > 40 \) GeV. In the following analysis only events for which there are at least two jets in the region \( |\eta| < 3 \), having \( E_T > 25 \) GeV are accepted. A circularity cut of \( C < 0.6 \) was imposed, where circularity is defined by \( C = \frac{1}{2} \min (\Sigma \vec{E}_t \cdot \hat{n})^2 / (\Sigma E_t^2) \). Here, the sum is taken over calorimeter cells and the minimization is performed over all unit vectors, \( \hat{n} \), in the transverse plane. \( C = 0 \) implies pencil-like events and \( C = 1 \) corresponds to isotropic events.

To determine the gluino mass, the event rate must be used in addition to the \( E_T^{\ell \max} \) and \( E_T^{j \max} \) distributions which only determine mass differences in the decay chain. To give an example, in the \( W \)-mediated decays the distributions for the cases \([M_{\tilde{g}}, M_{\tilde{\chi}_1^\pm}, M_{\tilde{\chi}_0^1}] = [300, 100, 50] \) GeV and \([350, 150, 100] \) GeV are intrinsically indistinguishable. However, the event rates after our basic cuts are very different: assuming the effective branching ratio of 1.6% discussed previously, we find 87,000 versus 44,000 like-sign events per SSC year. In this range of gluino masses there is a sufficient number of events and a 15% determination of \( M_{\tilde{g}} \) would be possible (if theoretical and experimental normalizations are reliable). It should be noted that we are using the fact that \( B(\tilde{g} \to q\bar{q}\tilde{\chi}_1^\pm) \) is almost always near its asymptotic value for \( M_{\tilde{g}} \) masses in the range considered. Of course, if the mass of the \( \tilde{\chi}_1^\pm \) is known from other data (e.g. LEP-II), the \( E_T^{j \max} \) distribution shape in principle allows a fairly accurate \( M_{\tilde{g}} \) determination for a given decay scenario, independent of the
Figure 1: For events with two isolated like-sign leptons, we illustrate the distribution of $M_{\text{est}}$, a variable defined in the text that is sensitive to the gluino mass. The curves shown correspond to one year of SSC running ($10^4$ pb$^{-1}$), with gluino masses of $M_{\tilde{g}} = 300$ (solid) and 350 GeV (dots). Dominance of the $\tilde{\chi}_1^\pm \to W^* \tilde{\chi}_1^0$ decays with $M_{\tilde{\chi}_1^\pm}$ and $M_{\tilde{\chi}_1^0}$ is assumed.

Although $E_{\ell}^\text{max}$ and $E_{j}^\text{max}$ and event rate are the most fundamental indicators of mass differences and the overall mass scale, an effective gluino mass variable, $M_{\text{est}}$, is also very useful. For the subset of events having four jets with $E_T > 100, 60, 60, 50$ GeV and $C < 0.3$, we have computed the combined mass of all leptons and jets in the two circularity hemispheres; $M_{\text{est}}$ is defined to be the larger of these two masses. $M_{\text{est}}$ is very sensitive to changes in $M_{\tilde{g}}$ for fixed ratios of decay product masses to $M_{\tilde{g}}$.

The value of the variable $M_{\text{est}}$ can be illustrated using $W$-mediated decays of
the $\tilde{\chi}_1^\pm$ in the limit of $|\mu| \gg M_1, M_2$ where $M_{\tilde{\chi}_1^0} \sim M_\tilde{g}/6$ and $M_{\tilde{\chi}_1^\pm} \sim M_\tilde{g}/3$.\textsuperscript{[13]}

In Fig. 1 we give the $M_{\text{est}}$ distribution shapes that would be obtained after one SSC year for $M_\tilde{g} = 300$ and 350 GeV. The distributions contain 4500 and 4000 events, respectively. We see that $M_{\text{est}}$ provides a clear separation between the two gluino mass cases considered. We estimate that a gluino mass determination accurate to within 25 GeV should be possible in the mass range considered here. In contrast, the $E_T^{\ell\text{max}}$ and $E_T^{j\text{max}}$ histograms (not shown) provide a much weaker gluino mass determination, barely allowing one to distinguish $M_\tilde{g} = 350$ GeV from $M_\tilde{g} = 300$ GeV. However, using the $M_{\text{est}}$ distribution, we estimate that the gluino mass can be determined to better than 10% if the gluino decay product masses are known. This determination can be cross-checked with theoretical expectations for the total event rate.

4. Conclusions

The like-sign signature for $g\tilde{g}$ production provides a powerful tool, both for discovering evidence for supersymmetry and for estimating the gluino mass. It is the Majorana nature of the gluino that yields this striking signature. At the Tevatron collider, under the most favorable assumptions concerning gluino cascade decay branching fractions, gluino production could yield as many as 1100 dilepton events (after significant lepton cuts) in the current $25 \text{ pb}^{-1}$ run, of which half would be like-sign. Since large numbers of events are not seen, many new constraints on the masses of the $\tilde{g}$, $\tilde{\chi}_1^\pm$, $\tilde{\chi}_1^0$, $\tilde{\ell}$ and $\tilde{\nu}$ will be obtained. If the handful of dilepton events currently observed at the Tevatron were due to $g\tilde{g}$ production, an integrated luminosity of at least $L = 100 \text{ pb}^{-1}$ would be required to obtain a $\pm15\%$ estimate of
the gluino mass. At the SSC, very large like-sign dilepton event rates are predicted, and a gluino mass determination would be possible for masses up to 2 TeV or more. For $M_{\tilde{g}} < 1$ TeV, the gluino mass determination would be accurate to about 15% (or even better if the gluino decay product masses are known). For a very heavy gluino, like-sign dilepton events provide the cleanest discovery signature.

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