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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 $e^-\gamma \longrightarrow \tilde{\chi}_1^0 \tilde{e}_{L/R}^-$ 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) [1] 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 [2]. 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 [3, 4, 5]. 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 $e^-\gamma \longrightarrow \tilde{\chi}_1^0 \tilde{e}_{L/R}^-$ with polarized beams and the subsequent direct leptonic decay $\tilde{e}_{L/R}^- \longrightarrow \tilde{\chi}_1^0 e^-$. 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

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single electron signal with, however, a less pronounced p_T [5]. 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 parameters M_1 and M_2, the higgsino mass parameter μ and the ratio $\tan\beta$ of the two Higgs vacuum expectation values. The parameters M_2, μ 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 $\sigma_P^{L/R}(s_{e\gamma})$ for the process $e^-\gamma \longrightarrow \tilde{\chi}_1^0\tilde{e}^-_{L/R}$ proceeds via electron exchange in the s-channel and selectron exchange in the t-channel. The electron-selectron-LSP couplings

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

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

for left and right selectrons with masses $m_{\tilde{e}_L}$ and $m_{\tilde{e}_R}$ 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 σ_P^L and σ_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 $\tilde{e}^-_{L/R}\tilde{\chi}_1^0$ production and the subsequent leptonic decay $\tilde{e}^-_{L/R} \longrightarrow e^-\tilde{\chi}_1^0$ by multiplying the production cross section with the leptonic branching ratio:

$$\sigma_{e\gamma}^{L/R}(s_{e\gamma}) = \sigma_P^{L/R}(s_{e\gamma}) \cdot \mathrm{Br}\left(\tilde{e}^-_{L/R} \longrightarrow e^-\tilde{\chi}_1^0\right). \tag{3}$$

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 λ_L) off longitudinally polarized electrons (polarization λ_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_γ 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 $\sigma_{ee}^{L/R}(s_{ee}, P_e, \lambda_e, \lambda_L)$ for the combined process in the laboratory frame (e^+e^- CMS) one has to convolute the total cross section $\sigma_{e\gamma}^{L/R}(s_{e\gamma})$ in the $e\gamma$ CMS with the energy distribution $P(y)$ and the mean helicity $\lambda(y)$ of the backscattered photon beam [11]:

$$\sigma_{ee}^{L/R} = \int dy P(y)\, \hat{\sigma}_{e\gamma}^{L/R}(s_{e\gamma} = y s_{ee}), \tag{4}$$

$$\begin{aligned}\hat{\sigma}_{e\gamma}^{L/R} &= \frac{1}{2}(1+\lambda(y))\left(\sigma_{e\gamma}^{L/R}\right)^{+} + \frac{1}{2}(1-\lambda(y))\left(\sigma_{e\gamma}^{L/R}\right)^{-} \\ &= \sigma_{e\gamma}^{L/R}\left(1+\lambda(y)\, A_c^{L/R}\right).\end{aligned} \tag{5}$$

In eq. (5) $\left(\sigma_{e\gamma}^{L/R}\right)^{+/-}$ 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.

$$A_c^{L/R} = \frac{\left(\sigma_{e\gamma}^{L/R}\right)^{+} - \left(\sigma_{e\gamma}^{L/R}\right)^{-}}{\left(\sigma_{e\gamma}^{L/R}\right)^{+} + \left(\sigma_{e\gamma}^{L/R}\right)^{-}} \tag{6}$$

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

$$\sigma_{ee} = \sigma_{ee}^{L} + \sigma_{ee}^{R}. \tag{7}$$

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 λ_L of the laser beam and the polarization λ_e of the converted electron beam:

$$A_{P_e} = \frac{\sigma_{ee}(s_{ee}, P_e, \lambda_e, \lambda_L) - \sigma_{ee}(s_{ee}, -P_e, \lambda_e, \lambda_L)}{\sigma_{ee}(s_{ee}, P_e, \lambda_e, \lambda_L) + \sigma_{ee}(s_{ee}, -P_e, \lambda_e, \lambda_L)}. \tag{8}$$

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

$$\sigma_{ee}(s_{ee}, P_e, \lambda_e, \lambda_L) = (1-P_e)\,\tilde{\sigma}_{ee}^{L} + (1+P_e)\,\tilde{\sigma}_{ee}^{R}, \tag{9}$$

we obtain

$$A_{P_e} = P_e \cdot \frac{\tilde{\sigma}_{ee}^{R} - \tilde{\sigma}_{ee}^{L}}{\tilde{\sigma}_{ee}^{R} + \tilde{\sigma}_{ee}^{L}}. \tag{10}$$

Here $\tilde{\sigma}_{ee}^{R}$ ($\tilde{\sigma}_{ee}^{L}$) 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 λ_L of the laser beam:

$$A_{\lambda_L} = \frac{\sigma_{ee}(s_{ee}, P_e, \lambda_e, \lambda_L) - \sigma_{ee}(s_{ee}, P_e, \lambda_e, -\lambda_L)}{\sigma_{ee}(s_{ee}, P_e, \lambda_e, \lambda_L) + \sigma_{ee}(s_{ee}, P_e, \lambda_e, -\lambda_L)}. \tag{11}$$

3 Numerical Results

In the following numerical analysis we study the total cross section $\sigma_{ee}^{(L/R)}$ and the polarization asymmetries A_{P_e} and A_{λ_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 $M_1 = M_2 \cdot \frac{5}{3}\tan^2\theta_W$.

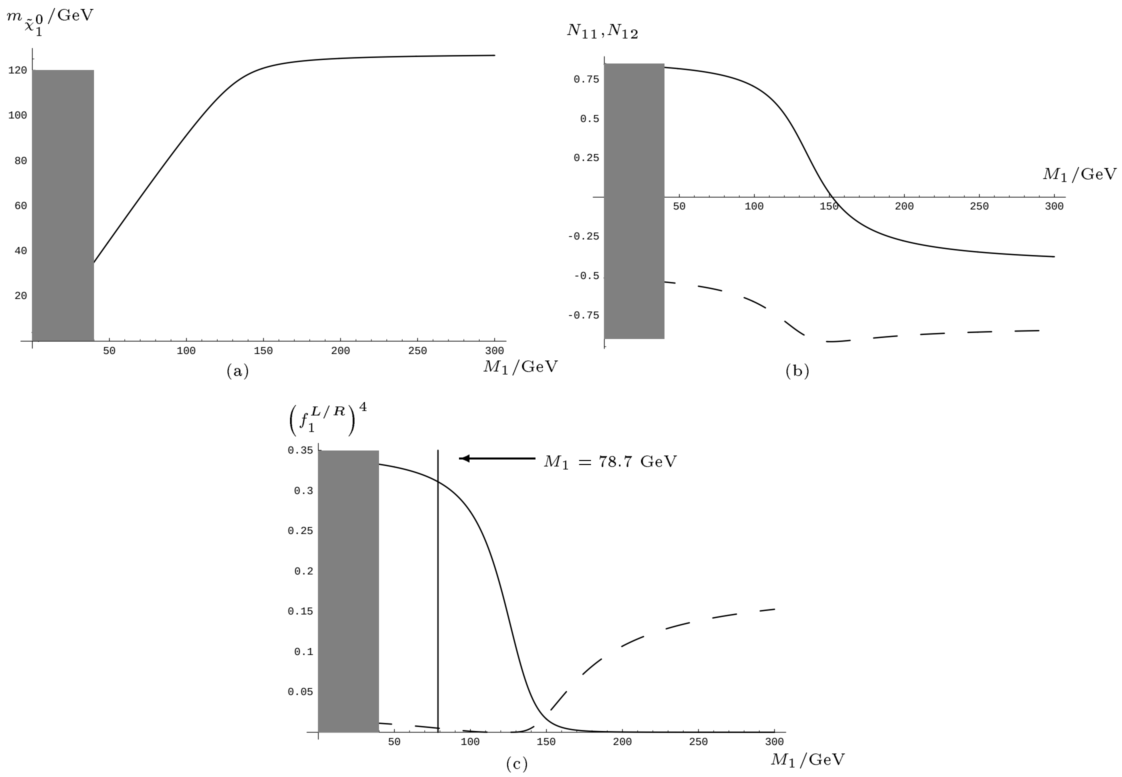


Figure 1: (a) M_1-dependence of the LSP mass $m_{\tilde{\chi}_1^0}$; (b) M_1-dependence of the photino component N_{11} (solid line) and of the zino component N_{12} (dashed line) of the LSP; (c) M_1-dependence of the couplings $\left(f_{e1}^R\right)^4$ (solid line) and $\left(f_{e1}^L\right)^4$ (dashed 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 $f_{e1}^{L/R}$ 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 $\int \mathcal{L} = 100$ 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_{e1} dominates whereas for $M_1 > 150$ GeV that of the left selectron f^L_{e1} 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 $f^{L/R}_{e1}$ 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.

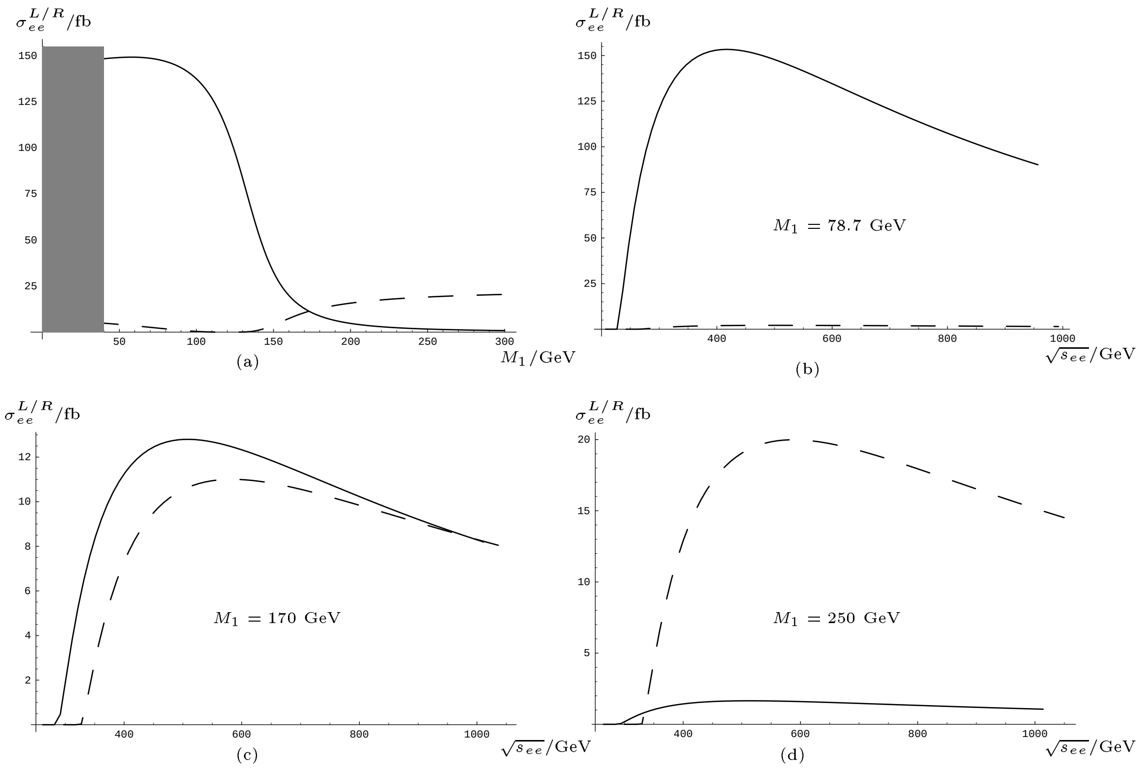


Figure 2: Total cross sections σ^R_{ee} (solid lines) and σ^L_{ee} (dashed lines) for $m_{\tilde{e}_R} = 137.7$ GeV, $m_{\tilde{e}_L} = 179.3$ GeV and unpolarized electron and photon beams ($P_e = \lambda_e = \lambda_L = 0$); (a) M_1-dependence of $\sigma^{L/R}_{ee}$ for $\sqrt{s_{ee}} = 500$ GeV; Energy dependence of $\sigma^{L/R}_{ee}$ for (b) $M_1 = 78.7$ GeV, (c) $M_1 = 170$ GeV and (d) $M_1 = 250$ GeV.

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 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 σ^R_{ee} with M_1. If we assume that a cross section $\sigma^R_{ee} = 100$ 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 λ_L and on λ_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 σ_{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_{λ_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.

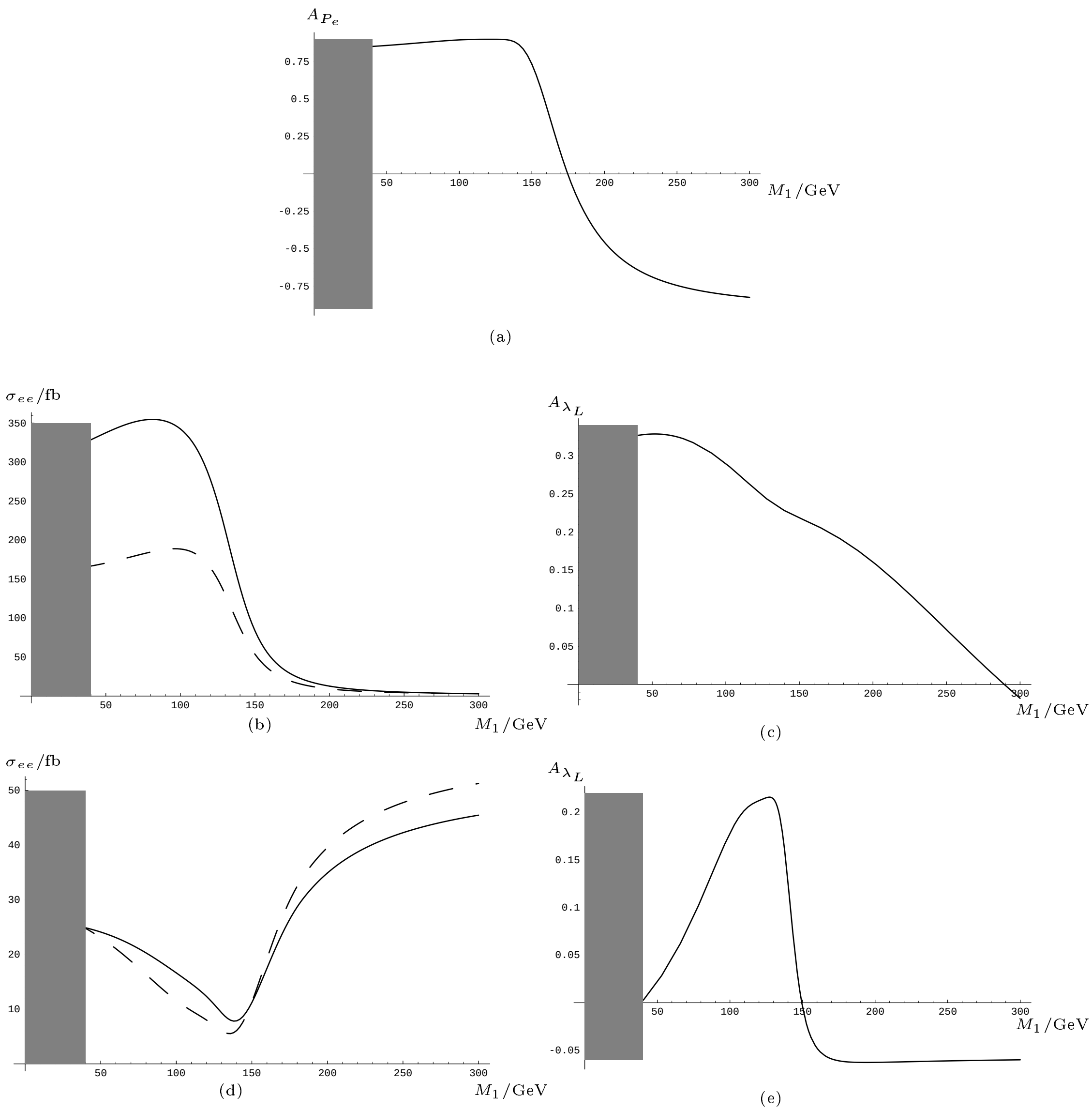
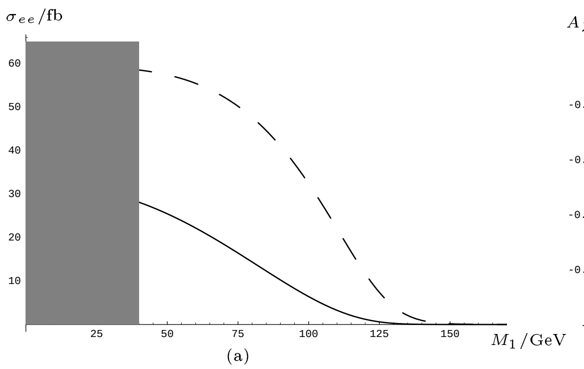


Figure 3: Total cross section $\sigma_{ee} = \sigma_{ee}^L + \sigma_{ee}^R$ and polarization asymmetries for $m_{\tilde{e}_R} = 137.7$ GeV and $m_{\tilde{e}_L} = 179.3$ GeV; (a) M_1-dependence of the asymmetry A_{P_e} for $P_e = \pm 0.9$ and $\lambda_e = \lambda_L = 0$; (b) M_1-dependence of σ_{ee} for $P_e = 0.9$, $\lambda_e = 1$, $\lambda_L = +1$ (solid line) and for $P_e = 0.9$, $\lambda_e = 1$, $\lambda_L = -1$ (dashed line); (c) M_1-dependence of the asymmetry A_{λ_L} for $P_e = 0.9$, $\lambda_e = +1$ and $\lambda_L = \pm 1$; (d) M_1-dependence of σ_{ee} for $P_e = -0.9$, $\lambda_e = -1$, $\lambda_L = +1$ (solid line) and for $P_e = -0.9$, $\lambda_e = -1$, $\lambda_L = -1$ (dashed line); (e) M_1-dependence of the asymmetry A_{λ_L} for $P_e = -0.9$, $\lambda_e = -1$ and $\lambda_L = \pm 1$.

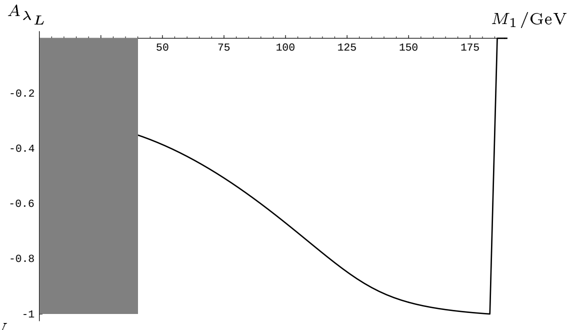
The cross section σ_{ee} and the asymmetry A_{λ_L} are depicted in fig. 3d, e for the polarization configuration $P_e = -0.9$ and $\lambda_e = -1$. For $\lambda_L = -1$ the total cross section has ambiguities in the region 40 GeV $< M_1 <$ 167 GeV and for $\lambda_L = +1$ in the region 40 GeV $< M_1 <$ 173 GeV. For $M_1 >$ 173 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 $\sigma_{ee} = 35$ fb $\pm 5\%$ is compatible with M_1 between 193 GeV and 209 GeV. For this polarization configuration the asymmetry A_{λ_L} (fig. 3e) grows practically linearly between $M_1 = 40$ GeV and $M_1 = 126$ GeV and is very sensitive on M_1 but shows ambiguities between $M_1 = 40$ GeV and $M_1 = 150$ GeV . If we assume that an asymmetry $A_{\lambda_L} = 0.15 \pm 5\%$ 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 $M_1 > 170$ GeV the asymmetry is nearly constant $A_{\lambda_L} \sim -0.07$.

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



(a)



(b)

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

We choose as a second example higher selectron masses $m_{\tilde{e}_L} = 350.0$ GeV and $m_{\tilde{e}_R} = 330.5$ GeV corresponding to $m_0 = 320$ GeV. Then for $\sqrt{s_{ee}} = 500$ GeV selectron pair production in e^+e^- annihilation is forbidden, whereas single selectron production in $e^-\gamma \longrightarrow \tilde{\chi}_1^0 \tilde{e}_{L/R}^-$ is still possible, provided that $\sqrt{s_{e\gamma}} > m_{\tilde{e}_{L/R}^-} + m_{\tilde{\chi}_1^0}$ where $\sqrt{s_{e\gamma}} \sim 0.91 \cdot \sqrt{s_{ee}}$ 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 GeV ($m_{\tilde{\chi}_1^0} <$ 124.6 GeV). In fig. 4a,b we show the total cross section and the asymmetry A_{λ_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 GeV $< M_1 <$ 115 GeV. For $M_1 >$ 115 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 GeV $< M_1 <$ 135 GeV. If we assume for example that a cross section $\sigma_{ee} = 45$ fb $\pm$ 5% has been measured this is compatible with M_1 between 80 GeV and 88 GeV. Also the polarization asymmetry A_{λ_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_{λ_L} can be helpful for determining M_1 in the greatest part (40 GeV $< M_1 <$ 135 GeV) of the kinematical accessible region $M_1 <$ 184 GeV.

4 Conclusion

We have demonstrated that associated selectron - LSP production with subsequent leptonic decay of the selectron $e^-\gamma \longrightarrow \tilde{\chi}_1^0 \tilde{e}^-_{L/R} \longrightarrow e^- \tilde{\chi}_1^0 \tilde{\chi}_1^0$ at a $\sqrt{s_{ee}} = 500$ 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 σ_{ee} and the polarization asymmetries A_{P_e} and A_{λ_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

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