$\gamma\gamma$ Collider

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(1)

The case

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$$\gamma\gamma \longrightarrow \gamma\gamma$$
$$\gamma\gamma \longrightarrow \gamma Z$$

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Old VMD $\Rightarrow$ The dominant amplitudes at high energies helicity conserving, mainly imaginary — Pomeron dominance

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Modern Picture

quarks, leptons, W

$s_{\gamma\gamma} > (250\,\mathrm{GeV})^2$; $F_{\lambda_1\lambda_2\lambda_3\lambda_4}(s,t,u) = \langle \lambda_3\lambda_4 | T | \lambda_1\lambda_2 \rangle$

1) Dominant amplitudes $\Rightarrow$
$F_{++++}(s,t,u)$, $F_{+-+-}(s,t,u) = F_{+--+}(s,u,t)$
(and their parity partners). Predominantly Imaginary
(All other amplitudes) $\lesssim \frac{1}{10}$ (Dominant amplitudes)

2)
W >> quarks, leptons
for the dominant amplitudes

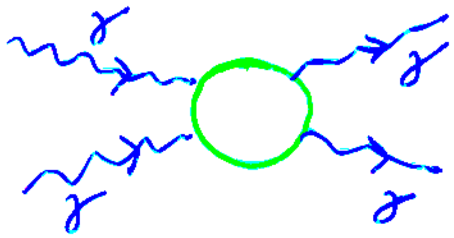
$$\boxed{\begin{array}{l}\gamma\gamma \to \gamma\gamma \\ \gamma\gamma \to \gamma Z\end{array}} \quad \text{at} \quad s_{\gamma\gamma} > (250\ \mathrm{GeV})^2$$

* It is intriguing that

W-loop for these processes behaves exactly as expected from

VMD + Pomeron.

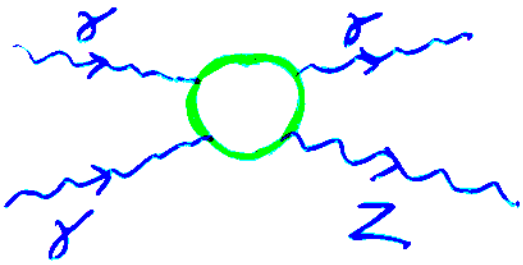
** Use them for searching for SUSY and other NP



It depends only on

Q_χ , M_χ

chargino search



It depends only

Q_{χ^+} , M_χ , $g_V^{\chi^+}$

*** Correspondingly for sleptons results depend only on

$Q_{\tilde{\ell}}$, $M_{\tilde{\ell}}$, $t_3^{(\tilde{\ell})}$

$$\frac{d\sigma}{dz\,d\cos\Theta^*} = \frac{d\bar{L}_{\gamma\gamma}}{dz}\Bigg\{ \frac{d\bar{\sigma}_0}{d\cos\Theta^*} + \langle \xi_2\,\xi_2' \rangle \frac{d\bar{\sigma}_{22}}{d\cos\Theta^*} +$$

$$\langle \xi_3 \rangle \cos(2\phi)\,\frac{d\bar{\sigma}_3}{d\cos\Theta^*} + \langle \xi_3' \rangle \cos(2\phi')\,\frac{d\bar{\sigma}_3'}{d\cos\Theta^*} +$$

$$\langle \xi_3\,\xi_3' \rangle \left[\cos(2(\phi+\phi'))\,\frac{d\bar{\sigma}_{33}}{d\cos\Theta^*} + \cos(2(\phi-\phi'))\,\frac{d\bar{\sigma}_{33}'}{d\cos\Theta^*}\right]$$

$$\langle \xi_2\,\xi_3' \rangle \sin(2\phi')\,\frac{d\bar{\sigma}_{23}}{d\cos\Theta^*} - \langle \xi_3\,\xi_2' \rangle \sin(2\phi)\,\frac{d\bar{\sigma}_{23}'}{d\cos\Theta^*} \Bigg\}$$

$$\bar{\sigma}_0 \Rightarrow \sum_{\lambda_3\lambda_4} \left\{ |F_{++\lambda_3\lambda_4}|^2 + |F_{+-\lambda_3\lambda_4}|^2 \right\} \sim |F_{++++}|^2 + |F_{+-+-}|^2$$

$$\bar{\sigma}_{22} \Rightarrow \sum_{\lambda_3\lambda_4} \left\{ |F_{++\lambda_3\lambda_4}|^2 - |F_{+-\lambda_3\lambda_4}|^2 \right\} \sim |F_{++++}|^2 - |F_{+-+-}|^2$$

$$\bar{\sigma}_3 \Rightarrow -\sum_{\lambda_3\lambda_4} \mathrm{Re}\left[F_{++\lambda_3\lambda_4} F^*_{-+\lambda_3\lambda_4} \right] \sim$$

$$\bar{\sigma}_3' \Rightarrow -\sum_{\lambda_3\lambda_4} \mathrm{Re}\left[F_{++\lambda_3\lambda_4} F^*_{+-\lambda_3\lambda_4} \right]$$

$$\bar{\sigma}_{33} \Rightarrow \sum_{\lambda_3\lambda_4} \mathrm{Re}\left[F_{+-\lambda_3\lambda_4} F^*_{-+\lambda_3\lambda_4} \right] \sim 2\,\mathrm{Re}\left\{ F_{+-+-} F^*_{+--+} \right\}$$

similar for γZ

$$\bar{\sigma}_{33}' \Rightarrow \sum_{\lambda_3\lambda_4} \mathrm{Re}\left[F_{++\lambda_3\lambda_4} F^*_{--\lambda_3\lambda_4} \right]$$

$$\bar{\sigma}_{23} \Rightarrow \sum_{\lambda_3\lambda_4} \mathrm{Im}\left[F_{++\lambda_3\lambda_4} F^*_{+-\lambda_3\lambda_4} \right]$$

$$\bar{\sigma}_{23}' \Rightarrow \sum_{\lambda_3\lambda_4} \mathrm{Im}\left[F_{++\lambda_3\lambda_4} F^*_{-+\lambda_3\lambda_4} \right]$$

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$\gamma\gamma \to \gamma\gamma$

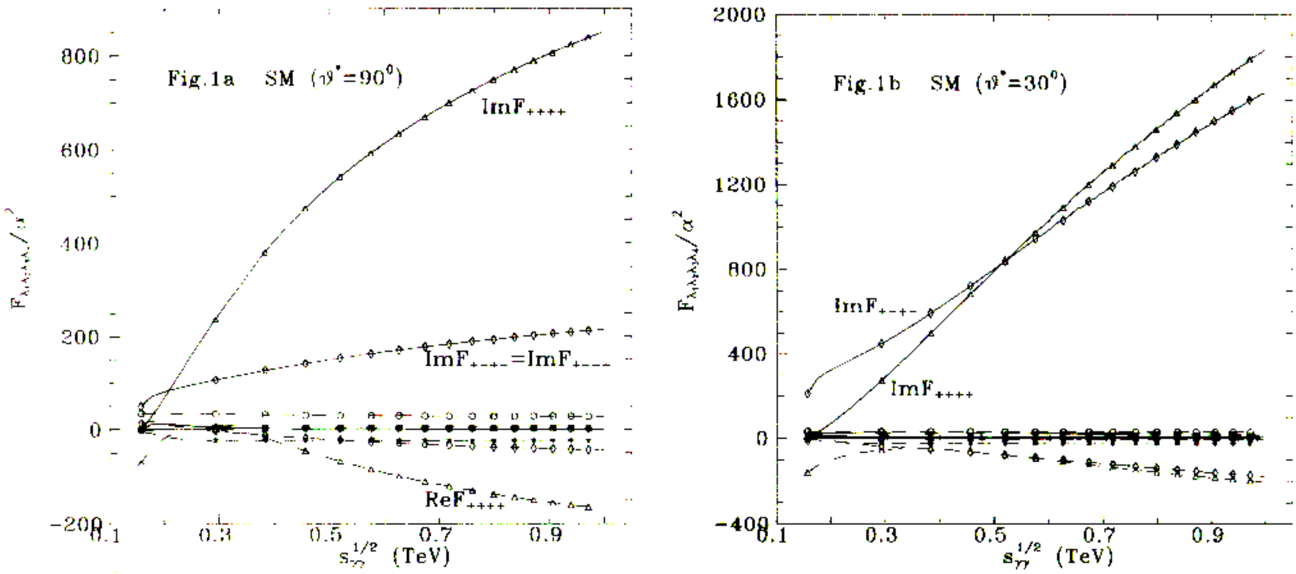
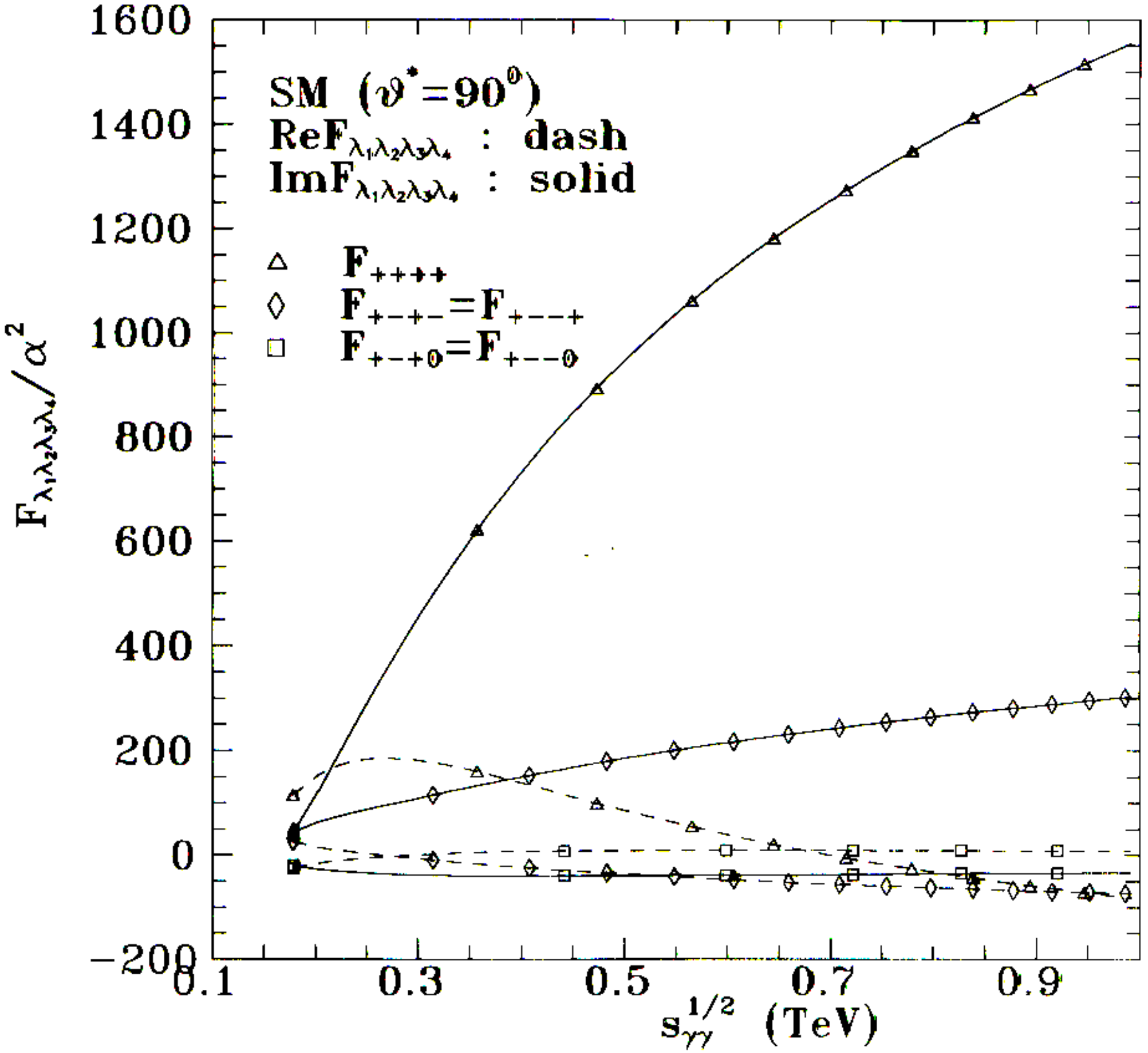


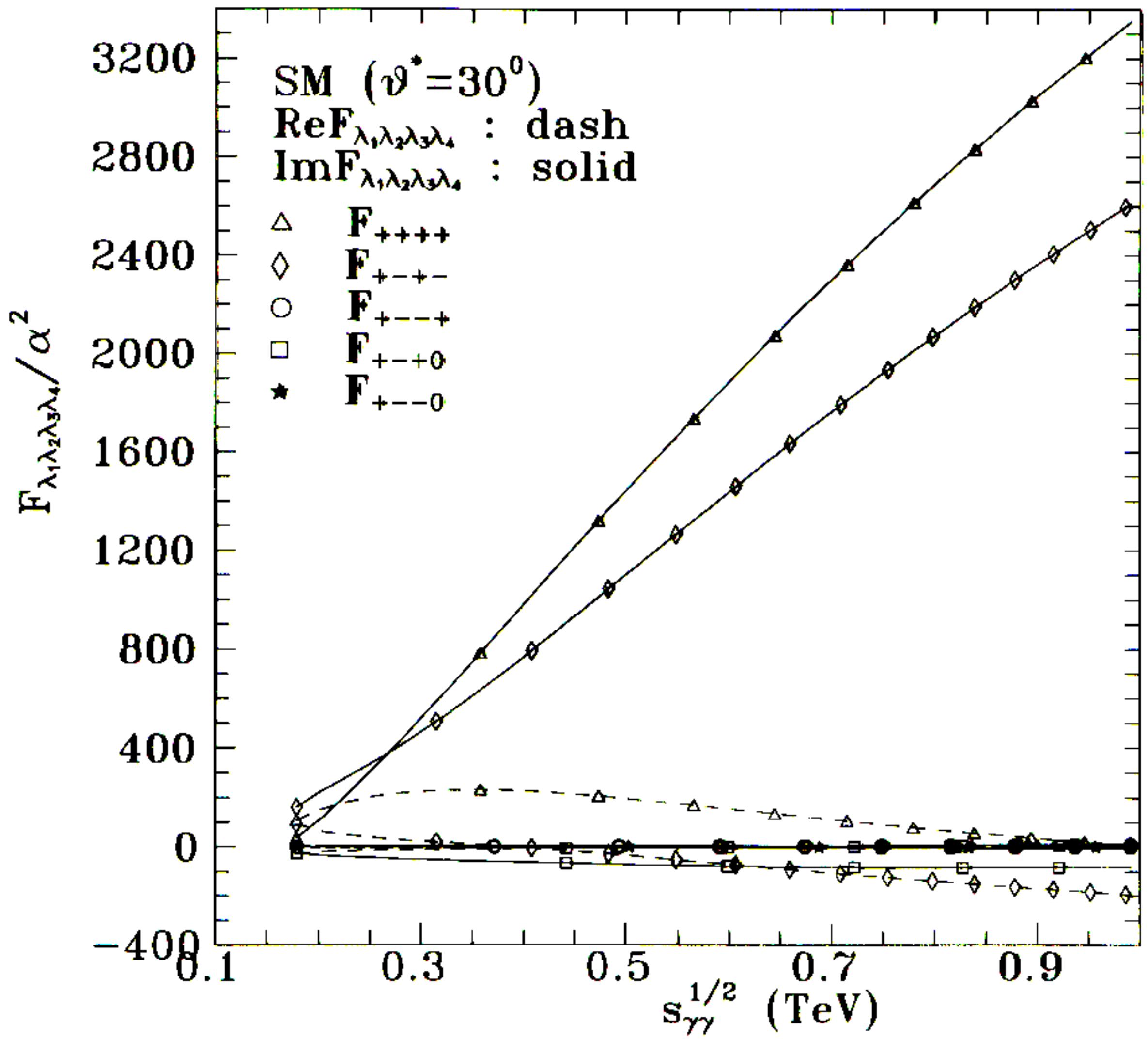
Figure 1: Imaginary (solid line) and real (dashed line) parts of the SM $\gamma\gamma \to \gamma\gamma$ helicity amplitudes at $\vartheta = 90^0$ (1a) and $\vartheta = 30^0$ (1b) for F_{++++} (triangles), F_{+++-} (circles), F_{+---} (stars), F_{+} [illegible] (rhombs). Finally F_{+-++} (crosses) is omitted in the (1a) case, since it is identical to F_{+-+-} at $\vartheta = 90^0$, while in the (1b) case it is negligibly small. We also note that $F_{++-+}(\hat{s},\hat{t},\hat{u}) = F_{+-++}(\hat{s},\hat{t},\hat{u}) = F_{+---}(\hat{s},\hat{t},\hat{u}) = F_{+++-}(\hat{s},\hat{t},\hat{u})$.

$\gamma\gamma \to \gamma Z$



(4)

$\gamma\gamma \to \gamma Z$



(a)

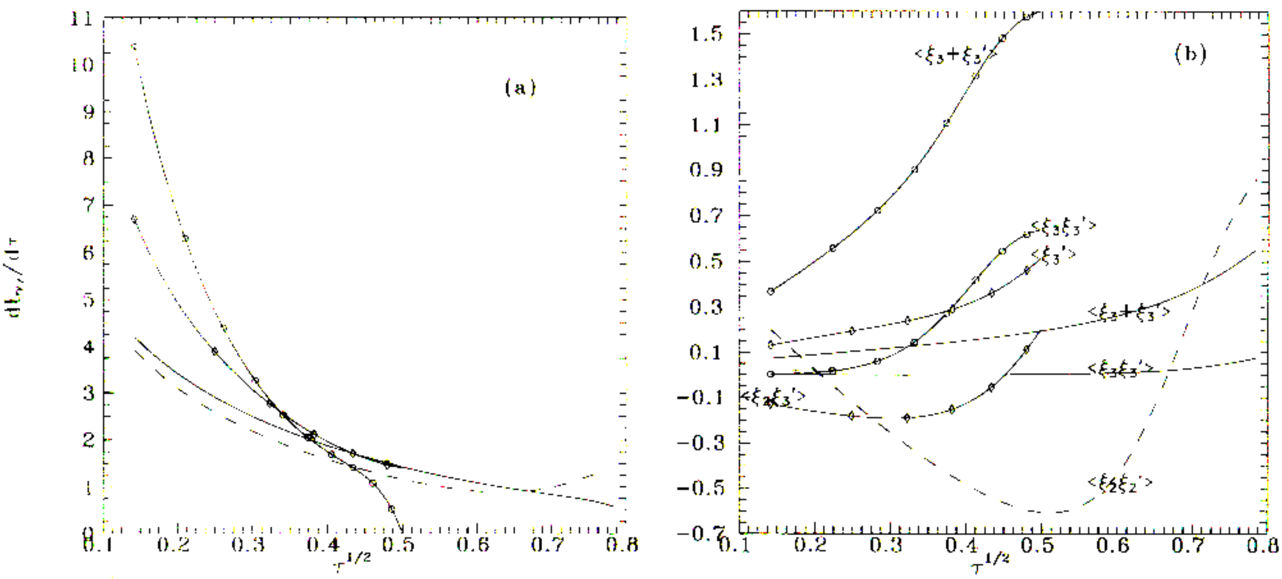


Figure 4: Overall flux factor (a) and elements of the normalized density matrix (b), for the two backscattered photons with $P_e = P_e' = 0.8$, $P_\gamma = P_\gamma' = -1$, $P_t = P_t' = 0$, $x_0 = x_0' = 4.83$, (dash); $P_e = P_e' = P_\gamma = P_\gamma' = 0$, $P_t = P_t' = 1$, and $x_0 = x_0' = 4.83$ (solid) or $x_0 = x_0' = 1$ (circles); $P_e = 0.8$, $P_\gamma = -1$, $P_t = 0$ $x_0 = 4.83$, $P_e' = 0$, $P_\gamma' = 0$, $P_t' = 1$ $x_0' = 1$, (rhombs).

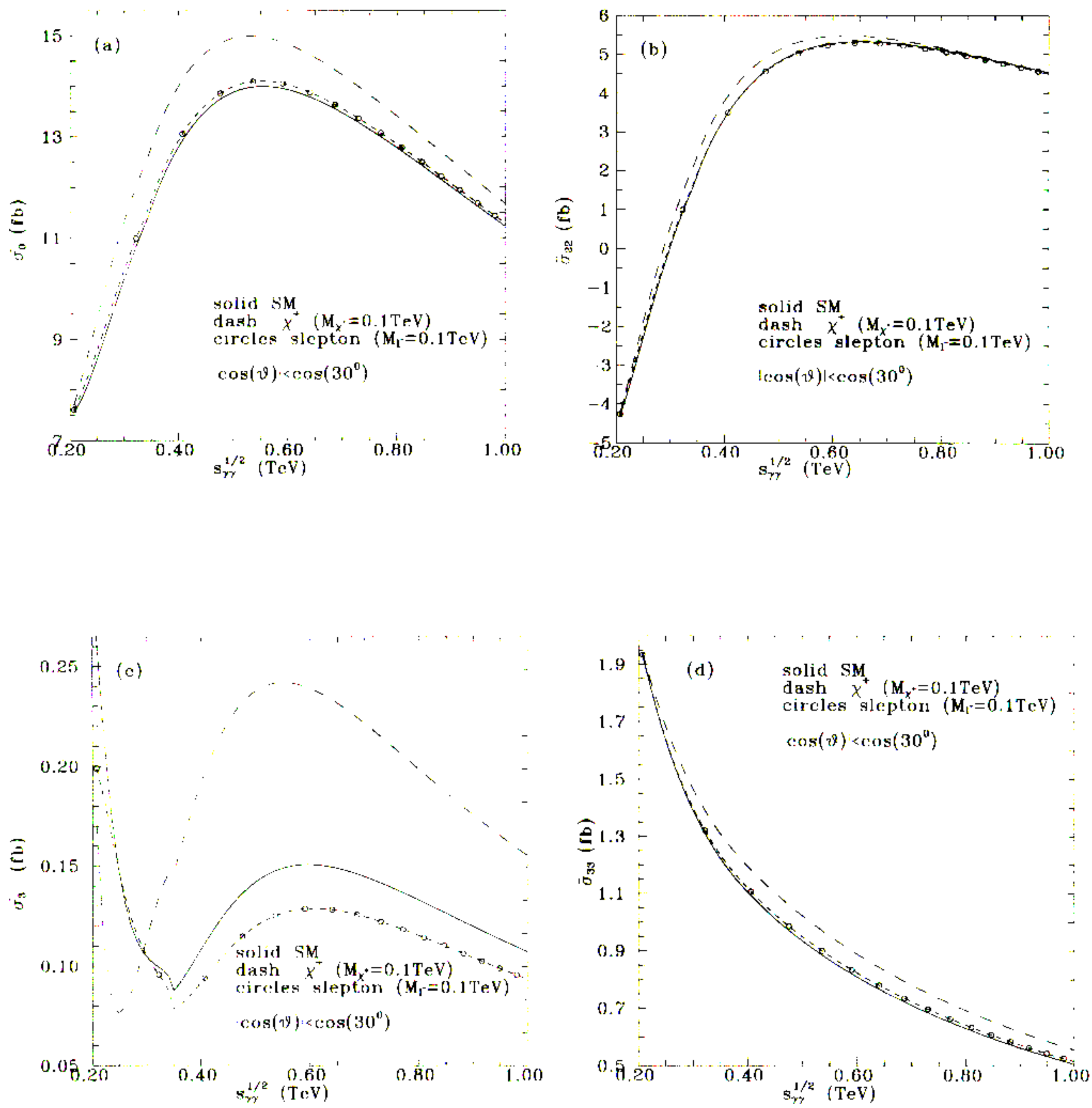


Figure 2: σ_0, σ_{22}, σ_3 and σ_{33} for SM (solid) and in the presence of a chargino (dash) or a charged slepton (circles) contribution.

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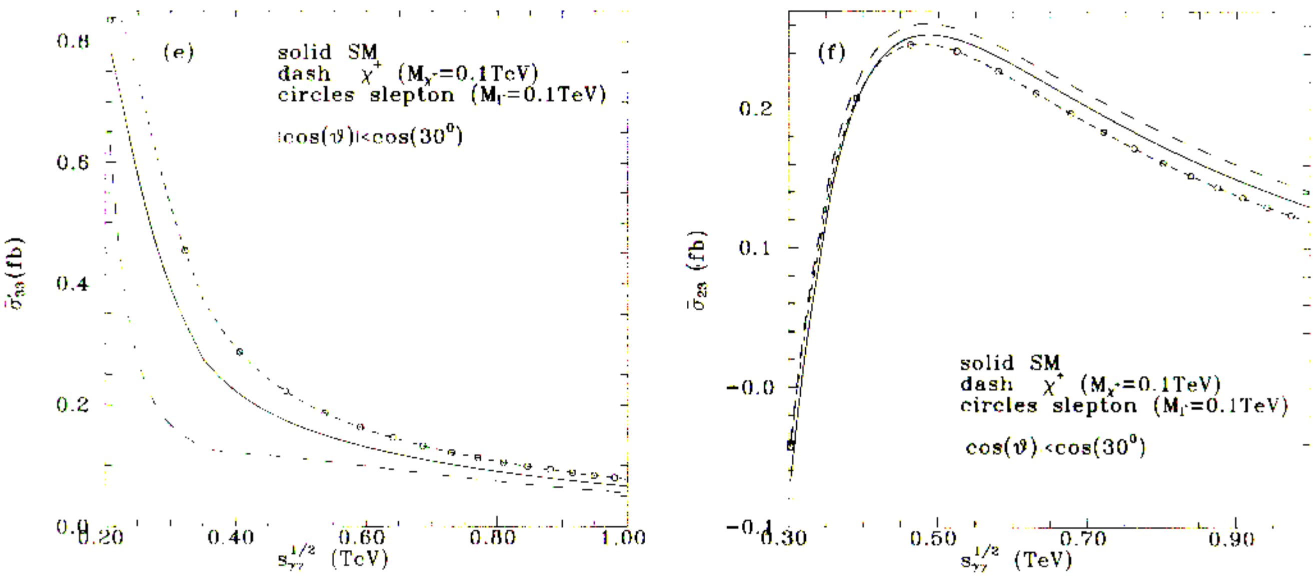
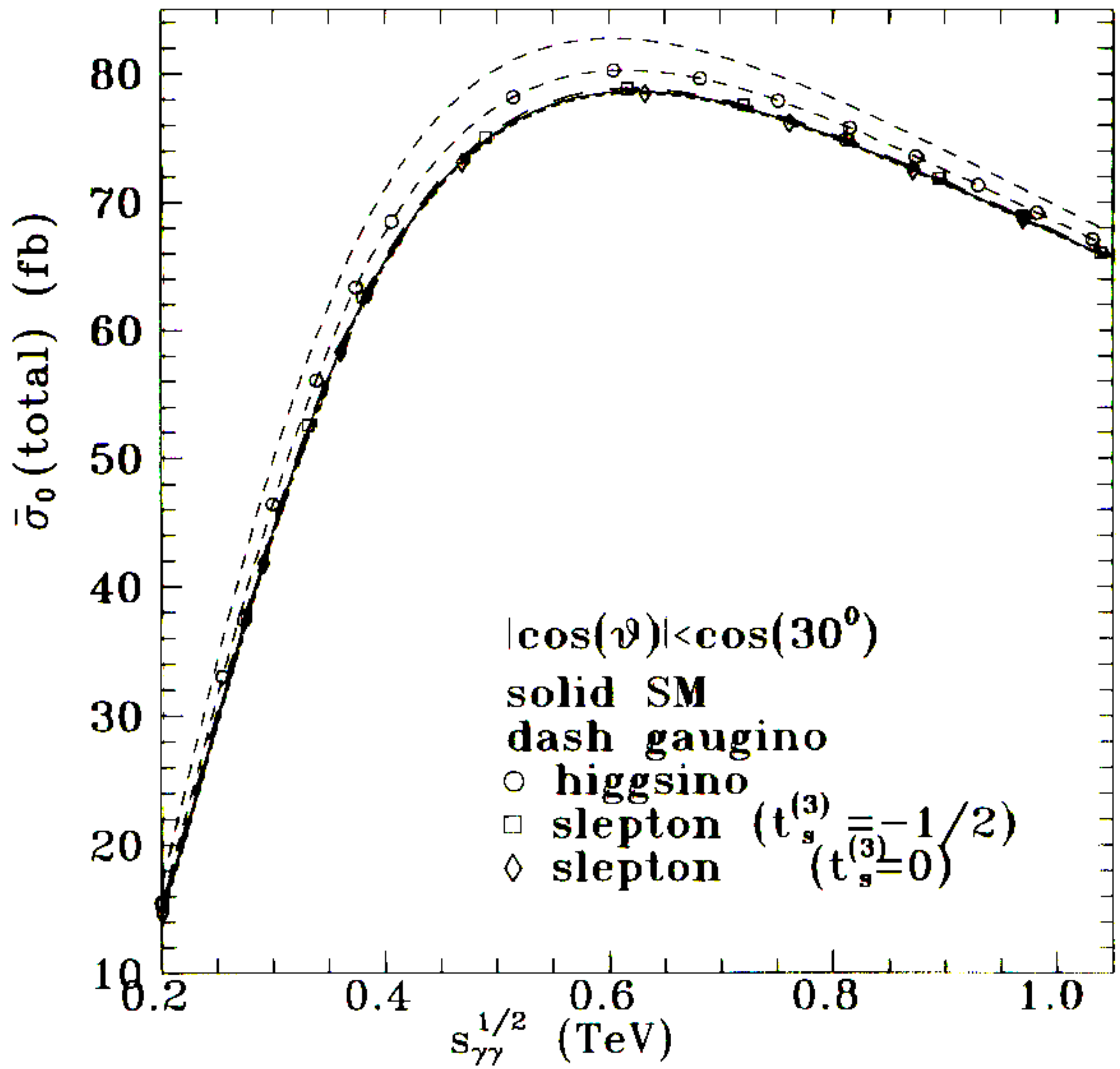


Figure 2: $\bar{\sigma}'_{33}$ and $\bar{\sigma}_{23}$ for SM (solid) and in the presence of a chargino (dash) or a charged slepton (circles) contribution.

$\gamma\gamma \to \gamma Z$ (preliminary)



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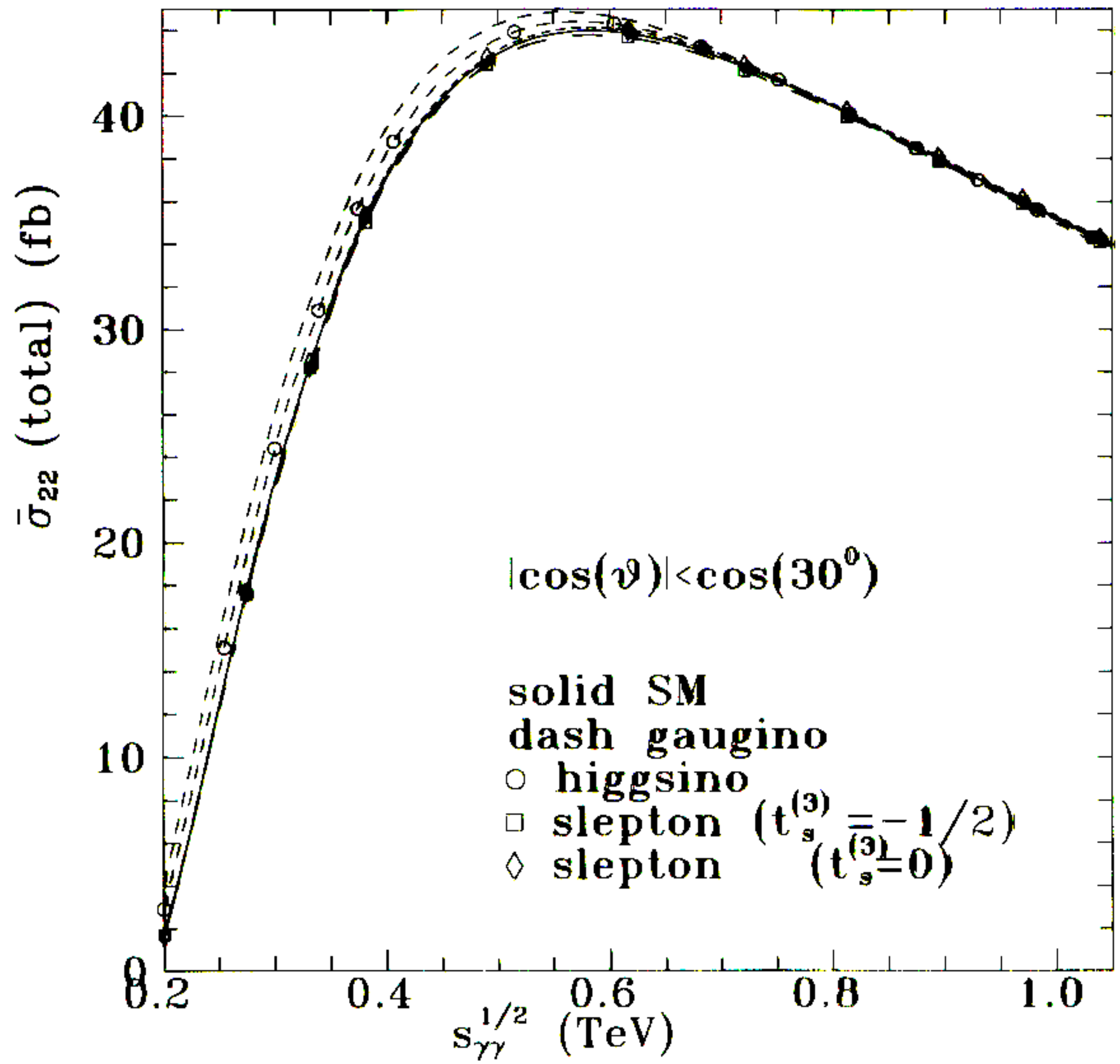
$\gamma\gamma \to \gamma Z$ (preliminary)



Conclusion

1) Chargino effects in
$\vec{\sigma}_0(\gamma\gamma \to \gamma\gamma)$

If only $\gamma\gamma \to \gamma\gamma$ is used

3 – 4 SD $\longleftrightarrow$ $M_{\chi^+} = 100$ GeV

1 SD $\longleftrightarrow$ $M_\chi \simeq 250$ GeV

2) Effect stronger for
$\gamma\gamma \to \gamma Z$

3) Combine them finally

If more SUSY particles exist their effect to $\vec{\sigma}_0$ allways ~~cum~~ cummulative (positive)

for both $\gamma\gamma \to \gamma\gamma$
$\gamma\gamma \to \gamma Z$