SLEPTON MASSES AND SEESAW SCALES

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Target : Precision ILC/LHC experiments : Reconstruction of fundamental theory near Planck scale

ν masses in seesaw : ... high intermediate scales

Scenario : seesaw scales $\sim M_{\nu R}$ couple in evolution of scalar masses prop Yukawa coupling :

– deactivated in generation 1 and 2 : regularities
universality

– activated in generation 3 : determining M_{R_3}

$\Leftarrow$ worked out for L/R extended mSUGRA in SPS1a$'$

SLEPTON MASSES IN SPS1a′

– Charged sleptons : scanning thresholds in $e^{\pm}e^{-}$

$$\delta m_{\tilde{e}_{R/L}} = 50/180 \text{ MeV}$$

– Sneutrinos : decay channel 100% $\tilde{\nu} \to \nu \tilde{\chi}_1^0$ invisible

Sparticle	Mass m [GeV]	Width Γ [GeV]	Decay modes	
$\tilde{\nu}_l = \tilde{\nu}_e/\tilde{\nu}_\mu$	169.6	0.09	$\tilde{\nu}_l \to \nu_l\, \tilde{\chi}_1^0$	100%
$\tilde{\nu}_\tau$	167.8	0.15	$\tilde{\nu}_\tau \to \nu_\tau\, \tilde{\chi}_1^0$	100%
$\tilde{\tau}_1$	105.7	0.0037	$\tilde{\tau}_1 \to \tau\, \tilde{\chi}_1^0$	100%
$\tilde{\chi}_1^0$	100.8	—	—	
$\tilde{\chi}_1^{\pm}$	180.5	0.074	$\tilde{\chi}_1^+ \to \tilde{\tau}_1^+\, \nu_\tau$	53%
			$\to \tilde{\nu}_e\, e^+$	13%
			$\to \tilde{\nu}_\mu\, \mu^+$	13%
			$\to \tilde{\nu}_\tau\, \tau^+$	19%

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$$\tilde{\chi}_1^- \to \tilde{\nu}_\ell \ell^-$$

Production channel : $e^+e^- \to \tilde{\chi}_1^+ \tilde{\chi}_1^- \to \tilde{\nu}_\mu \tilde{\nu}_e \mu^+ e^- \to \mu^+ e^- \not{E}$

$$\to \tilde{\nu}_\mu \tilde{\nu}_\tau \mu^+ \tau^- \to \mu^+ \tau^- \not{E}$$

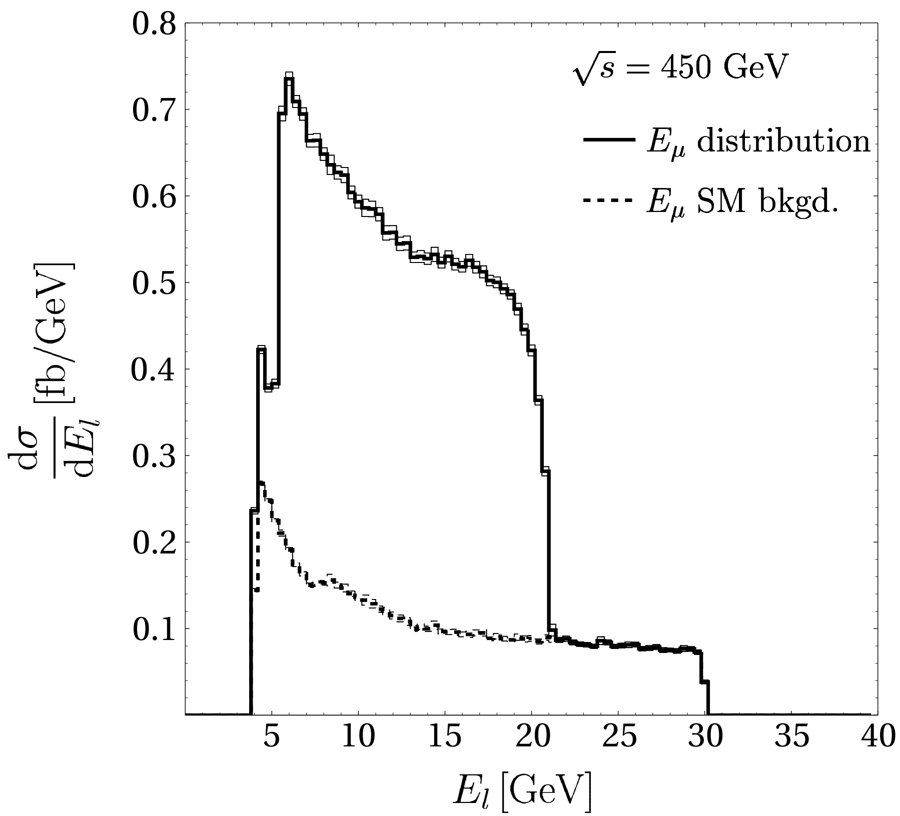
$$m_{\tilde{\nu}_\ell} = m_{\tilde{\chi}_1^\pm} \sqrt{1 - 2(E_{max} + E_{min})/\sqrt{s}}$$

Angle/energy cuts reduce SM/SUSY backgrounds : $e^+e^- \to W^+W^- \to \mu^+\tau^- \not{E}$ etc

$$e^+e^- \to \tilde{\tau}^+\tilde{\tau}^- \to \tau^+\tau^- \not{E} \to \mu^+\tau^- \not{E} \text{ etc}$$

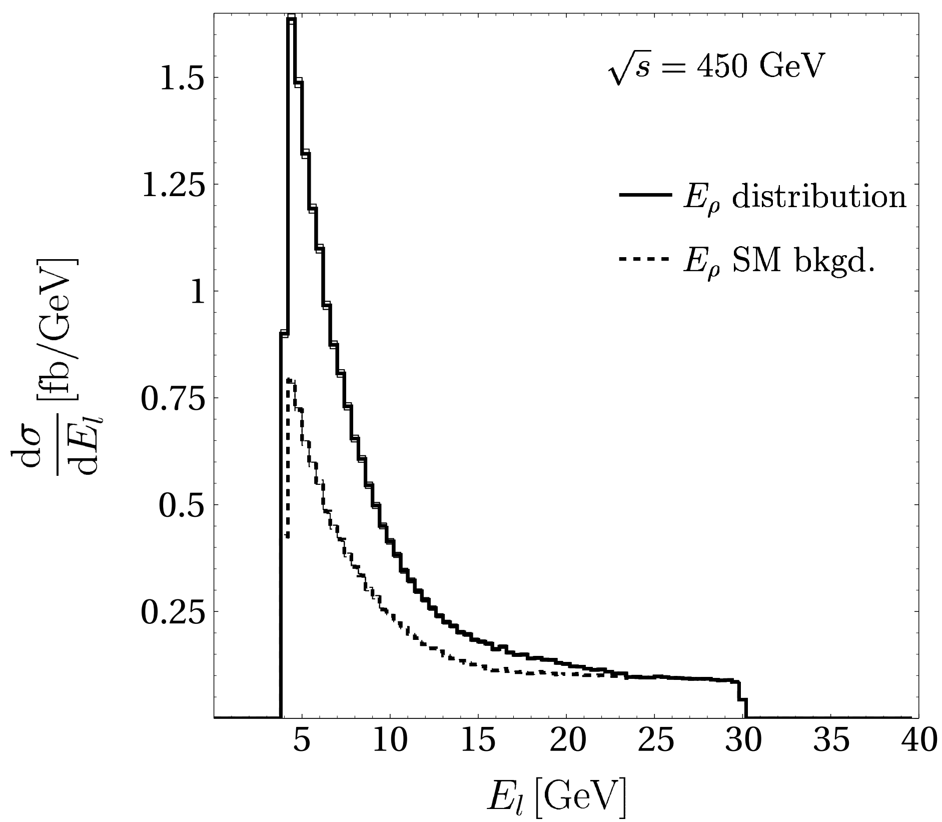
RESULTS

1: μe PAIRING



$$m_{\tilde{\nu}_\mu} = 169.6 \pm 0.4 \text{ GeV}$$

2: $\mu\tau[\rho]$ PAIRING



$$m_{\tilde{\nu}_\tau} = 167.8^{+0.9}_{-0.8} \text{ GeV}$$

SEESAW SCALE

min SO(10) model : universal scalar masses m_{16} at GUT scale

Yukawa cplgs ∼ fermion mass matrices : $up \sim \nu \sim \nu_R$

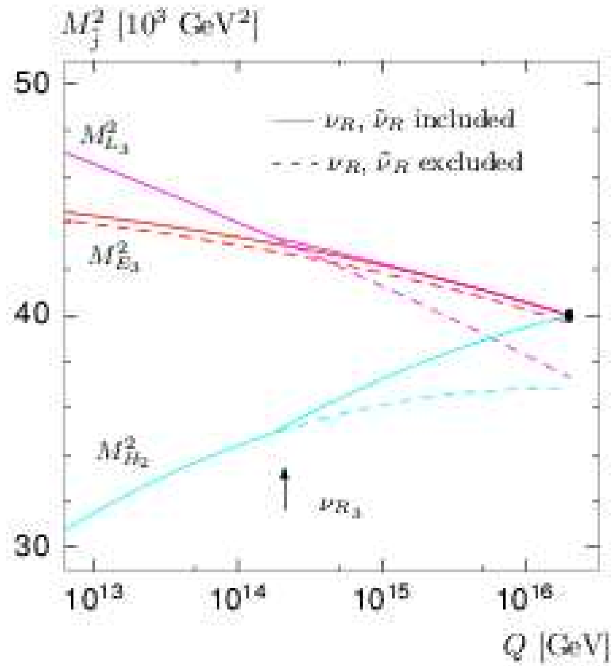
seesaw mechanism : $M_{R_j} = m^2_{u_j} / m_{\nu_j}$

⇒ standard RG evolution for slepton generation 1 and 2

RG for gen. 3 : $[\nu_L \tilde{H}]$ loop : Δ_τ

$[\nu_R \tilde{H}]$ loop : Δ_{ν_τ}

⇒ break above M_{ν_R}



mass differences: $m^2_{\tilde{\tau}_R} - m^2_{\tilde{e}_R} = -2\Delta_\tau + m^2_\tau$

$m^2_{\tilde{\tau}_L} - m^2_{\tilde{e}_L} = -\Delta_\tau - \Delta_{\nu_\tau} + m^2_\tau$

$m^2_{\tilde{\nu}_\tau L} - m^2_{\tilde{\nu}_e L} = -\Delta_\tau - \Delta_{\nu_\tau}$

sum rule: $\Delta_{\nu_\tau}[M_{R_3}] = \frac{1}{2}[(3m^2_{\tilde{\nu}_e L} - m^2_{\tilde{e}_L} - m^2_{\tilde{e}_R}) - (3m^2_{\tilde{\nu}_\tau L} - m^2_{\tilde{\tau}_1} - m^2_{\tilde{\tau}_2}) - 2m^2_\tau]$

evolution: $\Delta_{\nu_\tau}[M_{R_3}] \simeq \frac{Y_\nu^2}{16\pi^2}\left(3m^2_{16} + A_0^2\right)\log\frac{M^2_{GUT}}{M^2_{R_3}}$

seesaw: $Y_\nu^2 = m_{\nu_3} M_{R_3}/(v \sin\beta)^2$

Solution for SPS1a$'$:

$M_{R_3} = 3.7$ to $6.9 \cdot 10^{14}$ GeV

vs $id = 6 \cdot 10^{14}$ GeV

SENSIT INTERMED SCALE