SEARCHES FOR MONOPOLES, SUPERSYMMETRY, COMPOSITENESS, etc.

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:

$< 1.0 \times 10^{-15}$ cm^{-2}sr^{-1}s^{-1} for $1.1 \times 10^{-4} < \beta < 0.1$

Supersymmetric Particle Searches

Limits are based on the Minimal Supersymmetric Standard Model.

Assumptions include: 1) $\widetilde{\chi}^0_1$ (or $\widetilde{\gamma}$) is lightest supersymmetric particle; 2) R-parity is conserved; 3) All scalar quarks (except $\widetilde{t}_L$ and $\widetilde{t}_R$) are degenerate in mass, and $m_{\widetilde{q}_R} = m_{\widetilde{q}_L}$. 4) Limits for selectrons and smuons refer to the $\widetilde{\ell}_R$ states.

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

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

Mass $m_{\widetilde{\chi}^0_1} >$ 10.9 GeV, CL = 95%

Mass $m_{\widetilde{\chi}^0_2} >$ 45.3 GeV, CL = 95% [$\tan\beta > 1$]

Mass $m_{\widetilde{\chi}^0_3} >$ 75.8 GeV, CL = 95% [$\tan\beta > 1$]

Mass $m_{\widetilde{\chi}^0_4} >$ 127 GeV, CL = 95% [$\tan\beta > 3$]

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

Mass $m_{\widetilde{\chi}^\pm_1} >$ 65.7 GeV, CL = 95% [$m_{\widetilde{\chi}^\pm_1} - m_{\widetilde{\chi}^0_1} \geq 2$ GeV]

Mass $m_{\widetilde{\chi}^\pm_2} >$ 99 GeV, CL = 95% [GUT relations assumed]

$\widetilde{\nu}$ — scalar neutrino (sneutrino)

Mass $m >$ 37.1 GeV, CL = 95% [one flavor]

Mass $m >$ 43.1 GeV, CL = 95% [three degenerate flavors]

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

Mass $m >$ 58 GeV, CL = 95% $[m_{\widetilde{e}_R} - m_{\widetilde{\chi}_1^0} \geq 4\,\mathrm{GeV}]$

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

Mass $m >$ 55.6 GeV, CL = 95% $[m_{\widetilde{\mu}_R} - m_{\widetilde{\chi}_1^0} \geq 4\,\mathrm{GeV}]$

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

Mass $m >$ 45 GeV, CL = 95% [if $m_{\widetilde{\chi}_1^0} < 38$ GeV]

$\widetilde{q}$ — scalar quark (squark)

These limits include the effects of cascade decays, evaluated assuming a fixed value of the parameters μ and tanβ. The limits are weakly sensitive to these parameters over much of parameter space. Limits assume GUT relations between gaugino masses and the gauge coupling; in particular that for $|\mu|$ not small, $m_{\widetilde{\chi}_1^0} \approx m_{\widetilde{g}}/6$.

Mass $m >$ 176 GeV, CL = 95% [any $m_{\widetilde{g}} <$300 GeV, $\mu = -250$ GeV, tan$\beta = 2$]

Mass $m >$ 224 GeV, CL = 95% [$m_{\widetilde{g}} \leq m_{\widetilde{q}}$, $\mu = -400$ GeV, tan$\beta = 4$]

$\widetilde{g}$ — gluino

There is some controversy on whether gluinos in a low-mass window ($1 \lesssim m_{\widetilde{g}} \lesssim 5$ GeV) are excluded or not. See the Supersymmetry Listings for details.

The limits summarised here refere to the high-mass region ($m_{\widetilde{g}} \gtrsim 5$ GeV), and include the effects of cascade decays, evaluated assuming a fixed value of the parameters μ and tanβ. The limits are weakly sensitive to these parameters over much of parameter space. Limits assume GUT relations between gaugino masses and the gauge coupling; in particular that for $|\mu|$ not small, $m_{\widetilde{\chi}_1^0} \approx m_{\widetilde{g}}/6$.

Mass $m >$ 173 GeV, CL = 95% [any $m_{\widetilde{q}}$, $\mu = -200$ GeV, tan$\beta = 2$]

Mass $m >$ 212 GeV, CL = 95% [$m_{\widetilde{g}} \geq m_{\widetilde{q}}$, $\mu = -250$ GeV, tan$\beta = 2$]

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 $\Lambda \equiv \Lambda_{LL}^{\pm}$. 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.

$\Lambda_{LL}^{+}(e\,e\,e\,e)$ > 2.4 TeV, CL = 95%

$\Lambda_{LL}^{-}(e\,e\,e\,e)$ > 3.6 TeV, CL = 95%

$\Lambda_{LL}^{+}(e\,e\,\mu\,\mu)$ > 2.6 TeV, CL = 95%

$\Lambda_{LL}^{-}(e\,e\,\mu\,\mu)$ > 2.9 TeV, CL = 95%

$\Lambda_{LL}^{+}(e\,e\,\tau\,\tau)$ > 1.9 TeV, CL = 95%

$\Lambda_{LL}^{-}(e\,e\,\tau\,\tau)$ > 3.0 TeV, CL = 95%

$\Lambda_{LL}^{+}(\ell\ell\ell\ell)$ > 3.5 TeV, CL = 95%

$\Lambda_{LL}^{-}(\ell\ell\ell\ell)$ > 3.8 TeV, CL = 95%

$\Lambda_{LL}^{+}(e\,e\,q\,q)$ > 2.5 TeV, CL = 95%

$\Lambda_{LL}^{-}(e\,e\,q\,q)$ > 3.7 TeV, CL = 95%

$\Lambda_{LL}^{+}(e\,e\,b\,b)$ > 3.1 TeV, CL = 95%

$\Lambda_{LL}^{-}(e\,e\,b\,b)$ > 2.9 TeV, CL = 95%

$\Lambda_{LL}^{+}(\mu\,\mu\,q\,q)$ > 2.9 TeV, CL = 95%

$\Lambda_{LL}^{-}(\mu\,\mu\,q\,q)$ > 4.2 TeV, CL = 95%

$\Lambda_{LR}^{\pm}(\nu_\mu\,\nu_e\,\mu\,e)$ > 3.1 TeV, CL = 90%

$\Lambda_{LL}^{\pm}(q\,q\,q\,q)$ > 1.6 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, except for the third limit for e^* which is for nonchiral coupling. For chiral coupling, this limit corresponds to $\lambda_\gamma = \sqrt{2}$.

$e^{*\pm}$ — excited electron

Mass $m >$ 85.0 GeV, CL = 95% (from $e^{*+}e^{*-}$)
Mass $m >$ 91 GeV, CL = 95% (if $\lambda_Z > 1$)
Mass $m >$ 194 GeV, CL = 95% (if $\lambda_\gamma = 1$)

$\mu^{*\pm}$ — excited muon

Mass $m >$ 85.3 GeV, CL = 95% (from $\mu^{*+}\mu^{*-}$)
Mass $m >$ 91 GeV, CL = 95% (if $\lambda_Z > 1$)

$\tau^{*\pm}$ — excited tau

Mass $m >$ 84.6 GeV, CL = 95% (from $\tau^{*+}\tau^{*-}$)
Mass $m >$ 90 GeV, CL = 95% (if $\lambda_Z > 0.18$)

ν^* — excited neutrino

Mass $m >$ 84.9 GeV, CL = 95% (from $\nu^*\overline{\nu}^*$)
Mass $m >$ 91 GeV, CL = 95% (if $\lambda_Z > 1$)
Mass m = none 40–96 GeV, CL = 95% (from $ep \rightarrow \nu^* X$)

q^* — excited quark

Mass $m >$ 45.6 GeV, CL = 95% (from $q^*\overline{q}^*$)
Mass $m >$ 88 GeV, CL = 95% (if $\lambda_Z > 1$)
Mass $m >$ 570 GeV, CL = 95% ($p\overline{p} \rightarrow q^* X$)

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% ($\nu_8 \rightarrow \nu g$)