Constraints on New Physics from BaBar

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Outline

- R-Parity Violating SUSY.
- B Meson Decays.
- Tau Decays.
- Summary.

R-Parity Violating SUSY

R-parity Violating SUSY has superpotential of the following form

$$W_{\not R} = \frac{1}{2}\lambda_{ijk}\hat{L}\hat{L}\hat{E} + \lambda'_{ijk}\hat{L}\hat{Q}\hat{D} + \frac{1}{2}\lambda''_{ijk}\hat{U}\hat{D}\hat{D}$$

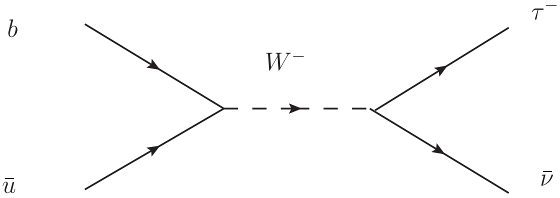
from this we can get the Lagrangian

$$\begin{aligned}
\mathcal{L}_{LQD} &= \lambda'_{ijk}[(\tilde{\nu}_{iL}\bar{d}_{kR}d_{jL} + \tilde{d}_{jL}\bar{d}_{kR}\nu_{iL} + \tilde{d}^*_{kR}\bar{\nu}^*_{iL}d_{jL}) \\
&\quad -(\tilde{e}_{iL}\bar{d}_{kR}u_{jL} + \tilde{u}_{jL}\bar{d}_{dR}e_{iL} + \tilde{d}^*_{kR}\bar{e}^c_{iL}u_{jL})] \\
\mathcal{L}_{LLE} &= \lambda_i jk(\tilde{\nu}_{iL}\bar{e}_{kR}e_{jL} + \tilde{e}_{jL}\bar{e}_{kR}\nu_{iL} + \tilde{e}^*_{kR}\bar{\nu}^c_{iL}e_{jL})
\end{aligned}$$

B Meson Decays

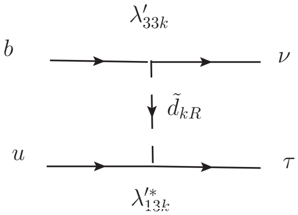
Including the new Babar data, the world average of B meson branching fraction is

$$\mathcal{B}(B \to \tau\bar{\nu}) = (1.51 \pm 0.33) \times 10^{-4}$$



B Meson Decays

$$(i\lambda'_{33k})(\tilde{d}^*_{kR}\bar{\nu}^c_{iL}d_{jL})(-i\lambda'^*_{31k})(\tilde{d}_{kR}\bar{u}_{1L}e^c_{3L})$$



$$M_{\tilde{d}_K} > \sqrt{\lambda'_{33k}\lambda'^*_{31k} + \lambda'^*_{33k}\lambda'_{31k}} \times 242\text{GeV}$$

$$M_{\tilde{d}_K} > \sqrt{\lambda'_{33k}\lambda'^*_{31k} + \lambda'^*_{33k}\lambda'_{31k}} \times 202\text{GeV}$$

Tau Decays

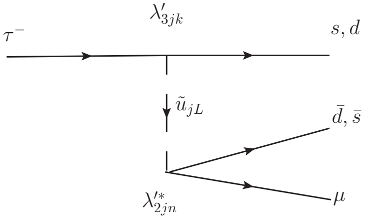
BaBar also measured the branching fractions for τ decay into μ and e respectively

$$\begin{aligned} \mathcal{B}(\tau \to \mu\nu) &< 4.0 \times 10^{-8} \\ \mathcal{B}(\tau \to e\nu) &< 3.3 \times 10^{-8} \end{aligned}$$

Tau Decays

Squark exchange

$$(-i\lambda'_{3jk})(\tilde{u}_{jL}\bar{d}_{kR}e_{3L})(-i\lambda'^{*}_{2jn})(\tilde{u}_{jL^*}\bar{e}_{2L}d_{nR})$$

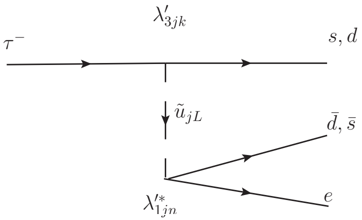


$$\Rightarrow M_{\tilde{u}_{jL}} > \sqrt{|\lambda'_{3jk}||\lambda'_{2jn}|} \times 5.3\mathrm{TeV}$$

Tau Decays

Squark exchange

$$(-i\lambda'_{3jk})(\tilde{u}_{jL}\bar{d}_{kR}e_{3L})(-i\lambda'^{*}_{1jn})(\tilde{u}_{jL^*}\bar{e}_{1L}d_{nR})$$

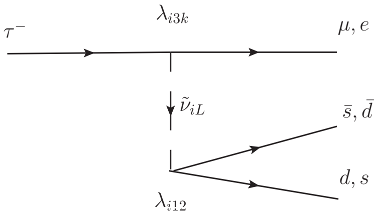


$$\Rightarrow M_{\tilde{u}_{jL}} \quad > \quad \sqrt{|\lambda'_{3jk}||\lambda'_{1jn}|} \times 5.6\mathrm{TeV}$$

Tau Decays

Sneutrino exchange

$$(i\lambda_{i3k})(\tilde{\nu}_{iL}\bar{e}_{kR}e_{3L})(i\lambda'^{*}_{imn})(\tilde{\nu}_{iL}\bar{d}_{mL}d_{nR})$$



$$M_{\tilde{\nu}_{iL}} > \sqrt{|\lambda_{i32}||\lambda'_{imn}|} \times 8.5\mathrm{TeV}$$
$$M_{\tilde{\nu}_{iL}} > \sqrt{|\lambda_{i31}||\lambda'_{imn}|} \times 9.0\mathrm{TeV}$$

Summary

$B \to l^- \nu$	$\sqrt{\lambda'_{33k}\lambda'^*_{31k} + \lambda'^*_{33k}\lambda'_{31k}} = 0.42$	$M_{\tilde{d}_{kR}} = 100\mathrm{GeV}$
$\tau \to \mu K^0_S$	$\sqrt{\lvert\lambda'_{3jm}\rvert\lvert\lambda_{2jn}\rvert} = 0.019$	$M_{\tilde{u}_{jL}} = 100\mathrm{GeV}$
	$\sqrt{\lvert\lambda_{i32}\rvert\lvert\lambda_{imn}\rvert} = 0.012$	$M_{\tilde{\nu}_{iL}} = 100\mathrm{GeV}$
$\tau \to e K^0_S$	$\sqrt{\lvert\lambda'_{3jm}\rvert\lvert\lambda'_{1jn}\rvert} = 0.018$	$M_{\tilde{u}_{jL}} = 100\mathrm{GeV}$
	$\sqrt{\lvert\lambda_{i33}\rvert\lvert\lambda'_{imn}\rvert} = 0.011$	$M_{\tilde{\nu}_{iL}} = 100\mathrm{GeV}$

$(m, n) = (1, 2) or (2, 1)$