# SEARCHES not in other sections

## Magnetic Monopole Searches

Isolated supermassive monopole candidate events have not been confirmed. The most sensitive experiments obtain negative results.

Best cosmic-ray supermassive monopole flux limit:

$< 1.4 \times 10^{-16}$ cm$^{-2}$sr$^{-1}$s$^{-1}$ for $1.1 \times 10^{-4} < \beta < 1$

## Supersymmetric Particle Searches

All supersymmetric mass bounds here are model dependent.

The limits assume:

1) $\widetilde{\chi}_1^0$ is the lightest supersymmetric particle; 2) $R$-parity is conserved, unless stated otherwise;

See the Particle Listings for a Note giving details of supersymmetry.

$\widetilde{\chi}_i^0$ — neutralinos (mixtures of $\widetilde{\gamma}$, $\widetilde{Z}^0$, and $\widetilde{H}_i^0$)

Mass $m_{\widetilde{\chi}_1^0} > 0$ GeV, CL = 95%
[general MSSM, non-universal gaugino masses]

Mass $m_{\widetilde{\chi}_1^0} > 46$ GeV, CL = 95%
[all $\tan\beta$, all $m_0$, all $m_{\widetilde{\chi}_2^0} - m_{\widetilde{\chi}_1^0}$]

Mass $m_{\widetilde{\chi}_2^0} > 670$ GeV, CL = 95%
[$3/4\ell + \not{E}_T$, Tn2n3B, $m_{\widetilde{\chi}_1^0} < 200$GeV]

Mass $m_{\widetilde{\chi}_3^0} > 670$ GeV, CL = 95%
[$3/4\ell + \not{E}_T$, Tn2n3B, $m_{\widetilde{\chi}_1^0} < 200$GeV]

Mass $m_{\widetilde{\chi}_4^0} > 116$ GeV, CL = 95%
[$1<\tan\beta<40$, all $m_0$, all $m_{\widetilde{\chi}_2^0} - m_{\widetilde{\chi}_1^0}$]

$\widetilde{\chi}_i^\pm$ — charginos (mixtures of $\widetilde{W}^\pm$ and $\widetilde{H}_i^\pm$)

Mass $m_{\widetilde{\chi}_1^\pm} > 94$ GeV, CL = 95%
[$\tan\beta < 40$, $m_{\widetilde{\chi}_1^\pm} - m_{\widetilde{\chi}_1^0} > 3$ GeV, all $m_0$]

Mass $m_{\widetilde{\chi}_1^\pm} > 500$ GeV, CL = 95%
[$2\ell^\pm + \not{E}_T$, Tchi1chi1B, $m_{\widetilde{\chi}_1^0} = 0$ GeV]

$\widetilde{\chi}^{\pm}$ — long-lived chargino

Mass $m_{\widetilde{\chi}^{\pm}} > 620$ GeV, CL = 95% [stable $\widetilde{\chi}^{\pm}$]

$\widetilde{\nu}$ — sneutrino

Mass $m >$ 41 GeV, CL = 95% [model independent]

Mass $m >$ 94 GeV, CL = 95%

[CMSSM, $1 \leq \tan\beta \leq 40$, $m_{\widetilde{e}_R} - m_{\widetilde{\chi}_1^0} > 10$ GeV]

Mass $m >$ 2300 GeV, CL = 95% [R-Parity Violating]

[RPV, $\widetilde{\nu}_\tau \rightarrow e\mu$, $\lambda'_{311} = 0.11$]

$\widetilde{e}$ — scalar electron (selectron)

Mass $m(\widetilde{e}_L) >$ 107 GeV, CL = 95% [all $m_{\widetilde{e}_L} - m_{\widetilde{\chi}_1^0}$]

Mass $m >$ 410 GeV, CL = 95% [R-Parity Violating]

[RPV, $\geq 4\ell^{\pm}$, $\widetilde{\ell} \rightarrow l\widetilde{\chi}_1^0$, $\widetilde{\chi}_1^0 \rightarrow \ell^{\pm}\ell^{\mp}\nu$]

$\widetilde{\mu}$ — scalar muon (smuon)

Mass $m >$ 94 GeV, CL = 95%

[CMSSM, $1 \leq \tan\beta \leq 40$, $m_{\widetilde{\mu}_R} - m_{\widetilde{\chi}_1^0} > 10\,\mathrm{GeV}$]

Mass $m >$ 410 GeV, CL = 95% [R-Parity Violating]

[RPV, $\geq 4\ell^{\pm}$, $\widetilde{\ell} \rightarrow l\widetilde{\chi}_1^0$, $\widetilde{\chi}_1^0 \rightarrow \ell^{\pm}\ell^{\mp}\nu$]

$\widetilde{\tau}$ — scalar tau (stau)

Mass $m >$ 81.9 GeV, CL = 95%

[$m_{\widetilde{\tau}_R} - m_{\widetilde{\chi}_1^0} > 15$ GeV, all $\theta_\tau$, B($\widetilde{\tau} \rightarrow \tau\widetilde{\chi}_1^0$) = 100%]

Mass $m >$ 286 GeV, CL = 95% [long-lived $\widetilde{\tau}$]

$\widetilde{q}$ – squarks of the first two quark generations

Mass $m >$ 1450 GeV, CL = 95%

[CMSSM, $\tan\beta = 30$, $A_0 = -2\max(m_0, m_{1/2})$, $\mu > 0$]

Mass $m >$ 1550 GeV, CL = 95%

[mass degenerate squarks]

Mass $m >$ 1050 GeV, CL = 95%

[single light squark bounds]

Mass $m > 1.600 \times 10^3$ GeV, CL = 95% [R-Parity Violating]

[RPV, $\widetilde{q} \rightarrow q\widetilde{\chi}_1^0$, $\widetilde{\chi}_1^0 \rightarrow \ell\ell\nu$, $\lambda_{121}$,$\lambda_{122} \neq 0$, $m_{\widetilde{g}}$=2400GeV]

$\widetilde{q}$ — long-lived squark

Mass $m >$ 1000, CL = 95%

[$\widetilde{t}$, charge-suppressed interaction model]

Mass $m >$ 845, CL = 95% [$\widetilde{b}$, stable, Regge model]

$\widetilde{b}$ — scalar bottom (sbottom)

Mass $m >$ 1230 GeV, CL = 95%
[jets+$\not{E}_T$, Tsbot1, $m_{\widetilde{\chi}_1^0} = 0$ GeV]

Mass $m >$ 307 GeV, CL = 95% [R-Parity Violating]
[RPV, $\widetilde{b} \to\ t\,d$ or $t\,s$, $\lambda''_{332}$ or $\lambda''_{331}$ coupling]

$\widetilde{t}$ — scalar top (stop)

Mass $m >$ 1120 GeV, CL = 95%
[$1\ell$+jets+$\not{E}_T$, Tstop1, $m_{\widetilde{\chi}_1^0} = 0$ GeV]

Mass $m >$ 610 GeV, CL = 95% [R-Parity Violating]
[RPV, 4 jets, Tstop1RPV, $\lambda''_{323}$ coupling]

$\widetilde{g}$ — gluino

Mass $m >$ $1.860 \times 10^3$ GeV, CL = 95%
[ $\geq 1$ jets + $\not{E}_T$, Tglu1A, $m_{\widetilde{\chi}_1^0} = 0$ GeV]

Mass $m >$ $2.260 \times 10^3$ GeV, CL = 95% [R-Parity Violating]
[RPV, $\geq 4\ell$, $\lambda_{12k} \neq 0$, $m_{\widetilde{\chi}_1^0} > 1000$ GeV]

## Technicolor

The limits for technicolor (and top-color) particles are quite varied depending on assumptions. See the Technicolor section of the full *Review* (the data listings).

## Quark and Lepton Compositeness, Searches for

### Scale Limits Λ for Contact Interactions (the lowest dimensional interactions with four fermions)

If the Lagrangian has the form

$$\pm\ \frac{g^2}{2\Lambda^2}\ \overline{\psi}_L \gamma_\mu \psi_L \overline{\psi}_L \gamma^\mu \psi_L$$

(with $g^2/4\pi$ set equal to 1), then we define $\Lambda\ \equiv\ \Lambda^{\pm}_{LL}$. For the full definitions and for other forms, see the Note in the Listings on Searches for Quark and Lepton Compositeness in the full *Review* and the original literature.

$\Lambda^+_{LL}(e\,e\,e\,e)$ > 8.3 TeV, CL = 95%

$\Lambda^-_{LL}(e\,e\,e\,e)$ > 10.3 TeV, CL = 95%

$\Lambda^+_{LL}(ee\mu\mu)$ $>$ 8.5 TeV, CL = 95%

$\Lambda^-_{LL}(ee\mu\mu)$ $>$ 9.5 TeV, CL = 95%

$\Lambda^+_{LL}(ee\tau\tau)$ $>$ 7.9 TeV, CL = 95%

$\Lambda^-_{LL}(ee\tau\tau)$ $>$ 7.2 TeV, CL = 95%

$\Lambda^+_{LL}(\ell\ell\ell\ell)$ $>$ 9.1 TeV, CL = 95%

$\Lambda^-_{LL}(\ell\ell\ell\ell)$ $>$ 10.3 TeV, CL = 95%

$\Lambda^+_{LL}(eeqq)$ $>$ 24 TeV, CL = 95%

$\Lambda^-_{LL}(eeqq)$ $>$ 37 TeV, CL = 95%

$\Lambda^+_{LL}(eeuu)$ $>$ 23.3 TeV, CL = 95%

$\Lambda^-_{LL}(eeuu)$ $>$ 12.5 TeV, CL = 95%

$\Lambda^+_{LL}(eedd)$ $>$ 11.1 TeV, CL = 95%

$\Lambda^-_{LL}(eedd)$ $>$ 26.4 TeV, CL = 95%

$\Lambda^+_{LL}(eecc)$ $>$ 9.4 TeV, CL = 95%

$\Lambda^-_{LL}(eecc)$ $>$ 5.6 TeV, CL = 95%

$\Lambda^+_{LL}(eebb)$ $>$ 9.4 TeV, CL = 95%

$\Lambda^-_{LL}(eebb)$ $>$ 10.2 TeV, CL = 95%

$\Lambda^+_{LL}(\mu\mu qq)$ $>$ 20 TeV, CL = 95%

$\Lambda^-_{LL}(\mu\mu qq)$ $>$ 30 TeV, CL = 95%

$\Lambda(\ell\nu\ell\nu)$ $>$ 3.10 TeV, CL = 90%

$\Lambda(e\nu qq)$ $>$ 2.81 TeV, CL = 95%

$\Lambda^+_{LL}(qqqq)$ $>$ 13.1 none 17.4–29.5 TeV, CL = 95%

$\Lambda^-_{LL}(qqqq)$ $>$ 21.8 TeV, CL = 95%

$\Lambda^+_{LL}(\nu\nu qq)$ $>$ 5.0 TeV, CL = 95%

$\Lambda^-_{LL}(\nu\nu qq)$ $>$ 5.4 TeV, CL = 95%

## Excited Leptons

The limits from $\ell^{*+}\ell^{*-}$ do not depend on $\lambda$ (where $\lambda$ is the $\ell\ell^*$ transition coupling). The $\lambda$-dependent limits assume chiral coupling.

$e^{*\pm}$ — excited electron

Mass $m >$ 103.2 GeV, CL = 95% (from $e^* e^*$)
Mass $m >$ $3.000 \times 10^3$ GeV, CL = 95% (from $e e^*$)
Mass $m >$ 356 GeV, CL = 95% (if $\lambda_\gamma = 1$)

$\mu^{*\pm}$ — excited muon

Mass $m >$ 103.2 GeV, CL = 95% (from $\mu^* \mu^*$)
Mass $m >$ $3.000 \times 10^3$ GeV, CL = 95% (from $\mu \mu^*$)

$\tau^{*\pm}$ — excited tau

Mass $m >$ 103.2 GeV, CL = 95% (from $\tau^* \tau^*$)
Mass $m >$ $2.500 \times 10^3$ GeV, CL = 95% (from $\tau \tau^*$)

$\nu^*$ — excited neutrino

Mass $m >$ $1.600 \times 10^3$ GeV, CL = 95% (from $\nu^* \nu^*$)
Mass $m >$ 213 GeV, CL = 95% (from $\nu^* X$)

$q^*$ — excited quark

Mass $m >$ 338 GeV, CL = 95% (from $q^* q^*$)
Mass $m >$ $6.000 \times 10^3$ GeV, CL = 95% (from $q^* X$)

### Color Sextet and Octet Particles

Color Sextet Quarks ($q_6$)

Mass $m >$ 84 GeV, CL = 95% (Stable $q_6$)

Color Octet Charged Leptons ($\ell_8$)

Mass $m >$ 86 GeV, CL = 95% (Stable $\ell_8$)

Color Octet Neutrinos ($\nu_8$)

Mass $m >$ 110 GeV, CL = 90% ($\nu_8 \to \nu g$)

## Extra Dimensions

Please refer to the Extra Dimensions section of the full *Review* for a discussion of the model-dependence of these bounds, and further constraints.

**Constraints on the radius of the extra dimensions,
for the case of two-flat dimensions of equal radii**

$R <$ 30 $\mu$m, CL = 95% (direct tests of Newton's law)
$R <$ 4.8 $\mu$m, CL = 95% ($pp \to jG$)
$R <$ 0.16–916 nm (astrophysics; limits depend on technique and assumptions)

**Constraints on the fundamental gravity scale**

$M_{TT} >$ 9.02 TeV, CL = 95% ($pp \to$ dijet, angular distribution)
$M_c >$ 4.16 TeV, CL = 95% ($pp \to \ell\overline{\ell}$)

**Constraints on the Kaluza-Klein graviton in warped extra dimensions**

$M_G >$ 4.25 TeV, CL = 95% ($pp \to \gamma\gamma$)

**Constraints on the Kaluza-Klein gluon in warped extra dimensions**

$M_{g_{KK}} > 3.8$ TeV, CL = 95% $(g_{KK} \rightarrow t\overline{t})$