Anomaly mediated SUSY breaking and its test in Linear Colliders

Sourov Roy
Technion, Israel

Based on :

1. D.K. Ghosh, A. Kundu, P. Roy, SR,
PR D64, 115001 (2001)

2. D.K. Ghosh, P. Roy, SR, JHEP 08, 031 (2000)

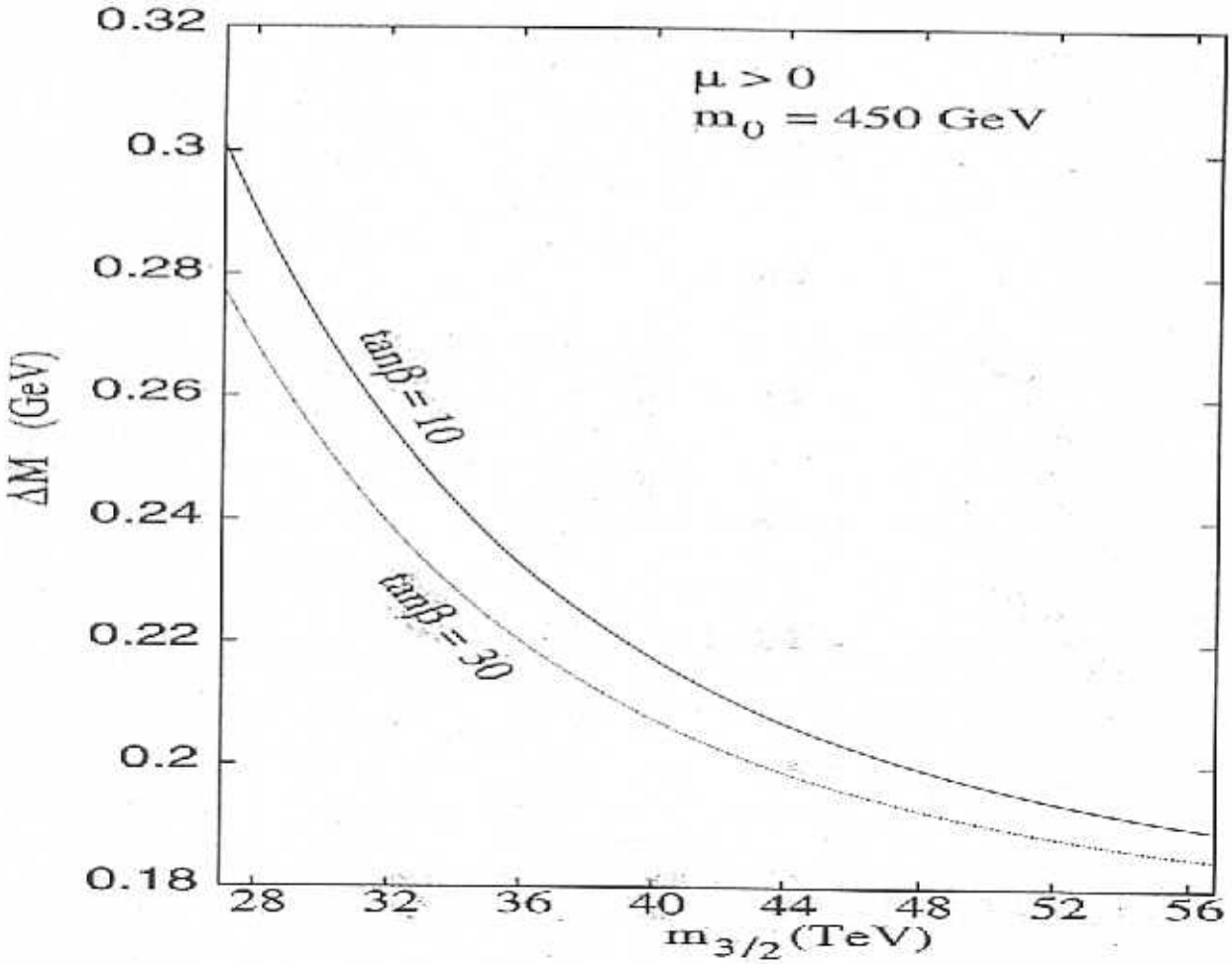
3. D. Choudhury, D.K. Ghosh, SR,
hep-ph/0208240

Characteristic features

- Gaugino mass parameters

$$M_1 : M_2 : M_3 :: 2.8 : 1 : 7.1$$

- $\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_1^0$ almost exclusively Wino
  masses of $\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_1^0$ very close
- $165\ \text{MeV} \lesssim \Delta M(\tilde{\chi}_1^{\pm} - \tilde{\chi}_1^0) \lesssim 500\ \text{MeV}$
- $\tilde{\chi}_2^0$ almost a Bino
- $\tilde{\chi}_1^{\pm}$ decays slowly and should show heavily ionizing charged track
- $\tilde{\chi}_1^{\pm} \longrightarrow \tilde{\chi}_1^0 + \text{soft } \pi^{\pm}$
  (dominant decay mode)
- $m_{\tilde{e}_L} \approx m_{\tilde{e}_R}$
- $m_{\tilde{q}} >> m_{\tilde{l}}$
- model parameters ($m_{3/2}$, m_0, $\tan\beta$, $\text{sgn}(\mu$


μ > 0
m0 = 450 GeV
tanβ = 10
tanβ = 30
ΔM (GeV)
m3/2 (TeV)
0.32
0.3
0.28
0.26
0.24
0.22
0.2
0.18
28
32
36
40
44
48
52
56

AMSB signals at an e^+e^- Linear Collider at $\sqrt{s} = 1$ TeV

AMSB sparticle spectrum

- spectrum A : $\tilde{\chi}_1^0 (\approx \tilde{\chi}_1^\pm) < \tilde{\nu} < \tilde{e}_R (\approx \tilde{e}_L) < \tilde{\chi}_2^0$
- spectrum B : $\tilde{\chi}_1^0 (\approx \tilde{\chi}_1^\pm) < \tilde{\chi}_2^0 < \tilde{\nu} < \tilde{e}_R (\approx \tilde{e}_L)$

Consider pair production processes

$e^+e^- \to \tilde{e}_L\tilde{e}_L, \tilde{e}_R\tilde{e}_R, \tilde{e}_L\tilde{e}_R, \tilde{\nu}\tilde{\nu}, \tilde{\chi}_1^0\tilde{\chi}_2^0, \tilde{\chi}_2^0\tilde{\chi}_2^0$

Signals analyzed comprise

multiple fast charged leptons (trigger)

+ displaced vertices x_D (heavily ionizing tracks)

and/or soft pions with characteristic momentum distribution + $\not{E}$

Example : $\tilde{e}_L$-$\tilde{e}_L$ pair production

$\tilde{e}_L \to e + \tilde{\chi}_1^0$, $\tilde{e}_L \to \nu + \tilde{\chi}_1^\pm$, $\tilde{\chi}_1^\pm \to \tilde{\chi}_1^0 + \pi^\pm$

fast $e^\pm$, heavily ionizing track and/or visible soft $\pi^\pm$ + $\not{E}$

[Ghosh, P. Roy, S.R (2000)]

$c\tau$ of $\tilde{\chi}_1^\pm$ > 3 cm could be observable

$c\tau < 3$ cm track may not be seen.

Spectrum	Signals	Parent Channels
A	$e\pi + \not{E}$	$\tilde{\nu}\tilde{\nu}$, $\tilde{e}_L\tilde{e}_L$, $\tilde{e}_L\tilde{e}_R$, $\tilde{\chi}_1^0\tilde{\chi}_2^0$, $\tilde{\chi}_2^0\tilde{\chi}_2^0$
	$\mu\pi + \not{E}$	$\tilde{\nu}\tilde{\nu}$, $\tilde{\chi}_1^0\tilde{\chi}_2^0$, $\tilde{\chi}_2^\pm\tilde{\chi}_2^0$
	$ee\,l\,\pi + \not{E}$	$\tilde{e}_R\tilde{e}_R$, $\tilde{e}_L\tilde{e}_R$, $\tilde{\chi}_1^0\tilde{\chi}_2^0$, $\tilde{\chi}_2^0\tilde{\chi}_2^0$
	$\mu\mu\,l\,\pi + \not{E}$	$\tilde{\chi}_1^0\tilde{\chi}_2^0$, $\tilde{\chi}_2^0\tilde{\chi}_2^0$
	$l_1 l_4\, l_2 l_2 l_3\, \pi + \not{E}$	$\tilde{\chi}_2^0\tilde{\chi}_2^0$
B	$e\pi + \not{E}$	$\tilde{\nu}\tilde{\nu}$, $\tilde{e}_L\tilde{e}_L$, $\tilde{e}_L\tilde{e}_R$, $\tilde{\chi}_1^0\tilde{\chi}_2^0$, $\tilde{\chi}_2^0\tilde{\chi}_2^0$
	$\mu\pi + \not{E}$	$\tilde{\nu}\tilde{\nu}$, $\tilde{e}_L\tilde{e}_L$, $\tilde{\chi}_1^0\tilde{\chi}_2^0$, $\tilde{\chi}_2^0\tilde{\chi}_2^0$
	$e\,l_1 l_2\,\pi + \not{E}$	$\tilde{e}_L\tilde{e}_R$, $\tilde{e}_R\tilde{e}_R$, $\tilde{e}_L\tilde{e}_L$, $\tilde{\nu}\tilde{\nu}$, $\tilde{\chi}_2^0\tilde{\chi}_2^0$
	$\mu\mu\mu\,\pi + \not{E}$	$\tilde{\chi}_2^0\tilde{\chi}_2^0$, $\tilde{\nu}\tilde{\nu}$
	$ee\,l_1 l_1\, l_2\,\pi + \not{E}$	$\tilde{e}_L\tilde{e}_L$, $\tilde{e}_R\tilde{e}_R$, $\tilde{e}_L\tilde{e}_R$

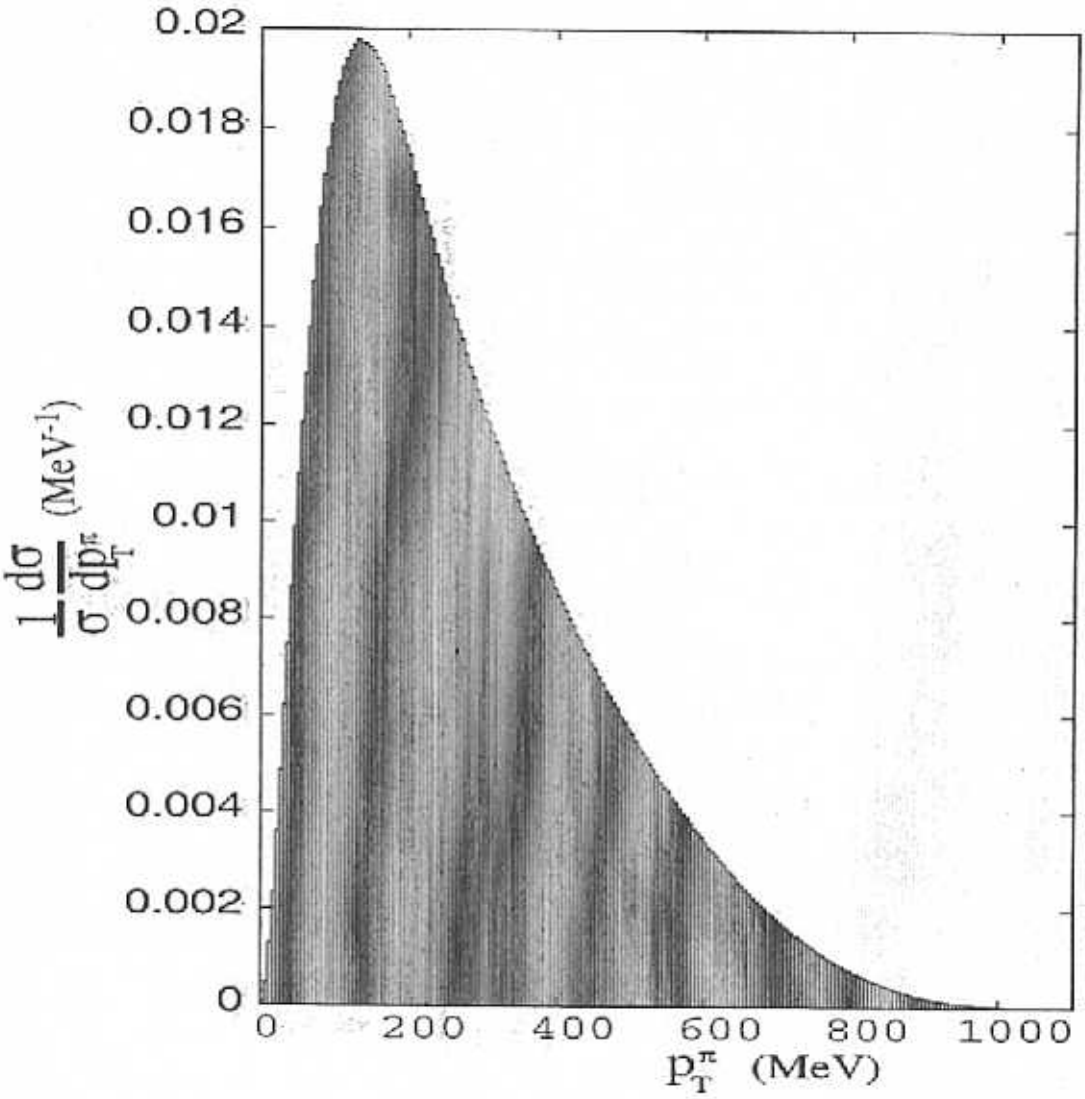
[D.K. Ghosh, A. Kundu, P. Roy, S.R. (2001)]

One can also look at two soft pions and two charged leptons.

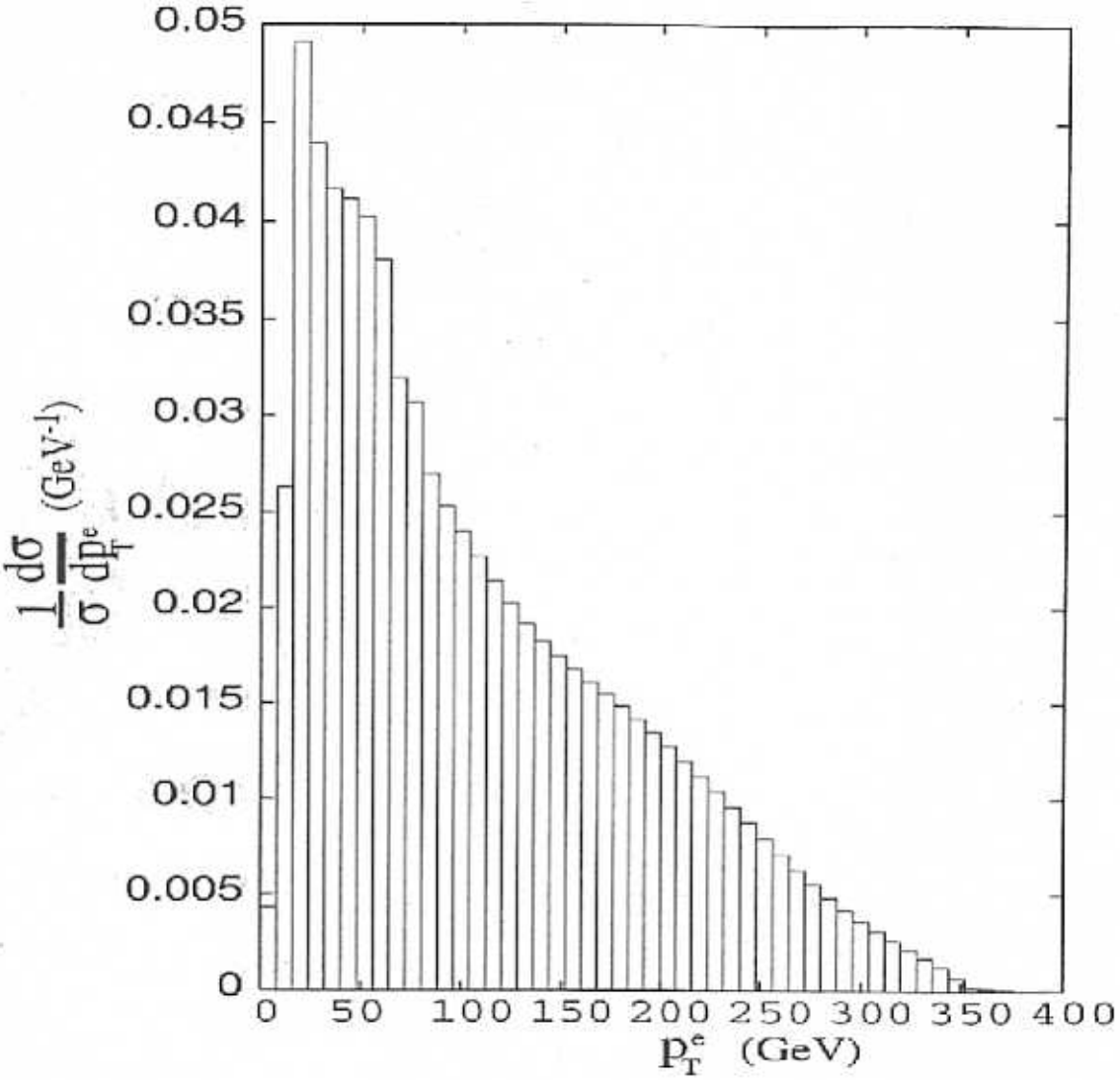
The process $e^+e^- \to \tilde{\chi}_1^+\tilde{\chi}_1^-\gamma$ has also been studied [A. Datta, S. Maity (2001)]

Spectrum	Parameter set	m_0 (GeV)	$m_{3/2}$ (TeV)	tanβ
A	1	340	44	10
	2	450	47	30
B	1	330	32	10
	2	510	47	30

Spectrum	Signal	Cross section (fb)	No. of events with $L = 100\ fb^{-1}$
A	$e\pi + \not{E}$	79.8	7980
		26.3	2630
	$ee\mu\pi + \not{E}$	2.01	201
		0.008	—
	$ee\pi\pi + \not{E}$	35.16	3516
		14.48	1448
B	$e\pi + \not{E}$	108.41	10841
		5.82	582
	$ee\mu\pi + \not{E}$	0.68	68
		0.066	6
	$ee\pi\pi + \not{E}$	63.81	6381
		4.23	423



Distribution of the p_T of charged pion



Distribution of the p_T of charged lepton

AMSB signal in an $e^-\gamma$ collider

consider the process

$$e^-\gamma \rightarrow \tilde{\nu}\,\tilde{\chi}_1^-$$

$$\tilde{\nu} \rightarrow e^- + \tilde{\chi}_1^+ \,, \quad \tilde{\chi}_1^\pm \rightarrow \tilde{\chi}_1^0 + \pi^\pm$$

signal :

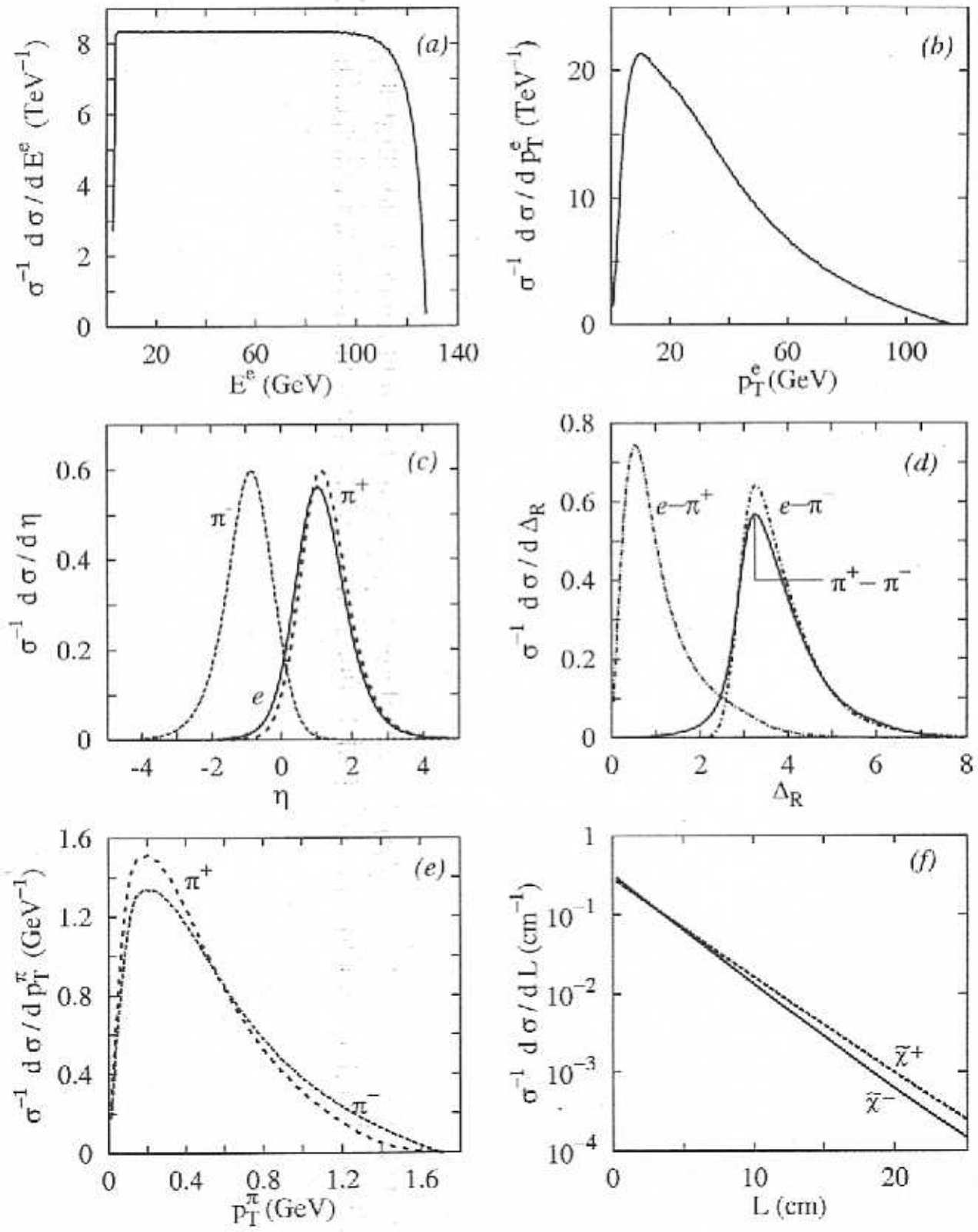
a fast e^- trigger

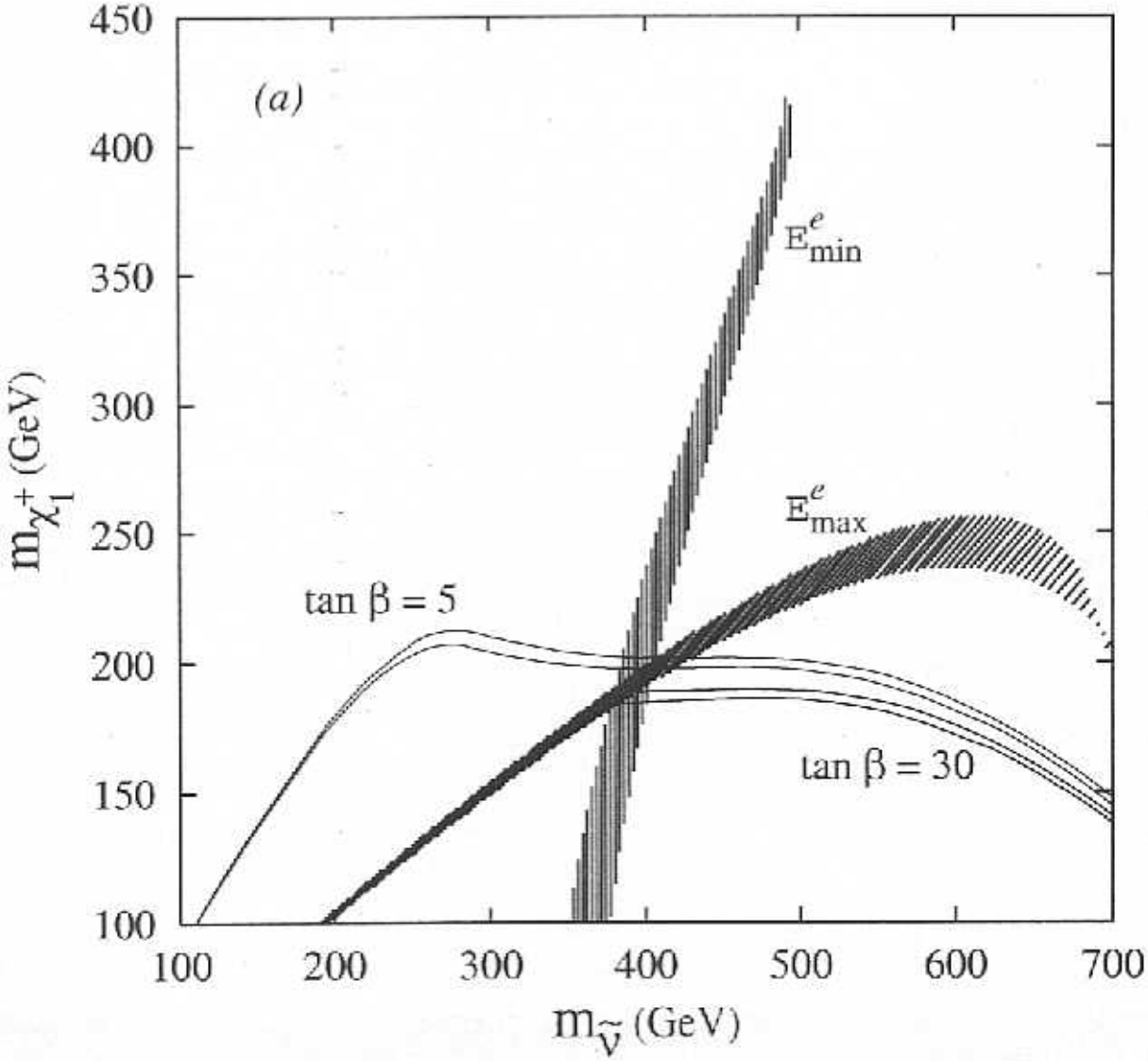
+ two heavily ionizing charged tracks and/or two $\pi^\pm$ (soft) with opposite charges + $\not{p}_T$

[D. choudhury, D.K.Ghosh, S.R., hep-ph/0208240]

selection Criteria

- $p_T^e > 20$ GeV
- $p_T^\pi > 0.2$ GeV
- $E^\pi < 2$ GeV
- $|\eta^{e,\pi}| < 2.5$
- $\Delta R \equiv \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2} > 0.4$
- $\not{p}_T > 20$ GeV


(a)
$\sigma^{-1}\, d\sigma / dE^e$ (TeV^{-1})
E^e (GeV)
(b)
$\sigma^{-1}\, d\sigma / dp_T^e$ (TeV^{-1})
p_T^e (GeV)
(c)
$\sigma^{-1}\, d\sigma / d\eta$
π^-
π^+
e
η
(d)
$\sigma^{-1}\, d\sigma / d\Delta_R$
$e-\pi^+$
$e-\pi^-$
$\pi^+ - \pi^-$
Δ_R
(e)
$\sigma^{-1}\, d\sigma / dp_T^\pi$ (GeV^{-1})
π^+
π^-
p_T^π (GeV)
(f)
$\sigma^{-1}\, d\sigma / dL$ (cm^{-1})
$\tilde{\chi}^+$
$\tilde{\chi}^-$
L (cm)


(a)
E^e_{min}
E^e_{max}
tan β = 5
tan β = 30
$m_{\chi_1^+}$ (GeV)
$m_{\tilde{\nu}}$ (GeV)
450
400
350
300
250
200
150
100
100
200
300
400
500
600
700

Conclusions

1. AMSB is an interesting way to generate gaugino and scalar masses

2. Many interesting collider signatures

3. Resolved soft pion + $\not{E}$ + lepton trigger an exciting linear collider possibility