Top Quark Analysis in the Light Gluino Scenario

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(August 1997)

Abstract

The Fermilab top quark analysis is heavily dependent on the assumption of standard model backgrounds only. In the light gluino scenario, the stop quarks lie near the top in mass and their decays can influence the resulting top quark mass by an amount that is not small relative to the currently quoted errors. Several slight anomalies in the top quark analysis find a natural explanation in the light gluino case.

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In the past few years the Tevatron at Fermilab has provided convincing evidence for physics beyond the topless standard model \[1\]. The events contain isolated leptons, missing energy, and evidence for b quark jets all of which are part of the expected signal for top quark production and decay. Analyzed within the context of the standard model the best fit to a top quark mass and production cross section gives

\[ m_t = 175.6 \text{GeV} \pm 5.7 \text{GeV}(\text{stat}) \pm 5.9 \text{GeV}(\text{sys}) \] (1)

\[ \sigma(t\bar{t}, (m_t = 175 \text{GeV})) = 7.5^{+1.9}_{-1.6} \text{ pb} \] . (2)

Due to the dependence of experimental acceptances and efficiencies on the top quark mass, the experimental production cross section rises with decreasing top mass, becoming \[10.0 \pm 1.4 \text{ pb}\] for a top quark mass of \[160 \text{ GeV}\]. Furthermore, it is clear that these values are strongly dependent on the assumption that the background is correctly given by the standard model which predicts very few events of the type seen in the mass region near 175 GeV. Indeed, in the absence of a specific model beyond the standard, no other assumption is possible. For this reason, if for no other, it is useful to construct a specific testable alternative to the standard model. The observation of b quarks in the events, however, severely constrains non-standard interpretations. The top sample is still a low statistics set and significant fluctuations are to be expected. Nevertheless, several slightly unsettling features of the sample have been noticed \[2,3\] which could be taken as hinting at effects beyond the standard model or, at least, as indicating in which directions there is room for such effects. Among these are the facts that

1) The joint probability that all the "top events" are due to a single quark of any given mass seems small in any of the standard monte-carlos. Put in another way, the spread in apparent top quark mass on an event by event basis is much greater than in the standard model monte-carlos with a 175GeV top quark \[2\].
2) There seems to be a systematic tendency for the events in which both tops decay leptonically to suggest a smaller mass than those in which a single top decays leptonically which again suggest a smaller top mass than the non-leptonic decay events. One finds from the di-lepton events $m_t = (162 \pm 21 \pm 7) GeV$, from the single lepton events $m_t = (176 \pm 4.4 \pm 4.8) GeV$, and from the hadronic events $m_t = (187 \pm 8 \pm 12) GeV$.

3) The CDF and D0 results for the top production cross section seem to be somewhat higher than the best theoretical estimates \[5\] for a 175 GeV top quark:

$$
\sigma_{th}(m) = \left( \exp \left( \frac{175 - m}{31.5} \right) \right) \left( 4.75^{+73}_{-62} pb \right)
$$

(3)

to be compared with the experimental result (primarily from the single lepton events) given in eq. \[4\].

4) In some of the events, the invariant mass of two jets identified as a non-leptonic W decay do not well reproduce the W mass. \[6\].

5) The $t\bar{t}$ system seems to be produced with somewhat greater transverse energy and to be accompanied by more extra jet activity than expected in the standard model \[3\].

While emphasizing again that all of these "effects" could easily disappear with better statistics, it is interesting to consider the effect on the top analysis of specific models for supersymmetry (SUSY) in the top region. Standard SUSY scenarios, such as that of squarks and gluinos in the 330 GeV region can, at best, \[7\] account for one or two of the anomalous top events. Recently, however, phenomenological hints have been noted suggesting squarks in the region below 200 GeV. \[8,9\]. The effect of these scenarios on the top analysis needs to be considered in detail.

In this article, we present the predictions of the light gluino (LG) scenario in which both
the universal gaugino mass $m_{1/2}$ and the trilinear coupling parameter $A$ are set to zero. This is a configuration of special symmetry in the supergravity (SUGRA) related SUSY breaking model and results in gluino and photino masses below 1 GeV. The remaining parameters will be constrained by phenomenological and theoretical requirements below. Problems for the LG scenario are posed by the $\tau$ decay data and by the ALEPH four-jet angular distribution data. These analyses are, however, each vulnerable to criticism and many other phenomenological observations have been noted as supporting the LG idea.

With $m_{1/2}$ and $A$ set to zero, the SUGRA-related SUSY standard model has four main parameters: a universal scalar mass $m_0$, the Higgs mixing parameter $\mu$, the ratio $\tan \beta$ of the Higgs vacuum expectation values, and the top quark mass $m_t$. Two of these parameters are tightly constrained in the LG scenario by the phenomenological requirement that the chargino and neutralino masses be above half the Z mass.

$$M_{\tilde{\chi}^\pm}^2 = M_W^2 + \mu^2/2 + \sqrt{\left(\frac{\mu^2}{2} + M_W^2\right)^2 - M_W^4 \sin^2(2\beta)} > M_Z^2/4$$

$$M_n = \frac{2\sqrt{3}}{\sqrt{M_Z^2 + m\mu^2}} |\cos((\phi + 2\pi n)/3)|$$

$$\cos(\phi) = -\frac{b}{2}(3/a)^{3/2}$$

with

$$b = \mu \sin(2\beta)/M_Z$$

$$a = 1 + \frac{\mu^2}{M_Z^2}.$$
LG scenario to begin in the 50 GeV region \[14\] very close to the values postulated on phenomenological grounds in Ref. \[8\]. In this latter approach, non-universal (and ad hoc) gaugino masses, $m_1$, $m_2$, and $m_3$, are introduced while keeping the gluino heavy.

A second strong constraint in the LG scenario comes from the attractive assumption of radiative breaking of the electroweak symmetry. In this picture, which in fact is difficult to avoid, one of the Higgs squared masses runs to negative values thus triggering the electroweak breakdown near the SUSY scale. The required value of $\mu$, which we label here as $\mu_{\text{rad}}$ is in lowest order related to the other parameters of the theory by

$$\mu_{\text{rad}}^2 = -m_Z^2/2 - m_0^2 - m_0^2 \left( \frac{m_t}{205 \text{ GeV}} \right)^2 \cos 2\beta / 2$$

where

$$f = 3 + \left( \frac{A}{m_0} + \frac{\mu_{\text{rad}}}{m_0 \tan \beta} \right)^2 (1 - \left( \frac{m_t}{205 \text{ GeV}} \right)^2 \sin^2 \beta)$$. \hspace{1cm}(9)

Since the third term of eq. \[9\] must overcome the first two negative terms to equal the positive definite left hand side, if $\mu^2$ is small as required by eq. \[4\] the radiative breaking can be satisfied only for highly constrained values of $m_t$. This relation requires unacceptable fine-tuning if $m_0$ is large. We seek solutions for $95 \text{ GeV} < m_0 < 150 \text{ GeV}$ and $130 \text{ GeV} < m_t < 180 \text{ GeV}$. The observed dijet angular distributions at Fermilab rule out squarks in the LG scenario with masses between 150 and 650 GeV \[15\]. Values of $m_0$ below 95 are most likely inconsistent (in the LG case) with measurements at LEP-2.

Since this is a perturbative result, we require only that $\mu_{\text{rad}}$ be equal to the $\mu$ of eq. \[4\] to within 10%. The stringent results of \[16\] are then relaxed. Still we find that the constraints can only be satisfied for $m_t < 169 \text{ GeV}$ and $m_0 < 142 \text{ GeV}$ and, if $m_t > 150 \text{ GeV}$, then $m_0 < 120 \text{ GeV}$. The low top masses found by generating events in the space of parameters via a Monte-Carlo scheme coincide with the apparent top mass seen experimentally in the di-lepton decays. We would therefore like to investigate whether the higher top masses seen in the single lepton and hadronic channels are due to contamination from top squark decays. The low output values of $m_0$ and the resulting low squark masses coincide with those
suggested by the low jet \( E_T \) and scaling anomalies seen at Fermilab \cite{9}. Such low squark masses are excluded in the heavy gluino case by direct searches for the expected decays into isolated energetic leptons and missing transverse energy \cite{17}. In the LG scenario, however, the squarks will decay primarily into a quark-gluino dijet thus evading the direct searches in the lepton plus missing energy channel.

In the SUGRA model the up type squark mass matrices are given by

\[
M_{\tilde{q}_L}^2 = M_0^2 + M_q^2 + M_Z^2 \cos(2\beta)\left(\frac{1}{2} - \frac{2}{3}\sin^2(\theta_W)\right)
\]

\[
M_{\tilde{q}_R}^2 = M_0^2 + M_q^2 + 2 \frac{2}{3} M_Z^2 \cos(2\beta)\sin^2(\theta_W)
\]

(11)\hspace{1cm} (12)

For each flavor there is also an off-diagonal term

\[
M_{LR}^2 = M_q(A + \frac{\mu}{\tan(\beta)})
\]

(13)

In \cite{14} non-zero values of \( A \) were considered with the result that the lightest stop quark could be made significantly lighter than the top quark due to the off-diagonal term in the mass matrix. This would then allow a large stop quark related enhancement in the \( Z \) decay into \( b \) quarks. In the heavy gluino case of the constrained SUSY model the large off-diagonal term would not by itself give light stop quarks due to a large diagonal contribution proportional to \( m_{1/2}^2 \). Now that the \( R_b \) anomaly has largely disappeared we can consider the case of zero \( A \) which is much more natural in the LG scenario. The off-diagonal term is then given by the \( \mu \) parameter with the result that the stop quarks can be predicted to be both near or above the top.

As a final constraint on the parameter space we consider the electroweak \( \rho \) parameter which measures the relative strength of neutral to charged currents. \( \rho \) differs from unity in the presence of non-degenerate weak doublets. The large \( t-b \) splitting makes the \( \rho \) parameter sensitive to the top quark mass. The current experimental value of \( \rho \) is essentially saturated by a 175GeV top quark leaving little room for SUSY contributions \cite{18},

\[
\delta \rho = 0.0095 \cdot \left( \frac{m_t}{175\text{GeV}} \right)^2 + \delta \rho_{SUSY} = 0.0095 \pm 0.0014
\]

(14)
This suggests that the squarks and sleptons are very degenerate as suggested by the SUGRA inspired mass matrices as given in eqs. [11], [12], [13]. If one abandons the SUGRA universality conditions, a ρ parameter near the standard model value could become unexplained unless the SUSY particles are much higher in mass. In fact, imposing the ρ parameter constraint already further constrains the parameters of the SUSY model for values of m_0 in the range we are considering. As can be seen from eq. [14] any non-degeneracy of the squarks and sleptons tends to reduce the top mass if the ρ parameter constraint is to be preserved. Using the one-loop SUSY contributions from [19] and imposing the experimental constraint of eq. [14] the solution space is further restricted to

\[
m_t < 162GeV
\]

\[
m_0 < 133GeV
\]

A top mass or scalar mass outside of this range would require abandoning the light gluino scenario or relaxing at least one of the other assumptions discussed above such as the radiative breaking constraint or the universality of scalar and gaugino masses. We note that those studying the heavy gluino case have already been lead to abandon the SUSY breaking mass universality relations while, in the light gluino case, it is still possible and interesting to maintain them. In addition we suspect that, in the heavy gluino scenario of [8] with stop and sneutrino in the 50GeV region and other squarks in the 200 – 300GeV region, the ρ parameter constraint will also force the top quark to low values such as those above. On the other hand, in this heavy gluino case, it is not clear whether such a lower top quark mass can be made consistent with the Fermilab data.

With the parameter space now tightly constrained we would like to discuss the phenomenology of the top quark region. The question now becomes what are the stop quark masses and what are their decay chains? In the current model the stop quarks are each almost equal mixtures of left and right handed stops with the lighter stop quark being 0.3 to 33 GeV above the top and the heavier stop being in the range 183GeV < m̃_t < 209GeV. These predicted stop quark masses are too high to cause a large b excess in Z decay. Nev-
Nevertheless, in the current model, there will be a (largely) flavor-independent enhancement of the hadronic decay rate of the $Z$ due to virtual squark-gluino corrections which will make the apparent value of $\alpha_s$ measured at the $Z$ higher than the actual one. The predicted hierarchy of masses and dominant decays are shown in table 1.

| Particle       | Mass       | prominent decay modes                                                                 |
|----------------|------------|---------------------------------------------------------------------------------------|
| photino        | $< 1\,\text{GeV}$ | stable or $\text{goldstino} + \gamma$                                                 |
| gluino         | $< 1\,\text{GeV}$ | $\tilde{\gamma} + \text{hadrons}$ possibly $\text{goldstino} + \text{gluon}$        |
| chargino       | $\simeq 50\,\text{GeV}$ | $q\bar{q}\tilde{\gamma}$                                                            |
| neutralino     | $\simeq 50\,\text{GeV}$ | $q\bar{q}\tilde{g}$                                                                  |
| u,d,s,c,b squarks | $\simeq 110\,\text{GeV}$ | $q\tilde{g}$                                                                          |
| sleptons       | $\simeq 110\,\text{GeV}$ | $\ell\tilde{\gamma}, \ell\chi$                                                     |
| top quark      | $< 162\,\text{GeV}$ | $Wb$                                                                                  |
| $\tilde{t}_1$  | $m_t + (.3 \sim 33\,\text{GeV})$ | $t\tilde{g}, b\tilde{\chi}$                                                         |
| $\tilde{t}_2$  | 183 $\sim$ 209 GeV | $t\tilde{g}, b\tilde{\chi}$                                                         |

Table 1. mass and decay channels for SUSY particles in the light gluino scenario ($m_{1/2} = A = 0$) assuming radiative breaking and $\rho$ parameter constraints.

The lightest chargino and neutralino in this model as well as the squarks near $110\,\text{GeV}$ have predominantly hadronic decay modes with only rare decays into leptons plus missing energy thus evading previous SUSY searches. The heavier chargino will have a prominent decay into $W\tilde{\gamma}$. Thus pair production of this chargino or of the sleptons could lead to events of the form $\ell^+\ell^-\gamma\gamma + \text{invisible}$ discussed by [8] providing the $\tilde{\gamma}$ decays into $\gamma + \text{Goldstino}$ or gravitino as treated for example in [20]. The top quark decays predominantly in the standard model mode $W + b$. The possible decay into $\tilde{c} + \tilde{g}$ is presumably highly suppressed
by Kobayashi-Maskawa angles. The stop quarks decay predominantly into $t + \tilde{g}$ and $b + \tilde{\chi}$ with approximate relative branching ratios

$$B_i = \frac{\Gamma(\tilde{t}_i \rightarrow t + \tilde{g})}{\Gamma(\tilde{t}_i \rightarrow b + \tilde{\chi})} = \frac{4\alpha_s \sin^2 \theta_W}{\alpha} \frac{(M_{t_i}^2 - M_{\tilde{t}}^2)^2}{(M_{\tilde{t}}^2 - M_W^2)^2} \frac{1}{1 + m_t^2/m_W^2} .$$  \hspace{1cm} (17)$$

We have included the final factor here as an estimate of the effect of Higgsino admixture in the chargino since the coupling of this component is proportional to the top mass. The corresponding leptonic branching ratios of the stops are

$$B_{L,i} = \frac{B_i B_{L,t}}{1 + B_i} .$$  \hspace{1cm} (18)$$

Here $B_{L,t} \approx 0.24$ is the inclusive (prompt) electron plus muon decay branching ratio of the top including feed-down from $\tau$. Due to phase space, the stops, especially the lighter, decay preferentially into $b + \text{chargino}$ which, according to table 1, very rarely leads to a high energy lepton plus missing energy. Thus the stop production will lead primarily to non-leptonic, b-containing events. The total invariant mass on each ”side” will be above the top mass but if the lowest energy jet from the chargino is partially or completely discarded due to experimental cuts, the apparent ”top” mass on an event by event basis could vary over a large range as, in fact, seems to be the case with the Fermilab top events. If the full jet energy is collected it should be possible to observe a peak at the chargino mass ($\sim 50 GeV$) instead of at the $W$ mass. It has been suggested [21] that this 50 GeV chargino is responsible for the anomalous events in the Aleph four-jet sample.

Since both the $t + \text{gluino}$ and the $b + \text{chargino}$ decays of the stop have an extra (possibly low energy) jet relative to the standard model $t\bar{t}$ production, one can expect the top quarks reconstructed in a standard model analysis to be accompanied by extra jet activity and to exhibit a greater than expected transverse momentum.

Furthermore, since the $B_{L,i}$ are small and the stop masses are above the top mass, the di-lepton decays are almost always attributable to direct $t\bar{t}$ production with only a small contribution from stop initiated events. The average reconstructed mass in the di-lepton events should then be only slightly higher than the true top quark mass. The single lepton
events will have a somewhat higher contribution from stop pair production with one stop decaying non-leptonically and the other decaying to a top with a subsequent leptonic decay. Since the mass attributed to the top in such events comes from the hadronic side, the effective top mass in single-lepton events will tend to be higher than in the di-lepton events. The gluon appearing in the stop to top decay could, in at least some fraction of the events, be mis-associated with the non-leptonic decay of the assumed recoiling top thus leading to a further enhancement of the apparent top mass in single lepton events.

To properly model these effects it would be necessary to construct a hadronization monte-carlo with the mass and coupling information of the light gluino model and including the effects of detector acceptances. With light gluinos and stops in the top region, there are important SUSY corrections to the top production cross section. Since such a monte-carlo is not available at present and since, in any case, the top production cross section would depart from the SM predictions due to light gluino and stop loops, we make the following preliminary model to estimate the possible size of expected effects. For each value of the four parameters $m_0, \mu, \tan(\beta)$, and $m_t$ and the consequent masses $m_{t_1}, m_{t_2}, M_{\tilde{\chi}}$ we define three pair production cross sections

$$\sigma_t = \sigma_{th}(m_t)$$  \hspace{1cm} (19)

$$\sigma_{t_1} = \frac{\sigma_{th}(m_{t_1})}{2}$$  \hspace{1cm} (20)

$$\sigma_{t_2} = \sigma_{th}(m_{t_2})$$  \hspace{1cm} (21)

where $\sigma_{th}(m)$ is the empirical fit to the theoretical top production cross section for mass $m$ given in eq. 3. We enhance the heavier stop production (by an estimated factor of 2) due to more important contributions from processes such as

$$q\bar{q} \rightarrow b\tilde{\chi}\tilde{t}$$  \hspace{1cm} (22)

$$q\bar{q} \rightarrow t\tilde{g}\tilde{t}$$  \hspace{1cm} (23)

With light gluinos and charginos, these processes have a mass advantage over the stop pair production which is not shared to the same extent by the analogous top or lighter stop...
production processes. A further enhancement of stop production above the crude estimate of eq. [21] would increase the difference between the apparent "top" masses seen in the different decay topologies. In subsequent studies of the scenario outlined here it will be important to incorporate a more precise calculation of the stop production cross sections and decay branching ratios as functions of the masses in the theory. Nevertheless, we content ourselves at present with the simple model discussed here in order to illustrate the approximate size of the expected effect.

We assume that each top initiated event will produce a reconstructed top mass $m_t$, and each $t_1$ or $t_2$ initiated event will produce a reconstructed mass $t_1$ or $t_2$. This is clearly oversimplified but is motivated by the expectation that, in the single lepton events, the mass is reconstructed from the hadronic side and that the extra jet activity from the stop decays will increase the measured top mass even in the case of stops to tops to dileptons. As it turns out, however the stop contribution to the di-lepton events is very small. The di-lepton events, single lepton events, and non-leptonic events will be produced with cross sections

$$\sigma_{2L} = B_{L,t}^2 \sigma_t + B_{L,1}^2 \sigma_{t_1} + B_{L,2}^2 \sigma_{t_2}$$

$$\sigma_{1L} = 2 \left( B_{L,t} (1 - B_{L,t}) \sigma_t + B_{L,1} (1 - B_{L,1}) \sigma_{t_1} + B_{L,2} (1 - B_{L,2}) \sigma_{t_2} \right)$$

$$\sigma_{had} = (1 - B_{L,t})^2 \sigma_t + (1 - B_{L,1})^2 \sigma_{t_1} + (1 - B_{L,2})^2 \sigma_{t_2}$$

The reconstructed masses in the di-lepton, single lepton, and hadronic events, will then be roughly:

$$M_{2L} = \left( m_t B_{L,t}^2 \sigma_t + m_{t_1} B_{L,1}^2 \sigma_{t_1} + m_{t_2} B_{L,2}^2 \sigma_{t_2} \right) / \sigma_{2L}$$

$$M_{1L} = 2 \left( B_{L,t} (1 - B_{L,t}) m_t \sigma_t + B_{L,1} (1 - B_{L,1}) m_{t_1} \sigma_{t_1} + B_{L,2} (1 - B_{L,2}) m_{t_2} \sigma_{t_2} \right) / \sigma_{1L}$$

$$M_{had} = \left( (1 - B_{L,t})^2 m_t \sigma_t + (1 - B_{L,1})^2 m_{t_1} \sigma_{t_1} + (1 - B_{L,2})^2 m_{t_2} \sigma_{t_2} \right) / \sigma_{had}$$

Since the Fermilab top measurements are dominated by the single lepton events, the reported top production cross section is approximately
\[
\sigma = \frac{\sigma_{1L}}{2B_{L,t}(1 - B_{L,t})} \quad . \tag{30}
\]

We make, therefore, a final loose cut in our monte-carlo requiring that \(4\, pb < \sigma < 12\, pb\) and that \(\sigma_{\text{had}}/(1 - B_{L,t})^2 < 20\, pb\). In the simplified model presented here we find \(9.3\, pb < \sigma < 12\, pb\) (upper limit imposed) which is consistent with the experimental values for a 160\,GeV top. The effective cross section in the di-lepton channel is about 1.5\,pb lower and the effective cross section in the hadronic channel is greater than 16\,pb. The apparent values of the experimental top production cross section as measured in the three channels are given in [22]. Although these experimental cross sections are consistent within errors with the standard model they are also consistent with a larger apparent top cross section in the fully hadronic channel as predicted here in the simplified model.

Although we have relied here on crude estimates of stop production cross sections and branching ratios, in the \(m_{1/2} = A = 0\) version of the supergravity-inspired SUSY breaking model which leads to light gluinos and photinos, when experimental constraints from LEP and Fermilab are imposed, the following conclusions can be drawn.

1) The top quark and stop quark masses are

\[
m_t = 157 \pm 4\, GeV \tag{31}
\]

\[
.3\, GeV < m_{t_1} - m_t < 21\, GeV \tag{32}
\]

\[
198\, GeV < m_{t_2} < 207\, GeV \tag{33}
\]

2) ”Top-like” events at Fermilab will exhibit a range of apparent masses of the top quark with the average masses of the three topologies satisfying \(M_{2L} < M_{1L} < M_{\text{had}}\). In the simple model presented here:

\[
M_{2L} \simeq 161 \pm 4\, GeV \tag{34}
\]

\[
M_{1L} - M_{2L} \simeq 5\, GeV \tag{35}
\]

\[
M_{\text{had}} - M_{1L} \simeq 5\, GeV \tag{36}
\]
3) Some of the "top" events will be associated with extra jet activity and total transverse momentum above that expected in the standard model.

4) Some of the events attributed to a non-leptonic top decay will not well reconstruct the $W$ mass. In some of these events the apparent $W$ mass will be larger than expected due to contamination from the predicted extra low energy jets. However, it should also be possible to find evidence for a $50\,\text{GeV}$ chargino recoiling against a $b$ quark jet.

5) In the most likely scenario where SUSY decays of the top quark are highly suppressed, all of the "top" events will have $b$ quark jets in their decays.

6) Apart from the stop quarks, squarks and sleptons will be in the 100 GeV region but will not have prominent decays into isolated leptons plus missing energy. This coincides with the postulated mass of the charged sleptons in [8] although, for phenomenological reasons in the heavy gluino case, these authors postulate a significantly lower sneutrino mass and a significantly higher squark mass.

7) Apart from the gluino and photino which will be in the ultra-low mass window, the tree-level gaugino masses are expected to be

$$46\,\text{GeV} < m_{\chi^\pm_1} < 51\,\text{GeV}$$  \hspace{1cm} (37)

$$116\,\text{GeV} < m_{\chi^\pm_2} < 131\,\text{GeV}$$  \hspace{1cm} (38)

$$46\,\text{GeV} < m_{N_1} < 51\,\text{GeV}$$  \hspace{1cm} (39)

$$76\,\text{GeV} < m_{N_2} < 87\,\text{GeV}$$  \hspace{1cm} (40)

$$122\,\text{GeV} < m_{N_3} < 137\,\text{GeV}$$  \hspace{1cm} (41)

These masses as well as the accompanying mixing angles are predicted before imposing constraints from the Fermilab "top quark" measurements. The squark and slepton masses are determined (after loosely imposing the Fermilab constraints) by the output parameters:

$$95\,\text{GeV} < m_0 < 118\,\text{GeV}$$  \hspace{1cm} (42)

$$1.50 < \tan(\beta) < 1.69$$  \hspace{1cm} (43)

$$39\,\text{GeV} < |\mu| < 79\,\text{GeV}$$  \hspace{1cm} (44)
The main purpose of the present paper has been to set forth the sparticle mass predictions of the $m_{1/2} = A = 0$ model subject to constraints from radiative breaking, $\rho$ parameter measurements, and cross section measurements at LEP and Fermilab. We have noted that the predicted mass hierarchy with, in particular, stop quarks in the 160 to 210$GeV$ region shows promise for explaining several possible anomalies in the top quark region. The model predicts a top quark mass several standard deviations below the 175$GeV$ mass resulting from a standard model analysis of the Fermilab events. A complete analysis of the scenario suggested in this paper is beyond the scope of the current work and will require the incorporation of the light gluino effects into a full hadronization monte-carlo with detailed treatment of experimental cuts. We feel that the light gluino scenario provides testable predictions for the top quark region that, at a minimum, are not ruled out by current measurements.

In the course of this analysis we profited from discussions with K. Sliwa of Tufts University. This work was supported in part by the Department of Energy under grant $DE-FG02-96ER40967$ at the University of Alabama and $DE-FG02-92ER40702$ at Tufts University. LC would like to thank the Department of Physics at Tufts for hospitality during the summer of 1997 when this work was undertaken.
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