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Neutrino masses in R-parity violating SUSY

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Nowadays it is well established that neutrinos have non-zero masses and mixing angles. Among the different proposals to include them in present models, the seesaw mechanism is the most popular choice. However, the high seesaw scale makes hard, if not impossible, to test it directly. On the other hand, supersymmetric models with R-parity violation are a very predictive alternative that can be easily tested at present and future colliders. In this poster I discuss the phenomenology of a model in which R-parity is spontaneously broken at the electroweak scale, generating neutrino masses and giving rise to distinctive signatures, both at the LHC and at low-energy experiments.

Based on: M. Hirsch, W. Porod and A. Vicente, PRD 77 (2008) 075005, arXiv:0802.2896
M. Hirsch, J. Meyer, W. Porod and A. Vicente, PRD 79 (2009) 055023, arXiv:0902.0525

Introduction

Oscillation experiments have measured neutrino parameters with great accuracy.

Parameter	Best fit	2σ	3σ
Δm^2_{21} $(10^{-5}\,\mathrm{eV}^2)$	$7.65^{+0.23}_{-0.20}$	7.25–8.11	7.05–8.34
$\lvert\Delta m^2_{31}\rvert$ $(10^{-3}\,\mathrm{eV}^2)$	$2.40^{+0.12}_{-0.11}$	2.18–2.64	2.07–2.75
$\sin^2\theta_{12}$	$0.304^{+0.022}_{-0.016}$	0.27–0.35	0.25–0.37
$\sin^2\theta_{23}$	$0.50^{+0.07}_{-0.06}$	0.39–0.63	0.36–0.67
$\sin^2\theta_{13}$	$0.01^{+0.016}_{-0.011}$	$\leqslant 0.040$	$\leqslant 0.056$

Taken from Schwetz et al, New J. Phys. 10 (2008) 113011 [arXiv:0808.2016v2]

Present models need to be enlarged in order to include a mechanism to explain this data.

The model

Extension of the MSSM proposed in A. Masiero and J.W.F. Valle, PLB 251 (1990) 273.

Particle content and superpotential

			$\hat{\nu}^c$	$\hat{S}$	$\hat{\Phi}$
MSSM	+	L:	-1	+1	0
			SU(2) singlets		

$$\mathcal{W} = h_U^{ij}\hat{Q}_i\hat{U}_j\hat{H}_u + h_D^{ij}\hat{Q}_i\hat{D}_j\hat{H}_d + h_E^{ij}\hat{L}_i\hat{E}_j\hat{H}_d + h_\nu^{i}\hat{L}_i\hat{\nu}^c\hat{H}_u - h_0\hat{H}_d\hat{H}_u\hat{\Phi} + h\hat{\Phi}\hat{\nu}^c\hat{S} + \frac{\lambda}{3!}\hat{\Phi}^3$$

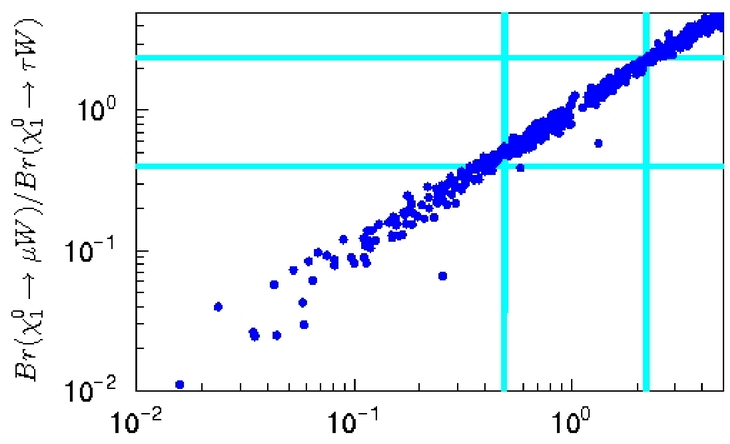
Spontaneous R-parity violation

$$\langle\tilde{\nu}^c\rangle = \frac{v_R}{\sqrt{2}} \quad \Rightarrow \quad h_\nu^i\hat{L}_i\hat{\nu}^c\hat{H}_u \rightarrow \epsilon_i\hat{L}_i\hat{H}_u \qquad \epsilon_i = h_\nu^i\frac{v_R}{\sqrt{2}}$$

Lepton number (and Rp) is spontaneously broken, leading to neutrino masses and LSP decay.

LSP decays and neutrino mixing angles

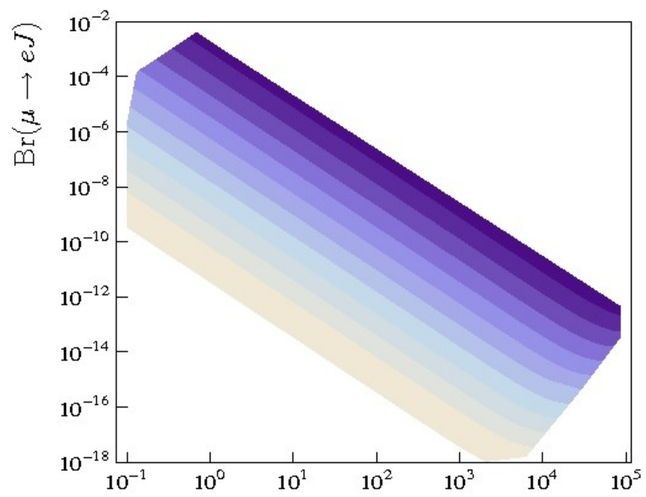
LPS decays and neutrino masses have a common origin and thus there is a link between them. In particular, it is found that some ratios of LSP BR's are correlated with neutrino mixing angles.



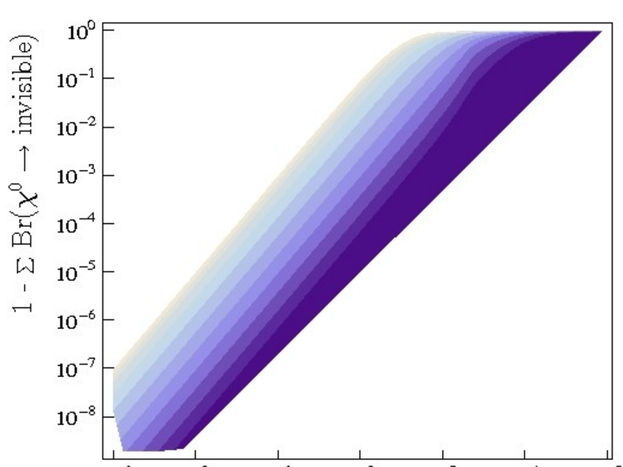
The model gives definite predictions for collider observables.

The majoron

The breaking of Rp implies the existence of a Goldstone boson, the Majoron (J), which strongly affects the phenomenology.



Exotic muon decays



Invisible neutralino decays

In conclusion, R-parity violation is a predictive framework to explain the origin of neutrino mass in the context of supersymmetric theories.

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