Tests of Conservation Laws

$\Gamma(B^+ \to K^+ e^- \mu^+)/\Gamma_{total}$		$<6.4 \times 10^{-3}$, CL = 90%
$\Gamma(B^0 \to e^\pm \mu^\mp)/\Gamma_{total}$	[i]	$<5.9 \times 10^{-6}$, CL = 90%
$\Gamma(B^0 \to e^\pm \tau^\mp)/\Gamma_{total}$	[i]	$<5.3 \times 10^{-4}$, CL = 90%
$\Gamma(B^0 \to \mu^\pm \tau^\mp)/\Gamma_{total}$	[i]	$<8.3 \times 10^{-4}$, CL = 90%

TOTAL LEPTON NUMBER

Violation of total lepton number conservation also implies violation of lepton family number conservation.

limit on $\mu^- \to e^+$ conversion		
$\sigma(\mu^- {}^{32}\text{S} \to e^+ {}^{32}\text{Si}^*)$ / $\sigma(\mu^- {}^{32}\text{S} \to \nu_\mu {}^{32}\text{P}^*)$		$<9 \times 10^{-10}$, CL = 90%
$\sigma(\mu^- {}^{127}\text{I} \to e^+ {}^{127}\text{Sb}^*)$ / $\sigma(\mu^- {}^{127}\text{I} \to$ anything)		$<3 \times 10^{-10}$, CL = 90%
$\sigma(\mu^- \text{Ti} \to e^+ \text{Ca})$ / $\sigma(\mu^- \text{Ti} \to$ capture)		$<8.9 \times 10^{-11}$, CL = 90%
$\Gamma(\tau^- \to \pi^- \gamma)/\Gamma_{total}$		$<2.8 \times 10^{-4}$, CL = 90%
$\Gamma(\tau^- \to \pi^- \pi^0)/\Gamma_{total}$		$<3.7 \times 10^{-4}$, CL = 90%
$\Gamma(\tau^- \to \mu^+ e^- e^-)/\Gamma_{total}$		$<1.4 \times 10^{-5}$, CL = 90%
$\Gamma(\tau^- \to \ell^\pm \pi^\mp \pi^-)/\Gamma_{total}$	[i,k]	$<6.3 \times 10^{-5}$, CL = 90%
$\Gamma(\tau^- \to e^\mp \pi^\pm \pi^-)/\Gamma_{total}$	[i]	$<6.0 \times 10^{-5}$, CL = 90%
$\Gamma(\tau^- \to e^+ \pi^- \pi^-)/\Gamma_{total}$		$<1.7 \times 10^{-5}$, CL = 90%
$\Gamma(\tau^- \to \mu^\mp \pi^\pm \pi^-)/\Gamma_{total}$	[i]	$<3.9 \times 10^{-5}$, CL = 90%
$\Gamma(\tau^- \to \mu^+ \pi^- \pi^-)/\Gamma_{total}$		$<3.9 \times 10^{-5}$, CL = 90%
$\Gamma(\tau^- \to \ell^\pm \pi^\mp K^-)/\Gamma_{total}$	[i,k]	$<1.2 \times 10^{-4}$, CL = 90%
$\Gamma(\tau^- \to (e\pi K)^-$, all charged$)/\Gamma_{total}$		$<7.7 \times 10^{-5}$, CL = 90%
$\Gamma(\tau^- \to e^+ \pi^- K^-)/\Gamma_{total}$		$<2.0 \times 10^{-5}$, CL = 90%
$\Gamma(\tau^- \to (\mu\pi K)^-$, all charged$)/\Gamma_{total}$		$<7.7 \times 10^{-5}$, CL = 90%
$\Gamma(\tau^- \to \mu^+ \pi^- K^-)/\Gamma_{total}$		$<4.0 \times 10^{-5}$, CL = 90%
$\Gamma(\tau^- \to \overline{p}\gamma)/\Gamma_{total}$		$<2.9 \times 10^{-4}$, CL = 90%
$\Gamma(\tau^- \to \overline{p}\pi^0)/\Gamma_{total}$		$<6.6 \times 10^{-4}$, CL = 90%
$\Gamma(\tau^- \to \overline{p}\eta)/\Gamma_{total}$		$<1.30 \times 10^{-3}$, CL = 90%
$\nu_e \to (\overline{\nu}_e)_L$		
$\alpha\Delta(m^2)$ for $\sin^2(2\theta) = 1$		<0.14 eV^2, CL = 90%
$\alpha^2\sin^2(2\theta)$ for "Large" $\Delta(m^2)$		<0.032, CL = 90%
$\nu_\mu \to (\overline{\nu}_e)_L$		
$\alpha\Delta(m^2)$ for $\sin^2(2\theta) = 1$		<0.16 eV^2, CL = 90%
$\alpha^2\sin^2(2\theta)$ for "Large" $\Delta(m^2)$		<0.001, CL = 90%
$\Gamma(\pi^+ \to \mu^+ \overline{\nu}_e)/\Gamma_{total}$	[n]	$<1.5 \times 10^{-3}$, CL = 90%
$\Gamma(K^+ \to \pi^- \mu^+ e^+)/\Gamma_{total}$		$<7 \times 10^{-9}$, CL = 90%
$\Gamma(K^+ \to \pi^- e^+ e^+)/\Gamma_{total}$		$<1.0 \times 10^{-8}$, CL = 90%
$\Gamma(K^+ \to \pi^- \mu^+ \mu^+)/\Gamma_{total}$		$<1.5 \times 10^{-4}$, CL = 90%
$\Gamma(K^+ \to \mu^+ \overline{\nu}_e)/\Gamma_{total}$	[n]	$<3.3 \times 10^{-3}$, CL = 90%
$\Gamma(K^+ \to \pi^0 e^+ \overline{\nu}_e)/\Gamma_{total}$	[n]	$<3 \times 10^{-3}$, CL = 90%
$\Gamma(D^+ \to \pi^- e^+ e^+)/\Gamma_{total}$		$<4.8 \times 10^{-3}$, CL = 90%
$\Gamma(D^+ \to \pi^- \mu^+ \mu^+)/\Gamma_{total}$		$<6.8 \times 10^{-3}$, CL = 90%
$\Gamma(D^+ \to \pi^- e^+ \mu^+)/\Gamma_{total}$		$<3.7 \times 10^{-3}$, CL = 90%
$\Gamma(D^+ \to K^- e^+ e^+)/\Gamma_{total}$		$<9.1 \times 10^{-3}$, CL = 90%
$\Gamma(D^+ \to K^- \mu^+ \mu^+)/\Gamma_{total}$		$<4.3 \times 10^{-3}$, CL = 90%
$\Gamma(D^+ \to K^- e^+ \mu^+)/\Gamma_{total}$		$<4.0 \times 10^{-3}$, CL = 90%
$\Gamma(B^+ \to \pi^- e^+ e^+)/\Gamma_{total}$		$<3.9 \times 10^{-3}$, CL = 90%
$\Gamma(B^+ \to \pi^- \mu^+ \mu^+)/\Gamma_{total}$		$<9.1 \times 10^{-3}$, CL = 90%
$\Gamma(B^+ \to \pi^- e^+ \mu^+)/\Gamma_{total}$		$<6.4 \times 10^{-3}$, CL = 90%
$\Gamma(B^+ \to K^- e^+ e^+)/\Gamma_{total}$		$<3.9 \times 10^{-3}$, CL = 90%
$\Gamma(B^+ \to K^- \mu^+ \mu^+)/\Gamma_{total}$		$<9.1 \times 10^{-3}$, CL = 90%
$\Gamma(B^+ \to K^- e^+ \mu^+)/\Gamma_{total}$		$<6.4 \times 10^{-3}$, CL = 90%
$\Gamma(\Xi^- \to p \mu^- \mu^-)/\Gamma_{total}$		$<4 \times 10^{-4}$, CL = 90%

BARYON NUMBER

$\Gamma(\tau^- \to \overline{p}\gamma)/\Gamma_{total}$		$<2.9 \times 10^{-4}$, CL = 90%
$\Gamma(\tau^- \to \overline{p}\pi^0)/\Gamma_{total}$		$<6.6 \times 10^{-4}$, CL = 90%
$\Gamma(\tau^- \to \overline{p}\eta)/\Gamma_{total}$		$<1.30 \times 10^{-3}$, CL = 90%
p mean life		$>1.6 \times 10^{25}$ years

A few examples of proton or bound neutron decay follow. For limits on many other nucleon decay channels, see the Baryon Summary Table.

$\tau(N \to e^+ \pi)$		> 130 (n), > 550 (p) $\times 10^{30}$ years, CL = 90%
$\tau(N \to \mu^+ \pi)$		> 100 (n), > 270 (p) $\times 10^{30}$ years, CL = 90%
$\tau(N \to e^+ K)$		> 1.3 (n), > 150 (p) $\times 10^{30}$ years, CL = 90%
$\tau(N \to \mu^+ K)$		> 1.1 (n), > 120 (p) $\times 10^{30}$ years, CL = 90%
mean time for $n\overline{n}$ transition in vacuum	[o]	$>1.2 \times 10^8$ s, CL = 90%

ELECTRIC CHARGE (Q)

e mean life / branching fraction	[p]	$>2.7 \times 10^{23}$ yr, CL = 68%
$\Gamma(n \to p \nu_e \overline{\nu}_e)/\Gamma_{total}$		$<9 \times 10^{-24}$, CL = 90%

$\Delta S = \Delta Q$ RULE

Allowed in second-order weak interactions.

$\Gamma(K^+ \to \pi^+ \pi^+ e^- \overline{\nu}_e)/\Gamma_{total}$		$<1.2 \times 10^{-8}$, CL = 90%
$\Gamma(K^+ \to \pi^+ \pi^+ \mu^- \overline{\nu}_\mu)/\Gamma_{total}$		$<3.0 \times 10^{-6}$, CL = 95%
$x = \text{A}(\overline{K}^0 \to \pi^- \ell^+ \nu)/\text{A}(K^0 \to \pi^- \ell^+ \nu) = \text{A}(\Delta S{=}-\Delta Q)/\text{A}(\Delta S{=}\Delta Q)$		
real part of x		0.006 ± 0.018 (S = 1.3)
imaginary part of x		-0.003 ± 0.026 (S = 1.2)
$\Gamma(\Sigma^+ \to n \ell^+ \nu)/\Gamma(\Sigma^- \to n \ell^- \overline{\nu})$		<0.043
$\Gamma(\Sigma^+ \to n e^+ \nu_e)/\Gamma_{total}$		$<5 \times 10^{-6}$, CL = 90%
$\Gamma(\Sigma^+ \to n \mu^+ \nu_\mu)/\Gamma_{total}$		$<3.0 \times 10^{-5}$, CL = 90%
$\Gamma(\Xi^0 \to \Sigma^- e^+ \nu_e)/\Gamma_{total}$		$<9 \times 10^{-4}$, CL = 90%
$\Gamma(\Xi^0 \to \Sigma^- \mu^+ \nu_\mu)/\Gamma_{total}$		$<9 \times 10^{-4}$, CL = 90%

$\Delta S = 2$ FORBIDDEN

Allowed in second-order weak interactions.

$\Gamma(\Xi^0 \to p \pi^-)/\Gamma_{total}$		$<4 \times 10^{-5}$, CL = 90%
$\Gamma(\Xi^0 \to p e^- \overline{\nu}_e)/\Gamma_{total}$		$<1.3 \times 10^{-3}$
$\Gamma(\Xi^0 \to p \mu^- \overline{\nu}_\mu)/\Gamma_{total}$		$<1.3 \times 10^{-3}$
$\Gamma(\Xi^- \to n \pi^-)/\Gamma_{total}$		$<1.9 \times 10^{-5}$, CL = 90%
$\Gamma(\Xi^- \to n e^- \overline{\nu}_e)/\Gamma_{total}$		$<3.2 \times 10^{-3}$, CL = 90%
$\Gamma(\Xi^- \to n \mu^- \overline{\nu}_\mu)/\Gamma_{total}$		$<1.5 \times 10^{-2}$, CL = 90%
$\Gamma(\Xi^- \to p \pi^- \pi^-)/\Gamma_{total}$		$<4 \times 10^{-4}$, CL = 90%
$\Gamma(\Xi^- \to p \pi^- e^- \overline{\nu}_e)/\Gamma_{total}$		$<4 \times 10^{-4}$, CL = 90%
$\Gamma(\Xi^- \to p \pi^- \mu^- \overline{\nu}_\mu)/\Gamma_{total}$		$<4 \times 10^{-4}$, CL = 90%
$\Gamma(\Omega^- \to \Lambda \pi^-)/\Gamma_{total}$		$<1.9 \times 10^{-4}$, CL = 90%

$\Delta S = 2$ VIA MIXING

Allowed in second-order weak interactions, e.g. mixing.

$m_{K^0_L} - m_{K^0_S}$		$(0.5333 \pm 0.0027) \times 10^{10}$ $\hbar$ s^{-1} (S = 1.2)
$m_{K^0_L} - m_{K^0_S}$		$(3.510 \pm 0.018) \times 10^{-12}$ MeV (S = 1.3)

$\Delta C = 2$ VIA MIXING

Allowed in second-order weak interactions, e.g. mixing.

$\lvert m_{D^0_1} - m_{D^0_2} \rvert$	[q]	$<20 \times 10^{10}$ $\hbar$ s^{-1}, CL = 90%
$\Gamma(K^+ \pi^-$ (via $\overline{D}^0$))$/\Gamma(K^- \pi^+)$		<0.0037, CL = 90%
$\Gamma(\mu^-$ anything (via $\overline{D}^0$))$/\Gamma(\mu^+$ anything)		<0.0056, CL = 90%

Limits are given at the 90% confidence level, while errors are given as ± 1 standard deviation.