Possible Test of the GUT Relation between $M_1$ and $M_2$ in Electron-Photon Scattering

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Abstract

We investigate associated production of selectrons and the lightest neutralino (LSP) in the process $e^-\gamma \rightarrow \tilde{\chi}_1^0 \tilde{e}_{L/R}$ with the selectron subsequently decaying into an electron and the LSP. Total cross sections and various polarization asymmetries are calculated for photons produced by Compton backscattering of a polarized laser beam at an $e^+e^-$ linear collider with CMS energy $\sqrt{s_{ee}} = 500$ GeV and with polarized beams. The total cross section and in particular the polarization asymmetries show a characteristic dependence on the gaugino mass parameter $M_1$. Therefore this process is suitable for testing the GUT relation $M_1 = M_2 \cdot \frac{5}{3} \tan^2 \theta_W$.

1 Introduction

The search for supersymmetry (SUSY) \cite{I} is one of the most important goals of a future $e^+e^-$ linear collider (LC) in the energy range between 500 GeV and 1000 GeV \cite{II}. In addition to the $e^+e^-$ option the $e^-\gamma$ mode is also technically realizable with high luminosity polarized photon beams obtained by backscattering of intensive laser pulses off the electron beam \cite{III, IV, V}. Associated production of selectrons with the lightest neutralino $\tilde{\chi}_1^0$ (assumed to be the LSP) in $e^-\gamma$ collisions allows to probe heavy selectrons beyond the kinematical limit of selectron pair production in $e^+e^-$ annihilation. Further associated production of selectrons and gaugino-like neutralinos provides us with the possibility to study the electron-selectron-neutralino couplings complementary to $e^+e^-$ annihilation.

In the present paper we study the associated production $e^-\gamma \rightarrow \tilde{\chi}_1^0 \tilde{e}_{L/R}$ with polarized beams and the subsequent direct leptonic decay $\tilde{e}_{L/R} \rightarrow \tilde{\chi}_1^0 e^-$. The beam polarization is chosen suitably to optimize cross sections and polarization asymmetries. The signal is a single electron with high transverse momentum $p_T$. We do not consider cascade decays of heavy selectrons, which may yield a similar single electron signal with, however, a less pronounced $p_T$ \cite{VI}. We also refrain from a discussion of the background.

The calculations are done in the Minimal Supersymmetric Standard Model (MSSM). The masses and couplings of the neutralinos depend on the gaugino mass

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parameters \(M_1\) and \(M_2\), the higgsino mass parameter \(\mu\) and the ratio \(\tan\beta\) of the two Higgs vacuum expectation values. The parameters \(M_2\), \(\mu\) and \(\tan\beta\) can in principle be determined by chargino production alone [6]. For the gaugino mass parameters usually the GUT relation \(M_1 = M_2 \cdot \frac{5}{3} \tan^2 \theta_W\) is assumed. A precise determination of \(M_1\) is, however, only possible in the neutralino sector [7].

In the present paper we investigate if associated production of selectrons and the LSP \(\tilde{\chi}_1^0\) is suitable as a test for this relation. We therefore study the influence of the gaugino mass parameter \(M_1\) on the total cross section and on polarization asymmetries for different selectron masses.

### 2 Cross Sections and Polarization Asymmetries

The production cross section \(\sigma^{L/R}_{\ell P} (s_{e\gamma})\) for the process \(e^-\gamma \rightarrow \tilde{\chi}_1^0 \tilde{\ell}_{L/R}^-\) proceeds via electron exchange in the s-channel and selectron exchange in the t-channel. The electron-selectron-LSP couplings

\[
f_{e1}^L = -\sqrt{2} \left[ \frac{1}{\cos \theta_W} \left( -\frac{1}{2} + \sin^2 \theta_W \right) N_{12} - \sin \theta_W N_{11} \right],
\]

\[
f_{e1}^R = \sqrt{2} \sin \theta_W \left[ \tan \theta_W N_{12}^* - N_{11}^* \right]
\]

for left and right selectrons with masses \(m_{\tilde{\ell}_L}\) and \(m_{\tilde{\ell}_R}\) depend on the photino component \(N_{11}\) and the zino component \(N_{12}\) of the LSP [1]. For an electron beam with longitudinal polarization \(P_e\) the cross sections \(\sigma_P^L\) and \(\sigma_P^R\) are proportional to \((1 - P_e)\) and \((1 + P_e)\), respectively. For special cases the cross sections are given in [5] and [8], the complete analytical expressions for the differential and the total cross section for polarized beams will be given in a forthcoming paper [9].

In the narrow width approximation one obtains the total cross section \(\sigma_{e\gamma}^{L/R}\) for the combined process of \(\tilde{\ell}_{L/R}^-\tilde{\chi}_1^0\) production and the subsequent leptonic decay \(\tilde{\ell}_{L/R}^- \rightarrow e^-\tilde{\chi}_1^0\) by multiplying the production cross section with the leptonic branching ratio:

\[
\sigma_{e\gamma}^{L/R} (s_{e\gamma}) = \sigma_{e\ell}^{L/R} (s_{e\gamma}) \cdot \text{Br} \left( \tilde{\ell}_{L/R}^- \rightarrow e^-\tilde{\chi}_1^0 \right).
\]

The LSP-selectron-electron coupling \(f_{e1}^{L/R}\) appears in the production amplitudes as well as in the decay amplitude, so that the total cross section \(\sigma_{e\gamma}^{L/R} (s_{e\gamma})\) is proportional to \(\left( f_{e1}^{L/R} \right)^4\).

The photon beam is assumed to be produced by Compton backscattering of circularly polarized laser photons (polarization \(\lambda_L\)) off longitudinally polarized electrons (polarization \(\lambda_e\)). The energy spectrum \(P(y)\) and the mean helicity \(\lambda(y)\) of the high energy photons are given in [4, 5, 10]. The ratio \(y = E_\gamma/E_e\) of the photon energy \(E_\gamma\) and the energy of the converted electron beam \(E_e\) is confined to \(y \lesssim 0.83\) [3]. For \(y > 0.83\) \(e^+e^-\) pairs can be produced via scattering of laser photons and backscattered photons, so that the flux of high energetic photons drops considerably. To obtain the total cross section \(\sigma_{e\gamma}^{L/R} (s_{e\gamma}, P_e, \lambda_e, \lambda_L)\) for the combined process in the laboratory frame \((e^+e^-\text{ CMS})\) one has to convolute the total cross section
\( \sigma_{e\gamma}^{L/R} \) in the \( e\gamma \) CMS with the energy distribution \( P(y) \) and the mean helicity \( \lambda(y) \) of the backscattered photon beam [11]:

\[
\sigma_{ee}^{L/R} = \int dy P(y) \hat{\sigma}_{e\gamma}^{L/R}(S_{e\gamma} = ys_{ee}),
\]

\[
\hat{\sigma}_{e\gamma}^{L/R} = \frac{1}{2} \left( 1 + \lambda(y) \right) \left( \sigma_{e\gamma}^{L/R} \right)^+ + \frac{1}{2} \left( 1 - \lambda(y) \right) \left( \sigma_{e\gamma}^{L/R} \right)^- = \sigma_{e\gamma}^{L/R} \left( 1 + \lambda(y) A_{c}^{L/R} \right).
\]

In eq. (3) \( \left( \sigma_{e\gamma}^{L/R} \right)^{+/-} \) are the total cross sections for a completely right (left) circular polarized photon beam whereas \( \sigma_{e\gamma}^{L/R} \) is the cross section for unpolarized photons.

\[
A_{c}^{L/R} = \frac{\left( \sigma_{e\gamma}^{L/R} \right)^+ - \left( \sigma_{e\gamma}^{L/R} \right)^-}{\left( \sigma_{e\gamma}^{L/R} \right)^+ + \left( \sigma_{e\gamma}^{L/R} \right)^-}
\]

is the polarization asymmetry for circular polarized photons.

Since the production and decay of right and left selectrons lead to the same final state we add both cross sections and obtain

\[
\sigma_{ee} = \sigma_{ee}^{L} + \sigma_{ee}^{R}.
\]

We consider two types of polarization asymmetries of the convoluted cross section. For the first one we flip the electron polarization \( P_e \) and fix the polarization \( \lambda_L \) of the laser beam and the polarization \( \lambda_e \) of the converted electron beam:

\[
A_{P_e} = \frac{\sigma_{ee} \left( s_{ee}, P_e, \lambda_e, \lambda_L \right) - \sigma_{ee} \left( s_{ee}, -P_e, \lambda_e, \lambda_L \right)}{\sigma_{ee} \left( s_{ee}, P_e, \lambda_e, \lambda_L \right) + \sigma_{ee} \left( s_{ee}, -P_e, \lambda_e, \lambda_L \right)}.
\]

If we split off from \( \sigma_{ee}^{L/R} \) the dependence of beam polarization \( (1 \mp P_e) \)

\[
\sigma_{ee} \left( s_{ee}, P_e, \lambda_e, \lambda_L \right) = (1 - P_e) \hat{\sigma}_{ee}^{L} + (1 + P_e) \hat{\sigma}_{ee}^{R},
\]

we obtain

\[
A_{P_e} = P_e \cdot \frac{\hat{\sigma}_{ee}^{R} - \hat{\sigma}_{ee}^{L}}{\hat{\sigma}_{ee}^{R} + \hat{\sigma}_{ee}^{L}}.
\]

Here \( \hat{\sigma}_{ee}^{R} \) (\( \hat{\sigma}_{ee}^{L} \)) is the cross section for production of right (left) selectrons with an unpolarized electron beam \( (P_e = 0) \) and their subsequent leptonic decay.

As a second asymmetry we discuss that with respect to the polarization \( \lambda_L \) of the laser beam:

\[
A_{\lambda_L} = \frac{\sigma_{ee} \left( s_{ee}, P_e, \lambda_e, \lambda_L \right) - \sigma_{ee} \left( s_{ee}, P_e, \lambda_e, -\lambda_L \right)}{\sigma_{ee} \left( s_{ee}, P_e, \lambda_e, \lambda_L \right) + \sigma_{ee} \left( s_{ee}, P_e, \lambda_e, -\lambda_L \right)}.
\]
3 Numerical Results

In the following numerical analysis we study the total cross section $\sigma^{(L/R)}_{ee}$ and the polarization asymmetries $A_{P,e}$ and $A_{\lambda_L}$ for $\sqrt{s_{ee}} = 500$ GeV. For the MSSM parameters we choose $M_2 = 152$ GeV, $\mu = 316$ GeV, $\tan \beta = 3$ with $M_1$ varying between $M_1 = 40$ GeV and $M_1 = 300$ GeV. The region $M_1 < 40$ GeV is excluded by assuming a lower limit of 35 GeV for the LSP mass $m_{\tilde{\chi}_1^0}$. In the figures the excluded region is shaded. For $M_1 = 78.7$ GeV this corresponds to the DESY/ECFA reference scenario for the Linear Collider [12], which implies the GUT relation $M_1 = M_2 \cdot \frac{5}{3} \tan^2 \theta_W$.

![Graphs showing M1-dependence of the LSP mass m_\tilde{\chi}_1^0, N_{11}, N_{12}, (f^{L/R}_{e1})^4](image)

Figure 1: (a) $M_1$-dependence of the LSP mass $m_{\tilde{\chi}_1^0}$; (b) $M_1$-dependence of the photino component $N_{11}$ (solid line) and of the zino component $N_{12}$ (dashed line) of the LSP; (c) $M_1$-dependence of the couplings $(f^{L}_{e1})^4$ (solid line) and $(f^{R}_{e1})^4$ (dashed line).

For this set of parameters one has $35$ GeV < $m_{\tilde{\chi}_1^0}$ < $m_{\tilde{\chi}_1^\pm}$ < 128 GeV. Fig. 1a shows that in the region 40 GeV < $M_1$ < 150 GeV the LSP mass depends very strongly on $M_1$, varying between $m_{\tilde{\chi}_1^0} = 35$ GeV for $M_1 = 40$ GeV and $m_{\tilde{\chi}_1^0} = 121$ GeV for $M_1 = 150$ GeV whereas for $M_1 > 150$ GeV the mass of the LSP is practically independent of $M_1$. In the whole $M_1$ region the LSP is gaugino-like (fig. 1b). At $M_1 = M_2$ the photino component $N_{11}$ changes its sign which leads to completely different strength of the couplings $f^{L/R}_{e1}$ in the regions $M_1 > 150$ GeV and $M_1 < 150$ GeV (fig. 1c). For the selectron masses we choose two examples: $m_{\tilde{e}_L} = 179.3$ GeV, $m_{\tilde{e}_R} = 137.7$ GeV corresponding to the value $m_0 = 110$ GeV of the common scalar.
mass at the GUT scale and $m_{\tilde{e}_L} = 350.0$ GeV, $m_{\tilde{e}_R} = 330.5$ GeV corresponding to $m_0 = 320$ GeV. In the second case selectron pair production at an $e^+e^-$ collider with $\sqrt{s_{ee}} = 500$ GeV is kinematically forbidden.

For the integrated luminosity of the $e\gamma$ machine we assume $\int L = 100$ fb$^{-1}$ so that cross sections of a few fb should be measurable.

Fig. 1c shows that in our scenario also the electron-selectron-LSP couplings strongly depend on $M_1$. For $M_1 < 150$ GeV the coupling of the right selectron $f^R_{e_1}$ dominates whereas for $M_1 > 150$ GeV that of the left selectron $f^L_{e_1}$ is the stronger one. Similarly the total cross sections $\sigma^{L/R}_{ee}$ depicted in fig. 2a for a CMS energy $\sqrt{s_{ee}} = 500$ GeV and for unpolarized beams ($P_e = \lambda_L = \lambda_e = 0$) have a pronounced $M_1$-dependence. Comparing fig. 2a for the cross sections with fig. 1c for the couplings $f^L/R_{e_1}$ one can see that even in the region $40$ GeV $< M_1 < 150$ GeV the influence of the additional $M_1$-dependence of the LSP mass (fig. 1a) is weak so that the total cross sections reflect essentially the $M_1$-dependence of the couplings.

As a consequence of the somewhat higher mass the cross section for production and decay of $\tilde{e}_L$ is additionally suppressed compared to that for $\tilde{e}_R$. Therefore in fig. 2a the crossing of the cross sections is at a somewhat higher value of $M_1 \sim 175$ GeV than that of the couplings at $M_1 \sim 150$ GeV in fig. 1c. For $M_1 < 175$ GeV

![Figure 2](image-url)
the production of $\tilde{e}_R$ dominates whereas for $M_1 > 175$ GeV that of $\tilde{e}_L$ dominates with, however, much smaller cross sections. Fig. 2a shows the strong variation of the cross section $\sigma_{ee}^R$ with $M_1$. If we assume that a cross section $\sigma_{ee}^R = 100$ fb has been measured with an error of $\pm 5\%$ this is compatible with $M_1$ between 122 GeV and 126 GeV.

For an unpolarized electron beam ($P_e = 0$) polarization of the laser beam and of the converted electrons essentially changes only the magnitude of the cross sections by a maximal factor between 0.7 and 1.3. As we have checked numerically the $M_1$ dependence is very similar to that given in fig. 2a.

Fig. 2b - 2d exhibit the energy dependence of the total cross section for three different values of $M_1$: the GUT value $M_1 = 78.7$ GeV (fig. 2b) and two higher values $M_1 = 170$ GeV (fig. 2c) and $M_1 = 250$ GeV (fig. 2d). For a polarization of the electron beam $P_e = +0.9$ ($P_e = -0.9$) the cross section for production and decay of left (right) selectrons is reduced and that for right (left) selectrons is enhanced.

In fig. 3a the asymmetry $A_{P_e}$ defined in eq. (10) is shown for unpolarized converted electrons ($\lambda_e = 0$), unpolarized laser photons ($\lambda_L = 0$) and electron polarization $P_e = \pm 0.9$. In our scenario the dependence of $A_{P_e}$ on $\lambda_L$ and on $\lambda_e$ turns out to be negligible. The $M_1$-dependence of $A_{P_e}$ is as expected from that of the cross sections (fig. 2). Since for $M_1 < 175$ GeV ($M_1 > 175$ GeV) the production of $\tilde{e}_R$ ($\tilde{e}_L$) dominates we obtain large positive asymmetries (large negative asymmetries) for $M_1 < 175$ GeV ($M_1 > 175$ GeV). For 40 GeV $< M_1 < 142$ GeV the asymmetry $A_{P_e}$ is larger than 0.85 and nearly independent of $M_1$. In this region, however, the LSP mass (fig. 1a) and the total cross section (fig. 2) depend strongly on $M_1$. For $M_1 > 205$ GeV the asymmetry increases up to large negative values between $A_{P_e} = -0.5$ for $M_1 = 205$ GeV and $A_{P_e} = -0.82$ for $M_1 = 300$ GeV with, however, rather small cross sections $< 38$ fb. For 142 GeV $< M_1 < 205$ GeV the asymmetry $A_{P_e}$ shows a strong variation with $M_1$. If we assume that for instance an asymmetry $A_{P_e} = 0.5 \pm 5\%$ has been measured this is compatible with $M_1$ in the narrow region between 158 GeV and 160 GeV.

Additional informations on the value of $M_1$ can be obtained if the laser beam and the converted electrons are polarized. In fig. 3b we show the $M_1$-dependence of the total cross section $\sigma_{ee}$ for $P_e = 0.9$ and $\lambda_e = +1$. For $\lambda_L = -1$ ambiguities exist in the region 40 GeV $< M_1 < 120$ GeV and for $M_1 > 180$ GeV the dependence on $M_1$ is rather weak. For 120 GeV $< M_1 < 180$ GeV however this cross section shows a strong variation with $M_1$. For $\lambda_L = +1$ the cross section again shows ambiguities in the region 40 GeV $< M_1 < 108$ GeV and is nearly independent on $M_1$ for $M_1 > 180$ GeV. The interval 108 GeV $< M_1 < 180$ GeV, where the cross section is sensitive to $M_1$ is however larger than for $\lambda_L = -1$. If we assume that a cross section $\sigma_{ee} = 250$ fb $\pm 5\%$ has been measured this is compatible with $M_1$ between 122 GeV and 127 GeV. In the region 60 GeV $< M_1 < 300$ GeV the asymmetry $A_{\lambda_L}$ (eq. (11)) depicted in fig. 3c for $P_e = 0.9$ and $\lambda_e = +1$ is nearly linearly dependent on $M_1$ so that it should be possible to determine $M_1$ uniquely in the region 60 GeV $< M_1 < 190$ GeV. An asymmetry $A_{\lambda_L} = 0.25 \pm 5\%$ would be compatible with $M_1$ between 116 GeV and 132 GeV according to fig. 3c. In the region $M_1 > 190$ GeV the cross sections are smaller than 16 fb.
The cross section $\sigma_{ee}$ and the asymmetry $A_{\lambda_L}$ are depicted in fig. 3d, e for the polarization configuration $P_e = -0.9$ and $\lambda_e = -1$. For $\lambda_L = -1$ the total cross section has ambiguities in the region $40 \text{ GeV} < M_1 < 167 \text{ GeV}$ and for $\lambda_L = +1$ in the region $40 \text{ GeV} < M_1 < 173 \text{ GeV}$. For $M_1 > 173 \text{ GeV}$ one notices a strong variation of the cross section for $\lambda_L = \pm 1$. As can be seen from fig. 3d with $\lambda_L = +1$
a cross section $\sigma_{ee} = 35 \text{ fb} \pm 5\%$ is compatible with $M_1$ between 193 GeV and 209 GeV. For this polarization configuration the asymmetry $A_{L_L}$ (fig. 3e) grows practically linearly between $M_1 = 40 \text{ GeV}$ and $M_1 = 126 \text{ GeV}$ and is very sensitive on $M_1$ but shows ambiguities between $M_1 = 40 \text{ GeV}$ and $M_1 = 150 \text{ GeV}$. If we assume that an asymmetry $A_{L_L} = 0.15 \pm 5\%$ has been measured this is compatible with $M_1$ between 89 GeV and 94 GeV or between 138 GeV and 140 GeV according to fig. 3e. One can distinguish between these two regions via the cross section for $\lambda_L = +1$ depicted in fig. 3d because one expects 18-19 fb for $M_1$ between 89 GeV and 94 GeV and 7-8 fb for $M_1$ between 138 GeV and 140 GeV. For $M_1 > 170 \text{ GeV}$ the asymmetry is nearly constant $A_{L_L} \sim -0.07$.

To sum up: for unpolarized laser beams ($\lambda_L = 0$) and converted electrons ($\lambda_e = 0$) the polarization asymmetry $A_{L_L}$ exhibits a pronounced $M_1$ dependence in the region $142 \text{ GeV} < M_1 < 205 \text{ GeV}$. For the polarization configuration $P_e = 0.9$, $\lambda_e = +1$ and $\lambda_L = \pm 1$ the cross sections $\sigma_{ee}$ and the polarization asymmetry $A_{L_L}$ are sensitive to $M_1$ in the region $60 \text{ GeV} < M_1 < 190 \text{ GeV}$. Finally for $P_e = -0.9$, $\lambda_e = -1$ and $\lambda_L = \pm 1$ these observables show a strong $M_1$ dependence in the region $40 \text{ GeV} < M_1 < 300 \text{ GeV}$.

Figure 4: Total cross section $\sigma_{ee} = \sigma_{ee}^L + \sigma_{ee}^R$ and polarization asymmetry $A_{L_L}$ for $m_{\tilde{e}_L} = 330.5 \text{ GeV}$ and $m_{\tilde{e}_R} = 350.0 \text{ GeV}$; (a) $M_1$-dependence of $\sigma_{ee}$ for $P_e = 0.9$, $\lambda_e = 1$, $\lambda_L = +1$ (solid line) and $P_e = 0.9$, $\lambda_e = 1$, $\lambda_L = -1$ (dashed line); (b) $M_1$-dependence of $A_{L_L}$ for $P_e = 0.9$, $\lambda_e = +1$ and $\lambda_L = \pm 1$.

We choose as a second example higher selectron masses $m_{\tilde{e}_L} = 350.0 \text{ GeV}$ and $m_{\tilde{e}_R} = 330.5 \text{ GeV}$ corresponding to $m_0 = 320 \text{ GeV}$. Then for $\sqrt{s_{ee}} = 500 \text{ GeV}$ selectron pair production in $e^+e^-$ annihilation is forbidden, whereas single selectron production in $e^-\gamma \rightarrow \chi_1^0 \tilde{e}_{L/R}$ is still possible, provided that $\sqrt{s_{ee}} > m_{\tilde{e}_{L/R}} + m_{\chi_1^0}$ where $\sqrt{s_{ee}} \sim 0.91 \cdot \sqrt{s_{ee}}$ is the energy of the hardest photon obtained by Compton backscattering [11]. Now the kinematical accessible $M_1$ region is confined to $M_1 < 184 \text{ GeV}$ ($m_{\chi_1^0} < 124.6 \text{ GeV}$). In fig. 4a,b we show the total cross section and the asymmetry $A_{L_L}$ for $P_e = 0.9$, $\lambda_e = +1$ and $\lambda_L = \pm 1$. For $\lambda_L = +1$ the cross section depends nearly linearly on $M_1$ in the region $40 \text{ GeV} < M_1 < 115 \text{ GeV}$. For $M_1 > 115 \text{ GeV}$ the cross section is smaller than 2 fb. The cross section for $\lambda_L = -1$ is higher and more sensitive to $M_1$ between $40 \text{ GeV} < M_1 < 135 \text{ GeV}$. If
we assume for example that a cross section $\sigma_{ee} = 45 \text{ fb} \pm 5\%$ has been measured
this is compatible with $M_1$ between 80 GeV and 88 GeV. Also the polarization asymmetry $A_{\lambda L}$ strongly
depends on $M_1$ in the whole region. According to fig. 4b an asymmetry $A_{\lambda L} = -0.7 \pm 5\%$ would be compatible with $M_1$
between 99 GeV and 109 GeV. The polarization asymmetry $A_{P_e}$ for this scenario is between 0.85 and 0.9
and depends only weakly on $M_1$. Also the polarization configuration $P_e = -0.9$, $\lambda_e = -1$ and $\lambda_L = \pm 1$
is not shown because the cross sections are smaller than 2 fb. Thus for the case of high selectron masses and polarization
configuration $P_e = 0.9$, $\lambda_e = +1$ and $\lambda_L = \pm 1$ both the cross section and the asymmetry $A_{\lambda L}$
can be helpful for determining $M_1$ in the greatest part $(40 \text{ GeV} < M_1 < 135 \text{ GeV})$ of the
kinematical accessible region $M_1 < 184 \text{ GeV}$.

4 Conclusion

We have demonstrated that associated selectron - LSP production with subsequent
leptonic decay of the electron $e^{-} \rightarrow \tilde{\chi}_1^{0} \tilde{e}_{L/R}^{\pm} \rightarrow e^{-} \tilde{\chi}_1^{0} \tilde{\chi}_1^{0}$
at a $\sqrt{s}_{ee} = 500 \text{ GeV}$ linear collider in the $e\gamma$ mode should allow to test for a gaugino-like LSP the GUT
relation $M_1 = M_2 \cdot \frac{5}{3} \tan^2 \theta_W$ between the MSSM gaugino mass parameters. The
polarization $P_e$ of the electron beam helps to enlarge the production cross section
for left or right selectrons. For suitably polarized electron beams and laser photons
the total cross section $\sigma_{ee}$ and the polarization asymmetries $A_{P_e}$ and $A_{\lambda L}$ are very
sensitive to the gaugino mass parameter $M_1$ in the whole investigated region between
40 GeV and 300 GeV. For high selectron masses $m_{\tilde{e}_{L/R}}$ the accessible $M_1$ region is
kinematically constrained. The optimal polarization configuration depends on the
values of the selectron masses. For realistic predictions a complete MC study with
inclusion of background processes and experimental cuts would be indispensable.

5 Acknowledgements

We are grateful to Gudrid Moortgat-Pick and Stefan Hesselbach for valuable dis-
cussions. This work was supported by the Deutsche Forschungsgemeinschaft under
contract no. FR 1064/4-1 and the Bundesministerium für Bildung und Forschung
(BMBF) under contract number 05 HT9WWA 9.

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