SEARCHES not in other sections

Magnetic Monopole Searches

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 $1.1 \times 10^{-4} < \beta < 0.99$

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 tanβ, all m_0, all $m_{\widetilde{\chi}_2^0} - m_{\widetilde{\chi}_1^0}$]

Mass $m_{\widetilde{\chi}_2^0} > 62.4$ GeV, CL = 95%
[1<tanβ <40, all m_0, all $m_{\widetilde{\chi}_2^0} - m_{\widetilde{\chi}_1^0}$]

Mass $m_{\widetilde{\chi}_3^0} > 99.9$ GeV, CL = 95%
[1<tanβ <40, all m_0, all $m_{\widetilde{\chi}_2^0} - m_{\widetilde{\chi}_1^0}$]

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

Mass $m_{\widetilde{\chi}}$ none 200–670 GeV, CL = 95% [R-Parity Violating]
[wino production, $\widetilde{\chi} \to b + \ell/\nu + t/b$ via λ'_{i33} coupling]

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

Mass $m_{\widetilde{\chi}_1^{\pm}} > 1170$ GeV, CL = 95% [R-Parity Violating]
[$\chi_1^0 \to b t \tau$]

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 $m_{\widetilde{\chi}_1^\pm}$ > 1000 GeV, CL = 95%
[$2\ell+\not{E}_T$, Tchi1chi1C, $m_{\widetilde{\chi}_1^0}$=0 GeV]
Mass $m_{\widetilde{\chi}_1^\pm}$ > 1600 GeV, CL = 95% [R-Parity Violating]
[Tchi1n2l , $\widetilde{\chi}_1^0 \to \ell^\pm \ell^\mp \nu$, $\lambda_{12k} \neq 0$, $m_{\widetilde{\chi}_1^0}$ = 1200 GeV]

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

Mass $m_{\widetilde{\chi}^\pm}$ > 1300 GeV, CL = 95%
[$\widetilde{\chi}^\pm \to \widetilde{\chi}_1^0 \pi^\pm$, wino LSP, stable, $\tau_{\widetilde{\chi}_1^\pm}$ > 100 ns]
Mass $m_{\widetilde{\chi}^\pm}$ > 1050 GeV, CL = 95%
[$\widetilde{\chi}^\pm \to \widetilde{\chi}_1^0 \pi^\pm$, wino LSP,$\tau$=20 ns]

$\widetilde{\nu}$ — 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 $m >$ 4200 GeV, CL = 95% [R-Parity Violating]
[$1e + 1\mu$, $\nu_\tau \to e\mu$, λ=λ' = 0.1]

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

Mass $m >$ 107 GeV, CL = 95% [all $m_{\widetilde{e}_L}$–$m_{\widetilde{\chi}_1^0}$]
Mass $m >$ 700 GeV, CL = 95%
[$2\ell+\not{E}_T$, $m_{\widetilde{\ell}_R} = m_{\widetilde{\ell}_L}$ and $\widetilde{\ell}$=$\widetilde{e}$, $\widetilde{\mu}$, $m_{\widetilde{\chi}_1^0}$=0 GeV]
Mass $m >$ 250 GeV, CL = 95%
[$\ell^\pm \ell^\mp + \not{E}_T$, $\widetilde{e}_R$, $m_{\widetilde{\chi}_1^0}$ = 0 GeV]
Mass $m >$ 410 GeV, CL = 95% [R-Parity Violating]
[$\geq 4\ell^\pm$, $\widetilde{\ell} \to l\widetilde{\chi}_1^0$, $\widetilde{\chi}_1^0 \to \ell^\pm \ell^\mp \nu$]
Mass $m >$ 1200 GeV, CL = 95% [R-Parity Violating]
[$\geq 4\ell$, $\lambda_{12k} \neq 0$, $m_{\widetilde{\chi}_1^0}$ = 900 GeV (m-degenerate $\widetilde{\ell}_L$, $\widetilde{\nu}$)]

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

Mass $m >$ 700 GeV, CL = 95%
[$2\ell+\not{E}_T$, $m_{\widetilde{\ell}_R} = m_{\widetilde{\ell}_L}$ and $\widetilde{\ell}$=$\widetilde{e}$, $\widetilde{\mu}$, $m_{\widetilde{\chi}_1^0}$=0 GeV]
Mass $m >$ 210, CL = 95%
[$\ell^\pm \ell^\mp + \not{E}_T$, $\widetilde{\mu}_R$, $m_{\widetilde{\chi}_1^0}$ = 0 GeV]
Mass $m >$ 94 GeV, CL = 95%
[CMSSM, $1 \leq$ tan$\beta \leq 40$, $m_{\widetilde{\mu}_R}$–$m_{\widetilde{\chi}_1^0}$ > 10 GeV]

Mass $m >$ 410 GeV, CL = 95% [R-Parity Violating]
[$\geq 4\ell^{\pm}$, $\widetilde{\ell} \rightarrow l\widetilde{\chi}_1^0$, $\widetilde{\chi}_1^0 \rightarrow \ell^{\pm}\ell^{\mp}\nu$]
Mass $m >$ 1200 GeV, CL = 95% [R-Parity Violating]
[$\geq 4\ell$, $\lambda_{12k} \neq 0$, $m_{\widetilde{\chi}_1^0} = 900$ GeV (m-degenerate $\widetilde{\ell}_L$, $\widetilde{\nu}$)]

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

Mass $m >$ 81.9 GeV, CL = 95%
[$m_{\widetilde{\tau}_R} - m_{\widetilde{\chi}_1^0}$ >15 GeV, all θ_τ, B($\widetilde{\tau} \rightarrow \tau\widetilde{\chi}_1^0$) = 100%]
Mass $m >$ 500 GeV, CL = 95%
[2 hadronic $\tau + \not{E}_T$, $\widetilde{\tau}_{R,L} \rightarrow \tau\widetilde{\chi}_1^0$, $m_{\widetilde{\chi}_1^0} = 1$ GeV]
Mass $m >$ 90 GeV, CL = 95% [R-Parity Violating]
[$\widetilde{\tau}_R$, indirect, Δm >5 GeV]
Mass $m >$ 1200, CL = 95% [R-Parity Violating]
[$\geq 4\ell$, $\lambda_{12k} \neq 0$, $m_{\widetilde{\chi}_1^0} = 900$ GeV (m-degenerate $\widetilde{\ell}_L$, $\widetilde{\nu}$)]
Mass $m >$ 286 GeV, CL = 95% [long-lived $\widetilde{\tau}$]

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

Mass $m >$ 1.220×10^3 GeV, CL = 95%
[jets + $\not{E}_T$, Tsqk1, 1 non-degenerate $\widetilde{q}$, $m_{\widetilde{\chi}_1^0} = 0$ GeV]
Mass $m >$ 1.600×10^3 GeV, CL = 95% [R-Parity Violating]
[$\widetilde{q} \rightarrow q\widetilde{\chi}_1^0$, $\widetilde{\chi}_1^0 \rightarrow \ell\ell\nu$, λ_{121},$\lambda_{122} \neq 0$, $m_{\widetilde{g}}$=2400GeV]
Mass $m >$ 1000 GeV, CL = 95% [R-Parity Violating]
[jets, $\widetilde{q} \rightarrow q\widetilde{\chi}_1^0$, $\widetilde{\chi}_1^0 \rightarrow \ell q q$, $m_{\widetilde{\chi}_1^0} = 108$ GeV and $2.5 < c\tau_{\widetilde{\chi}_1^0} < 200$ mm]

$\widetilde{q}$ — long-lived squark

Mass $m >$ 1340 GeV, CL = 95% [$\widetilde{t}$ R-hadrons]
Mass $m >$ 1250 GeV, CL = 95% [$\widetilde{b}$ R-hadrons]
Mass $m >$ 1470 GeV, CL = 95% [$\widetilde{t}$ R-hadrons]

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

Mass $m >$ 1.270×10^3 GeV, CL = 95%
[b-jets + $\not{E}_T$, Tsbot1, $m_{\widetilde{\chi}_1^0}$=0 GeV]
Mass $m >$ 307 GeV, CL = 95% [R-Parity Violating]
[$\widetilde{b} \rightarrow t d$ or $t s$, λ''_{332} or λ''_{331} coupling]

$\widetilde{t}$ — scalar top (stop)

Mass $m >$ 1.310×10^3 GeV, CL = 95%
[jets + $\not{E}_T$, Tstop1, $m_{\widetilde{\chi}_1^0} < 300$ GeV]
Mass $m >$ 1900 GeV, CL = 95% [R-Parity Violating]
[$\widetilde{t} \rightarrow b e$, prompt, Tstop2RPV]

Mass $m >$ 1800 GeV, CL = 95% [R-Parity Violating]
[$\widetilde{t} \to b\mu$, prompt, Tstop2RPV]
Mass $m >$ 800 GeV, CL = 95% [R-Parity Violating]
[$\widetilde{t} \to b\tau$, prompt, Tstop2RPV]
Mass $m >$ 460 GeV, CL = 95%
[R-Parity Violating, long-lived $\widetilde{t}$, $\widetilde{t} \to d\overline{\ell}$, 0.01cm $< c\tau <$ 1000 cm]

$\widetilde{g}$ — gluino

Mass $m >$ 2.300×10^3 GeV, CL = 95%
[jets + $\not{E}_T$, Tglu1A, $m_{\widetilde{\chi}_1^0} <$ 200 GeV]
Mass $m >$ 2.260×10^3 GeV, CL = 95% [R-Parity Violating]
[$\geq 4\ell$, $\lambda_{12k} \neq 0$, $m_{\widetilde{\chi}_1^0} >$ 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.

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

$\Lambda^-_{LL}(eeee)$ > 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%
$\Lambda^{+}_{LL}(\mu\mu qq)$	$>$ 23.3 TeV, CL = 95%
$\Lambda^{-}_{LL}(\mu\mu qq)$	$>$ 40.0 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 λ (where λ is the $\ell\ell^*$ transition coupling). The λ-dependent limits assume chiral coupling.

$e^{*\pm}$ — excited electron

Mass $m >$ 103.2 GeV, CL = 95% (from $e^* e^*$)
Mass $m >$ 5.600×10^3 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 $m >$ 5.700×10^3 GeV, CL = 95% (from $\mu\mu^*$)

$\tau^{*\pm}$ — excited tau

Mass $m >$ 103.2 GeV, CL = 95% (from $\tau^* \tau^*$)
Mass $m >$ 4.700×10^3 GeV, CL = 95% (from $\tau\tau^*$)

ν^* — excited neutrino

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

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

q^* — excited quark

(from $q^* q^*$)

Mass $m >$ 6700 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 (ℓ_8)

Mass $m >$ 86 GeV, CL = 95% (Stable ℓ_8)

Color Octet Neutrinos (ν_8)

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

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

(direct tests of Newton's law)

$R <$ 3.8 μm, CL = 95% ($p p \rightarrow j G$)

$R <$ 0.16–916 nm (astrophysics; limits depend on technique and assumptions)

Constraints on the fundamental gravity scale

$M_{TT} >$ 9.02 TeV, CL = 95% ($p p \rightarrow$ dijet, angular distribution)

$M_c >$ 4.16 TeV, CL = 95% ($p p \rightarrow \ell\overline{\ell}$)

Constraints on the Kaluza-Klein graviton in warped extra dimensions

$M_G >$ 4.78 TeV, CL = 95% ($p p \rightarrow e^+ e^-, \mu^+ \mu^-$)

Constraints on the Kaluza-Klein gluon in warped extra dimensions

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

WIMP and Dark Matter Searches

No confirmed evidence found for galactic
WIMPs from the GeV to the TeV mass scales and down to 1×10^{-10}
pb spin independent cross section at M = 100 GeV.