SEARCHES FOR MONOPOLES, SUPERSYMMETRY, TECHNICOLOR, COMPOSITENESS, EXTRA DIMENSIONS, 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) With the excepton of $\widetilde{t}$ and $\widetilde{b}$, all scalar quarks are assumed to be degenerate in mass and $m_{\widetilde{q}_R} = m_{\widetilde{q}_L}$. 4) Limits for sleptons 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 $m_{\widetilde{\chi}^0_1} > 37$ GeV, CL = 95% [all tanβ, all m_0]

Mass $m_{\widetilde{\chi}^0_2} > 62.4$ GeV, CL = 95%

[1<tanβ <40, all m_0, all $m_{\widetilde{\chi}^0_2} - m_{\widetilde{\chi}^0_1}$]

Mass $m_{\widetilde{\chi}^0_3} > 99.9$ GeV, CL = 95%

[1<tanβ <40, all m_0, all $m_{\widetilde{\chi}^0_2} - m_{\widetilde{\chi}^0_1}$]

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

Mass $m_{\widetilde{\chi}^\pm_1} > 67.7$ GeV, CL = 95%

[tan$\beta > 0.7$, $m_{\widetilde{\chi}^\pm_1} - m_{\widetilde{\chi}^0_1} > 3$ GeV]

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

Mass $m >$ 95 GeV, CL = 95% [$m_{\widetilde{e}_R} - m_{\widetilde{\chi}^0_1} > 15$ GeV]

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

Mass $m >$ 88 GeV, CL = 95% $[m_{\widetilde{\mu}_R} - m_{\widetilde{\chi}_1^0} > 15$ GeV]

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

Mass $m >$ 76 GeV, CL = 95%
$[m_{\widetilde{\tau}_R} - m_{\widetilde{\chi}_1^0} > 15$ GeV, all θ_τ]

$\widetilde{q}$ — 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.

Mass $m >$ 250 GeV, CL = 95% [tan$\beta = 2$, $\mu < 0$, $A = 0$]

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

Mass $m >$ 91 GeV, CL = 95%
$[m_{\widetilde{b}_1} - m_{\widetilde{\chi}_1^0} > 8$ GeV, $\theta_b = 0$]

$\widetilde{t}$ — scalar top (stop)

Mass $m >$ 86.4 GeV, CL = 95%
$[\widetilde{t} \rightarrow t\widetilde{\chi}_1^0$, all θ_t, $m_{\widetilde{t}} - m_{\widetilde{\chi}_1^0} > 5$ GeV]

$\widetilde{g}$ — 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 refer 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,

Mass $m >$ 195 GeV, CL = 95% [any $m_{\widetilde{q}}$]
Mass $m >$ 300 GeV, CL = 95% [$m_{\widetilde{q}} = m_{\widetilde{g}}$]

Technicolor

Searches for a color-octet techni-ρ constrain its mass to be greater than 260 to 480 GeV, depending on allowed decay channels. Similar bounds exist on the color-octet techni-ω.

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%
$\Lambda^-_{LL}(ee\mu\mu)$	$>$ 6.3 TeV, CL = 95%
$\Lambda^+_{LL}(ee\tau\tau)$	$>$ 5.4 TeV, CL = 95%
$\Lambda^-_{LL}(ee\tau\tau)$	$>$ 6.5 TeV, CL = 95%
$\Lambda^+_{LL}(\ell\ell\ell\ell)$	$>$ 9.0 TeV, CL = 95%
$\Lambda^-_{LL}(\ell\ell\ell\ell)$	$>$ 7.8 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%
$\Lambda^+_{LL}(eecc)$	$>$ 1.0 TeV, CL = 95%
$\Lambda^-_{LL}(eecc)$	$>$ 2.1 TeV, CL = 95%
$\Lambda^+_{LL}(eebb)$	$>$ 5.6 TeV, CL = 95%
$\Lambda^-_{LL}(eebb)$	$>$ 4.9 TeV, CL = 95%
$\Lambda^+_{LL}(\mu\mu qq)$	$>$ 2.9 TeV, CL = 95%
$\Lambda^-_{LL}(\mu\mu qq)$	$>$ 4.2 TeV, CL = 95%
$\Lambda(\ell\nu\ell\nu)$	$>$ 3.10 TeV, CL = 90%
$\Lambda(e\nu qq)$	$>$ 2.81 TeV, CL = 95%
$\Lambda^+_{LL}(qqqq)$	$>$ 2.7 TeV, CL = 95%
$\Lambda^-_{LL}(qqqq)$	$>$ 2.4 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 $m >$ 100.0 GeV, CL = 95% (from $e^* e^*$)
Mass $m >$ 223 GeV, CL = 95% (from $e e^*$)
Mass $m >$ 310 GeV, CL = 95% (if $\lambda_\gamma = 1$)

$\mu^{*\pm}$ — excited muon

Mass $m >$ 100.2 GeV, CL = 95% (from $\mu^* \mu^*$)
Mass $m >$ 178 GeV, CL = 95% (from $\mu \mu^*$)

$\tau^{*\pm}$ — excited tau

Mass $m >$ 99.8 GeV, CL = 95% (from $\tau^* \tau^*$)
Mass $m >$ 173 GeV, CL = 95% (from $\tau \tau^*$)

ν^* — excited neutrino

Mass $m >$ 99.4 GeV, CL = 95% (from $\nu^* \nu^*$)
Mass $m >$ 171 GeV, CL = 95% (from $\nu \nu^*$)

q^* — excited quark

Mass $m >$ 45.6 GeV, CL = 95% (from $q^* q^*$)
Mass $m >$ 570, none 580–760 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 fundamental gravity scale

$M_H > 1.1$ TeV, CL = 95% (dim-8 operators; $p\overline{p} \to e^+ e^-$, $\gamma\gamma$)
$M_D > 1.1$ TeV, CL = 95% ($e^+ e^- \to G\gamma$; 2-flat dimensions)
$M_D >$ 3–1000 TeV (astrophysics and cosmology; 2-flat dimensions; limits depend on technique and assumptions)

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

$r <$ 90–660 nm (astrophysics; limits depend on technique and assumptions)
$r <$ 0.22 mm, CL = 95% (direct tests of Newton's law; cited in Extra Dimensions review)