Probing charginos and neutralinos beyond the reach of the CERN e^+e^- collider LEP at the Fermilab Tevatron collider

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We investigate off-resonance chargino-neutralino production via the reaction $p\bar{p} \to W^* \to \tilde{W}_1\tilde{Z}_2X$ within the framework of the minimal supersymmetric standard model (MSSM) at the Fermilab Tevatron collider. This reaction can lead to observable rates for hadronically quiet trilepton events for which standard model backgrounds are small. Evaluation of these rates allows us to conclude that, after the accumulation of 100 pb^{-1} of integrated luminosity, the Collider Detector at Fermilab and D0 experiments can explore significant regions of MSSM parameter space beyond the reach of the CERN e^+e^- collider LEP, and in some cases beyond the reach of LEP 200. The dilepton signal from chargino pair production is also briefly discussed.

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The accumulation of 4.3 pb^{-1} of data by the Collider Detector at Fermilab (CDF) experiment at the Fermilab Tevatron $p\bar{p}$ collider has resulted in stringent lower limits on the masses of various particles that are expected to exist in different extensions of the standard model (SM) [1]. Of interest to us here are the limits on supersymmetric (SUSY) particles: the bounds, $m_{\tilde{q}} > 126$ GeV, $m_{\tilde{g}} > 141$ GeV, on the masses of the squarks and gluinos have recently been announced [2] assuming that these sparticles can only decay directly to a massless lightest supersymmetric particle (LSP). The same analysis shows that allowing for cascade decays [3] can reduce [4] the gluino bound by as much as 40 GeV, whereas the squark bound disappears for $m_{\tilde{g}} > 410$ GeV, primarily because the LSP is too heavy.

The new run of an upgraded Tevatron has already begun. With the D0 experiment also in place, it is expected that the two experiments will accumulate an integrated luminosity of $\sim$100 pb^{-1} over the next 2 years. Aside from increasing the range of squark and gluino masses that may be searched for at the Tevatron to over 200 GeV [5], the large data sample should make it possible to search for new processes with much smaller cross sections. These include the search for clean final states from the rare decays of squarks and gluinos (e.g., same sign dilepton events [5–7] or high $p_TZ^0 + \not{E}_T$ events [8]), or the search for electroweak processes that lead to hadronically quiet multilepton final states [e.g., chargino ($\tilde{W}_i$; $i = 1,2$) and neutralino ($\tilde{Z}_j$; $j = 1-4$) or slepton pair production]. The possibility of detecting charginos and neutralinos from the decays of *on-shell* W and Z bosons at hadron colliders has been extensively studied in the literature [9]. The nonobservation of any signal in the experiments at the CERN e^+e^- collider LEP [10], however, excludes most of these possibilities, so that production of $\tilde{W}_i$ and $\tilde{Z}_j$ at the Tevatron is expected to be considerably suppressed relative to rates from resonance production.

Nath and Arnowitt, however, have noted [11] that decays of *off-shell* W and Z bosons can also lead to substantial rates for chargino and neutralino production; in particular, they concluded that, within the framework of the minimal supersymmetric standard model (MSSM) [12], the reaction $p\bar{p} \to W^* \to \tilde{W}_1\tilde{Z}_2$ followed by the decays $\tilde{W}_1 \to l\nu\tilde{Z}_1$ and $\tilde{Z}_2 \to l\bar{l}\tilde{Z}_1$ can lead to an observable rate for trilepton events. Within the MSSM framework, the masses and couplings of the $\tilde{W}_i$ and $\tilde{Z}_j$ are fixed in terms of just a few parameters, which we may take to be (i) the supersymmetric Higgsino mass $\mu = -2m_1$, (ii) the soft SUSY-breaking gluino mass, $m_{\tilde{g}}$, which we assume also fixes the SU(2) and U(1) gaugino masses, (iii) $\tan\beta$, the ratio of the vacuum expectation of the two Higgs fields of the model, and (iv) the squark mass ($m_{\tilde{q}}$) which, together with the gluino mass, fixes the slepton masses via a unification condition, and (v) the pseudoscalar Higgs-boson mass (m_{H_p}) which fixes the Higgs sector (this is irrelevant unless the decay $\tilde{Z}_2 \to \tilde{Z}_1 + H_l$ is kinematically allowed). In the analysis of Ref. [11], it was assumed that $\tan\beta = 1$. In this case, the $Z\tilde{Z}_1\tilde{Z}_2$ coupling vanishes unless one of the two neutralinos is the Higgsino eigenstate. Thus, for significant ranges of parameters, Z-exchange contributions to the amplitude for $\tilde{Z}_2$ decay (which may be dominant if the sfermions are very heavy) are ignored. This can significantly affect the branching fraction for the decays, $\tilde{Z}_2 \to l\bar{l}\tilde{Z}_1$ for values of $\tan\beta$ different from unity. In Ref. [11], it was further assumed that the LSP is a light photino. Here, we expand upon the suggestion of Nath and Arnowitt, and reanalyze these signals taking into account sparticle masses and couplings as given by the MSSM with a view to study whether the CDF and D0 experiments can, during the current Tevatron run, explore regions of SUSY parameter space that are substantially beyond the reach of LEP.

The cross sections for chargino and neutralino pair production at the Tevatron have been calculated using the Eichten-Hinchliffe-Lane-Quigg (EHLQ) set 1 parton distributions [13], and are shown as a function of the Higgsino mixing parameter μ in Fig. 1. Here, we have fixed $m_{\tilde{g}} = 300$ GeV, $m_{\tilde{q}} = 600$ GeV, and illustrated our results for (a) $\tan\beta = 2$, and (b) $\tan\beta = 20$. While we have included all tree-level contributions in our computation of $\tilde{W}_1\bar{\tilde{W}}_1$ and $\tilde{Z}_i\tilde{Z}_j$ production, we have retained only the s-channel W exchange contributions in the calculation of the cross section for $\tilde{W}_1\tilde{Z}_i$ production [14]. The range of μ values between the vertical lines is excluded by constraints [10, 15] from experiments at LEP, which may be parametrized as [16] (i) any non-SM contribution to the Z width should satisfy $\Delta\Gamma_Z < 35$ MeV, (ii) non-SM invisible decays of the Z boson satisfy $\Delta\Gamma_Z$ (invisible) < 11 MeV, (iii) $m_{\tilde{W}_1} > 45$ GeV, and (iv) the branching fraction for visible neutralino decays of Z satisfy $B(Z \to \tilde{Z}_i\tilde{Z}_j) < 5 \times 10^{-5}$ (where i and j are both not 1).

We see from Fig. 1 that the cross sections for chargino and neutralino production are largest for values of μ near zero, which is excluded by LEP. In this case, $\tilde{W}_1$ and $\tilde{Z}_i$ can be produced via decays of real W and Z bosons. For larger values of $|\mu|$, $\tilde{W}_1$ and $\tilde{Z}_i$ become so massive that resonant production is kinematically forbidden. Nevertheless, the cross sections for $\tilde{W}_1\tilde{Z}_2$, $\tilde{W}_1\bar{\tilde{W}}_1$, and $\tilde{W}_1\tilde{Z}_1$ production, while suppressed by a factor of $\sim$100 from their resonant values, can still be $\sim$1 pb for a wide range of parameters that cannot be probed at LEP. It is thus possible that several hundred sparticle pairs may be expected in the course of the present Tevatron run.

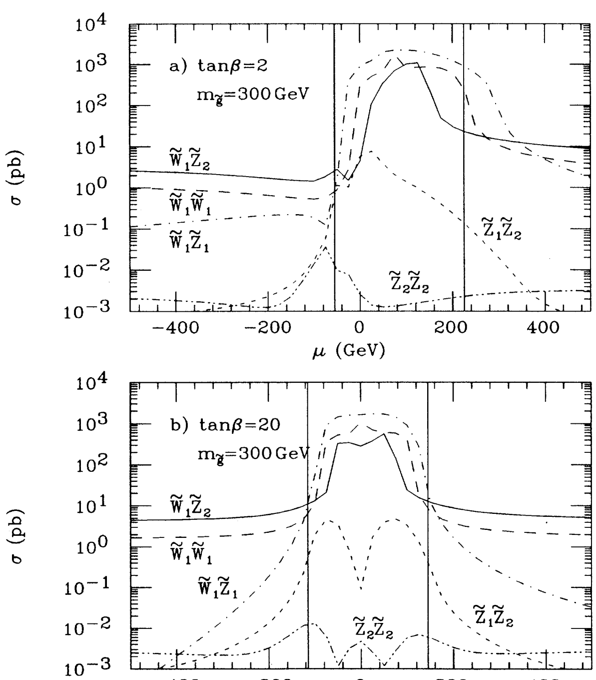

FIG. 1. Total cross sections for various chargino/neutralino pair production processes in $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV vs the parameter μ, for $m_{\tilde{g}} = 300$ GeV and $m_{\tilde{q}} = 600$ GeV. We show plots for (a) $\tan\beta = 2$ and (b) $\tan\beta = 20$. The region between the vertical lines is excluded by the constraints from LEP data, as discussed in the text.

We now turn to the prospects for detecting various signals from the decays of charginos and neutralinos produced at the Tevatron. Possible event topologies may be broadly classified as multijet $+\not{E}_T$ events, n jets $+m$ leptons $+\not{E}_T$ events, and hadronically quiet multilepton $+\not{E}_T$ events. There are significant SM backgrounds from heavy flavor (including top) production, $W+$ multijet production, and mismeasured multijet events to the first two classes of signals. Although it has been shown that these backgrounds can be overcome by a judicious choice of cuts if the cross sections are resonance enhanced, these backgrounds appear hopelessly large for the present case. Also, single lepton $+\not{E}_T$ events from $\tilde{W}_1\tilde{Z}_1$ production are likely to be obscured by $W \to l\nu$ and $W \to \tau\nu$ backgrounds. This leaves the hadronically clean isolated dilepton and trilepton events as the most promising way to detect chargino and neutralino production in the present Tevatron run [9].

W-pair production, which has a cross section of about 10 pb at the Tevatron, is the main background to the dilepton signal from the leptonic decay, $\tilde{W}_1 \to l\nu\tilde{Z}_1$, of chargino pairs. Unless sfermions are very light, the amplitude for this decay is dominated by (virtual) W. The leptonic branching fraction for chargino decays is then essentially the same as that for W decays. A glance at Fig. 1 then shows that the WW background exceeds the signal by a factor of $2 - 10$. The leptons from W decay are, however, likely to be considerably harder than those from the three-body decay of $\tilde{W}_1$ (also because $\tilde{Z}_1$ is massive). In view of the small signal dilepton event sample (about 15 dileptons of the e or μ type for a chargino pair production cross section around 3 pb) that can be expected in the Tevatron data, the detection of this signal appears to be a formidable task.

We are thus led to focus on the feasability of detecting the trilepton events from $\tilde{W}_1\tilde{Z}_2$ production, where both $\tilde{W}_1$ and $\tilde{Z}_2$ decay leptonically. Except for initial state QCD radiation and beam jet activity, these events are free from hadronic activity. WZ production, which has a cross section of $\sim$ 1 pb, is a possible SM source of trileptons at the Tevatron. These events should be readily distinguishable from trileptons from $\tilde{W}_1\tilde{Z}_2$ production since then one lepton pair must reconstruct the mass of Z. Trilepton events can also result from $c\bar{c}$, $b\bar{b}$, and $t\bar{t}$ production followed by cascade decays of the heavy flavors. In this case, however, the leptons will usually be accompanied by substantial hadronic activity; suitable leptonic isolation and p_T cuts ought to severely suppress this background. Hence, the hadronically quiet isolated trilepton events from $\tilde{W}_1\tilde{Z}_2$ production should be relatively background-free.

To test the above assertion, we have generated 25 000 $t\bar{t}$ events with $m_t = 150$ GeV, using the program PYTHIA [17]. The total cross section was $\sim$ 10 pb. Leptons with $p_T(l) > 5$ GeV and $|\eta(l)| < 2.5$ were taken to be isolated if there was less than 3 GeV additional activity in a cone of $\Delta R = \sqrt{\eta^2 + \phi^2} = 0.4$ about the lepton direction. In addition, we required at least one of the isolated leptons to have $p_T(l) > 20$ GeV as a trigger condition. Although we were able to find 1059 isolated dilepton events (summed over e and μ), we found only two isolated trilepton events, indicating the background from this source is $\sim 8 \times 10^{-4}$ pb, which is well below the signals considered here. The total cross section for $b\bar{b}$ production ($m_b = 5$ GeV) is about 3×10^7 pb, so a similar analysis would require a tremendous number of PYTHIA events to be generated. However, it is extremely unlikely for $b\bar{b}$ production to yield three hard, isolated leptons, especially if one requires in addition a substantial lepton-lepton angular separation. A study of this background would require, in addition, an accurate simulation of the particular detector to be used. While such detailed studies are beyond the scope of this paper, we do not believe that the production and cascade decays of bottom or charm quark pairs can yield event configurations that would mimic the trilepton signal.

Aside from the obvious dependence on the $\tilde{W}_1\tilde{Z}_2$ production cross section, the trilepton signal is determined by the branching fractions for the leptonic decays of $\tilde{W}_1$ and $\tilde{Z}_2$. As mentioned above, unless sfermions are very light, the amplitude for chargino decays is dominated by the virtual W so that the branching fraction for the decay $\tilde{W}_1 \to l\nu\tilde{Z}_1$ is insensitive to model parameters. This is, however, not the case for the $\tilde{Z}_2$ decays since the $Z\tilde{Z}_1\tilde{Z}_2$ coupling can be strongly suppressed. In this case, sfermion mediated decay amplitudes can be important even if the sfermions are rather heavy [14]. This occurs when $|\mu|$ is much larger than the soft SUSY-breaking SU(2) and U(1) gaugino masses. If the Z-mediated amplitudes are indeed small, the decays of $\tilde{Z}_2$ will be very sensitive to the spectrum of sfermion masses. Motivated by supergravity models where supersymmetry breaking leads to a common mass for sfermions at the unification scale, squarks and sleptons have been assumed to be degenerate in previous analyses [9, 11] of these signals. As is well known [12], the degeneracy of sfermions present at the unification scale is broken when these masses are evolved down to the weak scale. The slepton masses can then be written as [18]

$$m^2_{\tilde{l}_L} = m^2_{\tilde{q}} - 0.73m^2_{\tilde{g}} - 0.27M^2_Z \cos 2\beta, \qquad (1a)$$

$$m^2_{\tilde{l}_R} = m^2_{\tilde{q}} - 0.78m^2_{\tilde{g}} - 0.23M^2_Z \cos 2\beta, \qquad (1b)$$

$$m^2_{\tilde{\nu}_L} = m^2_{\tilde{q}} - 0.73m^2_{\tilde{g}} + 0.5M^2_Z \cos 2\beta, \qquad (1c)$$

where $m^2_{\tilde{q}}$ is the squark mass squared averaged over all the flavors. For our purposes, the most significant impact of Eq. (1) is that sleptons can be considerably lighter than squarks if gluinos and squarks are rather close in mass. Some recent calculations [19] of sparticle spectra seem to suggest that this may well be the case. Then, for parameter ranges where the Z amplitude for $\tilde{Z}_2$ decay is suppressed relative to the sfermion exchange amplitudes, the slepton mediated leptonic decays would be strongly enhanced relative to hadonic decays of $\tilde{Z}_2$.

We therefore calculate the branching ratios for $\tilde{Z}_2$ decays allowing for different masses for the sfermions. In our computation we have ignored any splitting between the masses of different squark flavors and assumed that the charged slepton and sneutrino masses are given by Eq. (1). The results of our calculation of the branching fraction for the decay $\tilde{Z}_2 \to e^+e^-\tilde{Z}_1$ (the branching fraction is the same for all lepton families) is shown in Fig. 2 and Fig. 3 for $m_{\tilde{q}} = m_{\tilde{g}}$ and $m_{\tilde{q}} = 2m_{\tilde{g}}$, respectively, for (a) $\tan\beta = 2$, and (b) $\tan\beta = 20$ as a contour plot in the μ-$m_{\tilde{g}}$ plane. We have fixed the pseudoscalar Higgs-boson mass to be 0.5 TeV and taken $m_t = 150$ GeV. Also shown in these figures is the region excluded by the constraints (i)–(iv) supplemented by the constraint that the sleptons are also all heavier than 45 GeV. It is this last constraint that is responsible for the difference in the "LEP excluded region" in Figs. 2(a) and 3(a). The following comments are worth noting.

(a) We see that the charged leptonic branching fraction for $\tilde{Z}_2$ decay can be larger than 20% per family if $m_{\tilde{g}} =$

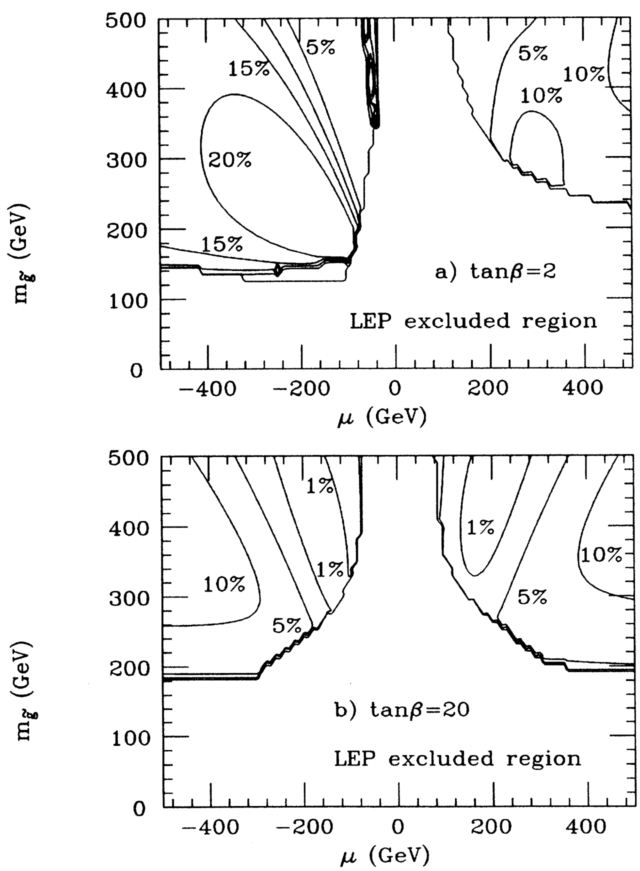

FIG. 2. Contour plot of the branching fraction for $\tilde{Z}_2 \to e^+e^-\tilde{Z}_1$ in the μ vs $m_{\tilde{g}}$ plane, for (a) $\tan\beta = 2$ and (b) $\tan\beta = 20$. We have taken $m_{\tilde{q}} = m_{\tilde{g}}$, and fixed the various slepton masses as in Eq. (1). We have also fixed $m_t = 150$ GeV and $m_{H_p} = 500$ GeV. The branching fraction contours are only exhibited in the region of parameter space allowed by constraints from LEP data. The crowding of the curves near the LEP excluded region is an artifact of our plotting routine.

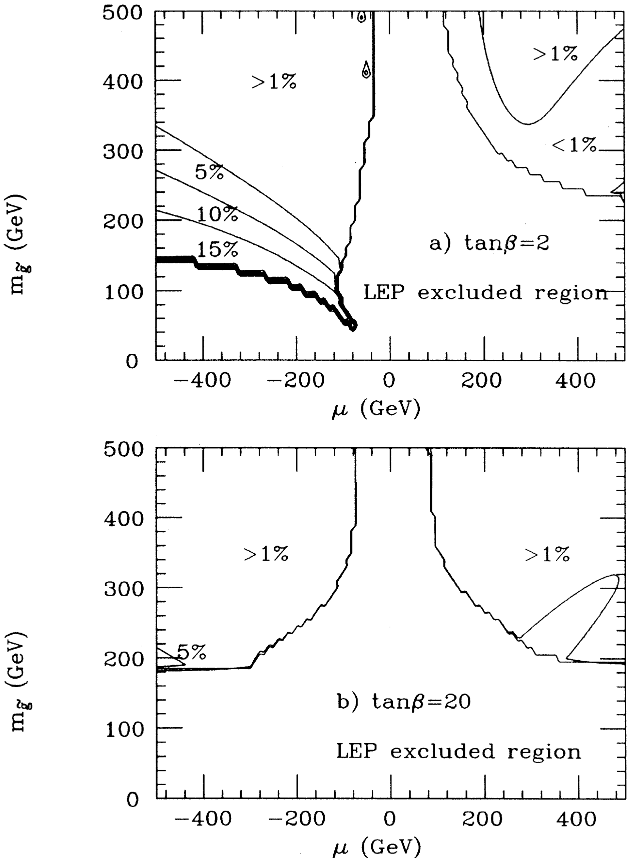

FIG. 3. The same as Fig. 2, except we have taken $m_{\tilde q} = 2m_{\tilde g}$.

$m_{\tilde q}$. In fact, this branching fraction exceeds 15% (30% for the useful decays $\tilde Z_2 \to e^+e^-\tilde Z_1$ and $\mu^+\mu^-\tilde Z_1$) over a large range of parameters not excluded by LEP. For positive values of μ, the branching fractions in Fig. 2(a) are about half those for $\mu < 0$. The production cross sections in Fig. 1 are correspondingly larger for positive values of μ, so that the trilepton rate should be rougly comparable.

(b) For the $m_{\tilde q} = 2m_{\tilde g}$ case in Fig. 3(a) we see that the leptonic branching fraction is large only for smaller values of $m_{\tilde g}$, where the electroweak gaugino masses are considerably smaller than $|\mu|$; as discussed previously, this is precisely when the $Z\tilde Z_1\tilde Z_2$ coupling is suppressed, and sfermions are light enough to make significant contributions. The leptonic branching fraction drops off for large values of $m_{\tilde g}$ and fixed μ, and can even fall below the leptonic branching fraction for Z decay because of complicated interference between various amplitudes. This situation should be contrasted with that in Fig. 2(a) where the leptonic branching fraction remains very large even for large values of $m_{\tilde g}$, as long as $|\mu|$ is not very small.

(c) Comparing the $\tan\beta = 2$ and 20 cases, in Fig. 2 and Fig. 3, we see that the decays to charged leptons are significantly reduced if $\tan\beta$ is very large. We have checked that even for the $m_{\tilde q} = m_{\tilde g}$ case shown in Fig. 2, this is typically due to an increase in the hadronic branching fraction of $\tilde Z_2$ (despite the fact squarks are considerably heavier than sleptons) and not due to an increase in the branching fraction for the $\tilde Z_2 \to \nu\bar\nu\tilde Z_1$ decays. We have traced this increase in the hadronic branching fraction to a complicated interference between the Z and sfermion exchange amplitudes contributing to $\tilde Z_2$ decay. Finally, we have checked that if the sfermions are all very heavy ($m \simeq 1$ TeV), the leptonic branching fraction is at most $3-4\%$.

(d) We note that the branching fractions shown in Fig. 2 and Fig. 3 can be dramatically different if one of the sleptons (usually $\tilde l_R$ or $\tilde\nu$) becomes lighter than $\tilde Z_2$ in which case the $\tilde Z_2$ would dominantly decay into $l\tilde l_R$ or $\nu\tilde\nu$. This can occur if the gluino is somewhat heavier

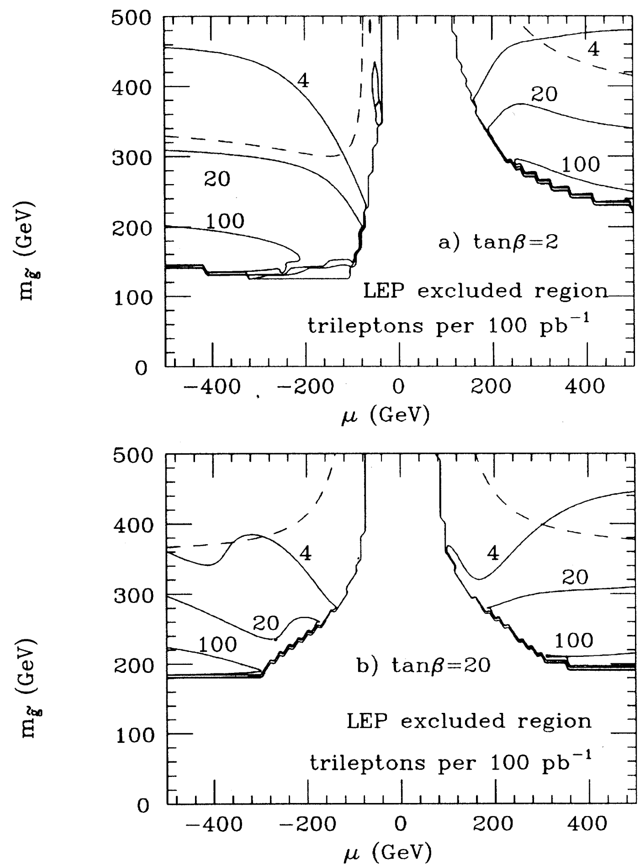

FIG. 4. Contour plot of the number of trilepton events expected per 100 pb^{-1} of integrated luminosity at the Tevatron collider, in the μ vs $m_{\tilde g}$ plane, for (a) $\tan\beta = 2$ and (b) $\tan\beta = 20$. We have taken $m_{\tilde q} = m_{\tilde g}$, and fixed the various slepton masses as in Eq. (1). We have also fixed $m_t = 150$ GeV and $m_{H_p} = 500$ GeV. We have summed over eee, $ee\mu$, $e\mu\mu$, and $\mu\mu\mu$ event topologies. Event number contours are only exhibited in the region of parameter space allowed by constraints from LEP data. The dashed curve denotes where $m_{\tilde W_1} = 90$ GeV, the approximate reach of LEP 200. The rates shown must be multiplied by the detection efficiency appropriate to the particular experiment.

than the squark. The resulting trilepton signal may then be greatly reduced because the $\tilde{Z}_2$ either decays invisibly, or the daughter lepton is too soft to be identified.

The expectation for the total rate for the production of hadronically quiet trilepton (summed over all configurations containing e or μ) events from the leptonic decays of $\tilde{W}_1\tilde{Z}_2$ pairs produced at the Tevatron is shown in Fig. 4 and Fig. 5 for $m_{\tilde{q}} = m_{\tilde{g}}$ and $m_{\tilde{q}} = 2m_{\tilde{g}}$, respectively, for (a) $\tan\beta = 2$, and (b) $\tan\beta = 20$. In this calculation, we have assumed that the chargino decays are dominated by W exchange. This is indeed true except near the boundary of the "LEP excluded region" in Fig. 4, where the sleptons are rather light. There, the leptonic decays of $\tilde{W}_1$ can be considerably enhanced, so that the trilepton rate shown may be an underestimate. It should, however, be kept in mind that when $m_{\tilde{W}_1} \simeq m_{\tilde{l}}$, decay matrix element effects can cause one of the daughter leptons to be very soft, and more apt to escape detection. We have shown our results as contours of the number of trileptons expected per 100 pb^{-1} of integrated luminosity. Of course, these event rates must be multiplied by an experimental efficiency factor to obtain the true number of events expected at a particular detector.

For the $m_{\tilde{q}} = m_{\tilde{g}}$ case illustrated in Fig. 4, there is a large region that cannot be probed at LEP for which the trilepton signal ought to be observable at the Tevatron. Over most of this region the mass difference between the decaying parent and the LSP is between 20 and 50 GeV (this grows with increasing $m_{\tilde{g}}$), so that it is clear that the size of the signal will depend on the ability of the detector to identify isolated leptons down to rather low values of p_T. Since the fastest lepton is likely to be hard enough to serve as a trigger [9, 11], we believe the cleanliness of the multilepton signal should make it possible to detect the accompanying electrons with p_T as small as 5 GeV, and muons to possibly even lower values. We note also that the masses of the parents increase as we move away from the LEP region so that the experimental acceptance is expected to increase with increasing values of $m_{\tilde{g}}$ and $|\mu|$.

The dashed contours indicate where $m_{\tilde{W}_1} = 90$ GeV, which is the approximate reach of LEP 200. Since the

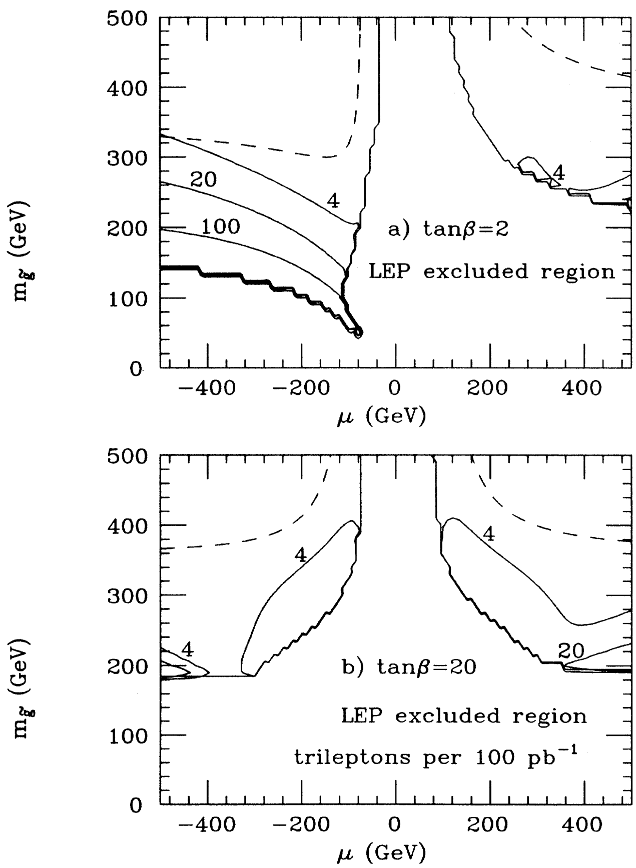

FIG. 5. The same as Fig. 4, except we have taken $m_{\tilde{q}} = 2m_{\tilde{g}}$.

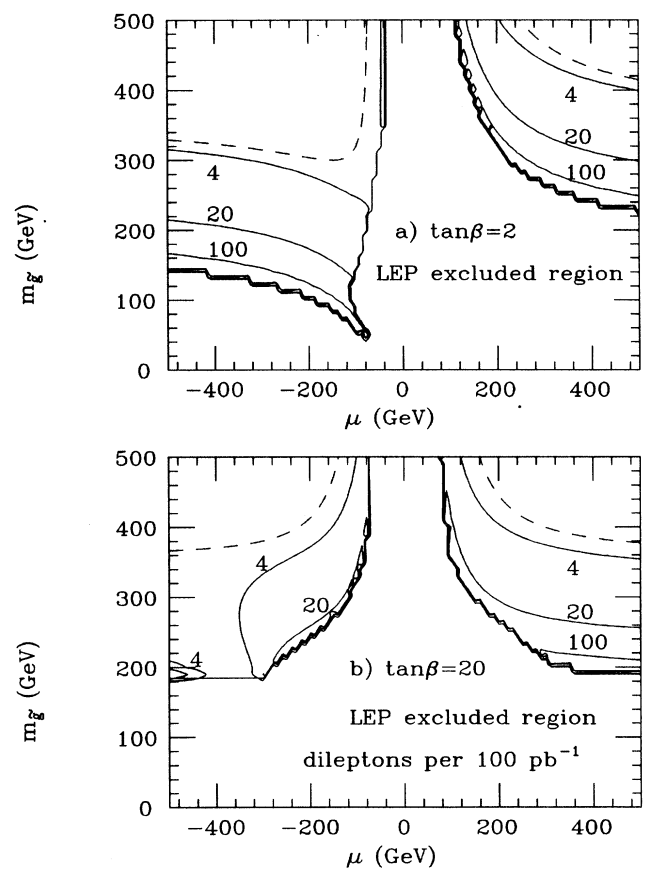

FIG. 6. Contour plot of the number of dilepton events expected per 100 pb^{-1} of integrated luminosity from the production of chargino pairs at the Tevatron collider, in the μ vs $m_{\tilde{g}}$ plane, for (a) $\tan\beta = 2$ and (b) $\tan\beta = 20$. We have taken $m_{\tilde{q}} = 2m_{\tilde{g}}$ and fixed other parameters as in Fig. 4. We have summed over ee, $e\mu$, and $\mu\mu$ event topologies. The dashed curve denotes where $m_{\tilde{W}_1} = 90$ GeV, the approximate reach of LEP 200. The rates shown must be multiplied by the detection efficiency appropriate to the particular experiment. Trilepton events, where one of the leptons escapes detection, will make an additional contribution to this signal.

trilepton signal is essentially only rate limited, we see that even allowing for a detection efficiency of $\sim 50\%$ [20], the Tevatron should be able to probe a substantial region of parameter space (if $\tan\beta$ is not very large) that is beyond the reach of LEP, and also beyond the reach of direct searches for gluino and squark pair production at the Tevatron. In fact, if $m_{\tilde{q}} \simeq m_{\tilde{g}}$, the parameter space reach using the SUSY trilepton signal may be comparable to and in some regions can even exceed the reach of LEP 200. Of course, there are other ranges of MSSM parameters where the trilepton signal may be unobservable at the Tevatron (e.g., when $m_{\tilde{q}} \simeq m_{\tilde{l}} \gg m_{\tilde{g}}$). It is, however, amusing to note that sample recent calculations [19] of sparticle masses in light of the LEP data find that gluinos and squarks are approximately degenerate, while the stability of the proton suggests that $\tan\beta$ is not very large [21]. A comparison of Figs. 4 and 5 with the sparticle spectra of Ref. [19] suggests that the resulting trilepton signal may be on the edge of observability in some of these scenarios.

Motivated by the fact that the trilepton rates for the $m_{\tilde{q}} = 2m_{\tilde{g}}$ case shown in Fig. 5 are rather small for large regions of parameter space, we were led to examine the corresponding dilepton rates from chargino pair production. Our results are shown in Fig. 6 for (a) $\tan\beta = 2$, and (b) $\tan\beta = 20$. We see that substantial event rates are possible in regions where the trilepton signal is unobservable. Over much of the region where there is in excess of 20 dilepton events per 100 pb^{-1} of integrated luminosity (compared to ~ 44 background events from WW production), we have checked that $m_{\tilde{W}_1} \lesssim 65$ GeV. The fact that charginos decay into three particles, one of which is considerably massive, suggests that a careful study of distributions may help distinguish the signal from background in some of these regions of parameter space. Detailed simulations are needed to draw definitive conclusions.

In order to assess the experimental viability of the trilepton and dilepton signals at the Tevatron as a function of SUSY parameters, we have incorporated $\tilde{W}_1\tilde{Z}_2$ and $\tilde{W}_1\tilde{W}_1$ processes into the event generator program ISASUSY [22]. This program interfaces the predicted MSSM sparticle mass and branching fraction predictions with the ISAJET Monte Carlo program [23]. Sparticle production is simulated including initial and final state parton showers, hadronization, and beam jet evolution. The simulated events can then be run through any detector simulation package to examine trigger requirements and experimental acceptances particular to each experiment. Spin correlation effects have been neglected at this level, but are not expected to be important [9].

To sum up, we have shown that there is a large range of MSSM parameters consistent with the LEP data for which the trilepton signal from the production of $\tilde{W}_1\tilde{Z}_2$ pairs may be observable in the present run of the Fermilab Tevatron. This is due to an enhancement in the branching fraction for leptonic decays of the neutralinos which is expected if sfermions are not too heavy and sleptons are considerably lighter than squarks as is expected if $m_{\tilde{q}} \simeq m_{\tilde{g}}$. The signal, which consists of events containing three hard isolated leptons and essentially free from hadronic activity, is expected to have tiny SM backgrounds after suitable cuts are applied, and so is only rate limited. Although we have not attempted to perform detailed simulations to delineate precisely the region of MSSM parameter space that can be probed at a high luminosity Tevatron, the program ISASUSY that generates the trileptons from SUSY sources can readily be interfaced with detector simulation packages to test the viability of the signal. In view of the fact that this signal may enable one to probe regions of parameters that can otherwise be probed only at LEP 200 or at hadron supercolliders, we urge our colleagues on the CDF and D0 experiments to carry out more detailed studies of the trilepton signal.

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