

TESTS OF DISCRETE SPACE-TIME SYMMETRIES

CHARGE CONJUGATION (C) INVARIANCE

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| $\Gamma(\pi^0 \rightarrow 3\gamma)/\Gamma_{\text{total}}$ | $<3.1 \times 10^{-8}$, CL = 90% |
| η C-nonconserving decay parameters | |
| $\pi^+ \pi^- \pi^0$ left-right asymmetry | $(0.09^{+0.11}_{-0.12}) \times 10^{-2}$ |
| $\pi^+ \pi^- \pi^0$ sextant asymmetry | $(0.12^{+0.10}_{-0.11}) \times 10^{-2}$ |
| $\pi^+ \pi^- \pi^0$ quadrant asymmetry | $(-0.09 \pm 0.09) \times 10^{-2}$ |
| $\pi^+ \pi^- \gamma$ left-right asymmetry | $(0.9 \pm 0.4) \times 10^{-2}$ |
| $\pi^+ \pi^- \gamma$ parameter β (<i>D</i> -wave) | -0.02 ± 0.07 ($S = 1.3$) |
| $\Gamma(\eta \rightarrow \pi^0 \gamma)/\Gamma_{\text{total}}$ | $<9 \times 10^{-5}$, CL = 90% |
| $\Gamma(\eta \rightarrow 2\pi^0 \gamma)/\Gamma_{\text{total}}$ | $<5 \times 10^{-4}$, CL = 90% |
| $\Gamma(\eta \rightarrow 3\pi^0 \gamma)/\Gamma_{\text{total}}$ | $<6 \times 10^{-5}$, CL = 90% |
| $\Gamma(\eta \rightarrow 3\gamma)/\Gamma_{\text{total}}$ | $<1.6 \times 10^{-5}$, CL = 90% |
| $\Gamma(\eta \rightarrow \pi^0 e^+ e^-)/\Gamma_{\text{total}}$ | [a] $<4 \times 10^{-5}$, CL = 90% |
| $\Gamma(\eta \rightarrow \pi^0 \mu^+ \mu^-)/\Gamma_{\text{total}}$ | [a] $<5 \times 10^{-6}$, CL = 90% |
| $\Gamma(\omega(782) \rightarrow \eta \pi^0)/\Gamma_{\text{total}}$ | $<2.1 \times 10^{-4}$, CL = 90% |
| $\Gamma(\omega(782) \rightarrow 2\pi^0)/\Gamma_{\text{total}}$ | $<2.1 \times 10^{-4}$, CL = 90% |
| $\Gamma(\omega(782) \rightarrow 3\pi^0)/\Gamma_{\text{total}}$ | $<2.3 \times 10^{-4}$, CL = 90% |
| asymmetry parameter for $\eta'(958) \rightarrow \pi^+ \pi^- \gamma$ decay | -0.03 ± 0.04 |
| $\Gamma(\eta'(958) \rightarrow \pi^0 e^+ e^-)/\Gamma_{\text{total}}$ | [a] $<1.4 \times 10^{-3}$, CL = 90% |
| $\Gamma(\eta'(958) \rightarrow \eta e^+ e^-)/\Gamma_{\text{total}}$ | [a] $<2.4 \times 10^{-3}$, CL = 90% |
| $\Gamma(\eta'(958) \rightarrow 3\gamma)/\Gamma_{\text{total}}$ | $<1.0 \times 10^{-4}$, CL = 90% |
| $\Gamma(\eta'(958) \rightarrow \mu^+ \mu^- \pi^0)/\Gamma_{\text{total}}$ | [a] $<6.0 \times 10^{-5}$, CL = 90% |
| $\Gamma(\eta'(958) \rightarrow \mu^+ \mu^- \eta)/\Gamma_{\text{total}}$ | [a] $<1.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(J/\psi(1S) \rightarrow \gamma\gamma)/\Gamma_{\text{total}}$ | $<5 \times 10^{-6}$, CL = 90% |

PARITY (P) INVARIANCE

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| e electric dipole moment | $<10.5 \times 10^{-28}$ ecm, CL = 90% |
| μ electric dipole moment | $(-0.1 \pm 0.9) \times 10^{-19}$ ecm |
| $\text{Re}(d_\tau = \tau \text{ electric dipole moment})$ | $-0.220 \text{ to } 0.45 \times 10^{-16}$ ecm, CL = 95% |
| $\Gamma(\eta \rightarrow \pi^+ \pi^-)/\Gamma_{\text{total}}$ | $<1.3 \times 10^{-5}$, CL = 90% |
| $\Gamma(\eta \rightarrow 2\pi^0)/\Gamma_{\text{total}}$ | $<3.5 \times 10^{-4}$, CL = 90% |
| $\Gamma(\eta \rightarrow 4\pi^0)/\Gamma_{\text{total}}$ | $<6.9 \times 10^{-7}$, CL = 90% |
| $\Gamma(\eta'(958) \rightarrow \pi^+ \pi^-)/\Gamma_{\text{total}}$ | $<6 \times 10^{-5}$, CL = 90% |
| $\Gamma(\eta'(958) \rightarrow \pi^0 \pi^0)/\Gamma_{\text{total}}$ | $<4 \times 10^{-4}$, CL = 90% |
| $\Gamma(\eta_c(1S) \rightarrow \pi^+ \pi^-)/\Gamma_{\text{total}}$ | $<1.1 \times 10^{-4}$, CL = 90% |

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| $\Gamma(\eta_c(1S) \rightarrow \pi^0 \pi^0)/\Gamma_{\text{total}}$ | $<3.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(\eta_c(1S) \rightarrow K^+ K^-)/\Gamma_{\text{total}}$ | $<6 \times 10^{-4}$, CL = 90% |
| $\Gamma(\eta_c(1S) \rightarrow K_S^0 K_S^0)/\Gamma_{\text{total}}$ | $<3.1 \times 10^{-4}$, CL = 90% |
| ρ electric dipole moment | $<0.54 \times 10^{-23}$ e cm |
| n electric dipole moment | $<0.29 \times 10^{-25}$ e cm, CL = 90% |
| Λ electric dipole moment | $<1.5 \times 10^{-16}$ e cm, CL = 95% |

TIME REVERSAL (T) INVARIANCE

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| e electric dipole moment | $<10.5 \times 10^{-28}$ e cm, CL = 90% |
| μ electric dipole moment | $(-0.1 \pm 0.9) \times 10^{-19}$ e cm |
| μ decay parameters | |
| transverse e^+ polarization normal to plane of μ spin, e^+ momentum | $(-2 \pm 8) \times 10^{-3}$ |
| α'/A | $(-10 \pm 20) \times 10^{-3}$ |
| β'/A | $(2 \pm 7) \times 10^{-3}$ |
| $\text{Re}(d_T = \tau \text{ electric dipole moment})$ | $-0.220 \text{ to } 0.45 \times 10^{-16}$ e cm, CL = 95% |
| P_T in $K^+ \rightarrow \pi^0 \mu^+ \nu_\mu$ | $(-1.7 \pm 2.5) \times 10^{-3}$ |
| P_T in $K^+ \rightarrow \mu^+ \nu_\mu \gamma$ | $(-0.6 \pm 1.9) \times 10^{-2}$ |
| $\text{Im}(\xi)$ in $K^+ \rightarrow \pi^0 \mu^+ \nu_\mu$ decay (from transverse μ pol.) | -0.006 ± 0.008 |
| asymmetry A_T in $K^0 \bar{K}^0$ mixing | $(6.6 \pm 1.6) \times 10^{-3}$ |
| $\text{Im}(\xi)$ in $K_{\mu 3}^0$ decay (from transverse μ pol.) | -0.007 ± 0.026 |
| $A_T(D^\pm \rightarrow K_S^0 K^\pm \pi^+ \pi^-)$ | [b] $(-12 \pm 11) \times 10^{-3}$ |
| $A_T(D^0 \rightarrow K^+ K^- \pi^+ \pi^-)$ | [b] $(1 \pm 7) \times 10^{-3}$ |
| $A_T(D_S^\pm \rightarrow K_S^0 K^\pm \pi^+ \pi^-)$ | [b] $(-14 \pm 8) \times 10^{-3}$ |
| $\Delta S_T^+ (S_{\ell^-, K_S^0}^- - S_{\ell^+, K_S^0}^+)$ | -1.37 ± 0.15 |
| $\Delta S_T^- (S_{\ell^-, K_S^0}^+ - S_{\ell^+, K_S^0}^-)$ | 1.17 ± 0.21 |
| $\Delta C_T^+ (C_{\ell^-, K_S^0}^- - C_{\ell^+, K_S^0}^+)$ | 0.10 ± 0.16 |
| $\Delta C_T^- (C_{\ell^-, K_S^0}^+ - C_{\ell^+, K_S^0}^-)$ | 0.04 ± 0.16 |
| ρ electric dipole moment | $<0.54 \times 10^{-23}$ e cm |
| n electric dipole moment | $<0.29 \times 10^{-25}$ e cm, CL = 90% |
| $n \rightarrow p e^- \bar{\nu}_e$ decay parameters | |
| ϕ_{AV} , phase of g_A relative to g_V | [c] $(180.017 \pm 0.026)^\circ$ |
| triple correlation coefficient D | [d] $(-1.2 \pm 2.0) \times 10^{-4}$ |
| triple correlation coefficient R | [d] 0.004 ± 0.013 |
| Λ electric dipole moment | $<1.5 \times 10^{-16}$ e cm, CL = 95% |
| triple correlation coefficient D for $\Sigma^- \rightarrow n e^- \bar{\nu}_e$ | 0.11 ± 0.10 |

CP INVARIANCE

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| $\text{Re}(d_{\tau}^W)$ | $<0.50 \times 10^{-17} \text{ e cm, CL} = 95\%$ |
| $\text{Im}(d_{\tau}^W)$ | $<1.1 \times 10^{-17} \text{ e cm, CL} = 95\%$ |
| $\eta \rightarrow \pi^+ \pi^- e^+ e^-$ decay-plane asymmetry | $(-0.6 \pm 3.1) \times 10^{-2}$ |
| $\Gamma(\eta \rightarrow \pi^+ \pi^-) / \Gamma_{\text{total}}$ | $<1.3 \times 10^{-5}, \text{ CL} = 90\%$ |
| $\Gamma(\eta \rightarrow 2\pi^0) / \Gamma_{\text{total}}$ | $<3.5 \times 10^{-4}, \text{ CL} = 90\%$ |
| $\Gamma(\eta \rightarrow 4\pi^0) / \Gamma_{\text{total}}$ | $<6.9 \times 10^{-7}, \text{ CL} = 90\%$ |
| $\Gamma(\eta'(958) \rightarrow \pi^+ \pi^-) / \Gamma_{\text{total}}$ | $<6 \times 10^{-5}, \text{ CL} = 90\%$ |
| $\Gamma(\eta'(958) \rightarrow \pi^0 \pi^0) / \Gamma_{\text{total}}$ | $<4 \times 10^{-4}, \text{ CL} = 90\%$ |
| $K^{\pm} \rightarrow \pi^{\pm} \pi^+ \pi^-$ rate difference/average | $(0.08 \pm 0.12)\%$ |
| $K^{\pm} \rightarrow \pi^{\pm} \pi^0 \pi^0$ rate difference/average | $(0.0 \pm 0.6)\%$ |
| $K^{\pm} \rightarrow \pi^{\pm} \pi^0 \gamma$ rate difference/average | $(0.9 \pm 3.3)\%$ |
| $K^{\pm} \rightarrow \pi^{\pm} \pi^+ \pi^- (g_+ - g_-) / (g_+ + g_-)$ | $(-1.5 \pm 2.2) \times 10^{-4}$ |
| $K^{\pm} \rightarrow \pi^{\pm} \pi^0 \pi^0 (g_+ - g_-) / (g_+ + g_-)$ | $(1.8 \pm 1.8) \times 10^{-4}$ |
| $\Delta(K_{\pi ee}^{\pm}) = \frac{\Gamma(K_{\pi ee}^+) - \Gamma(K_{\pi ee}^-)}{\Gamma(K_{\pi ee}^+) + \Gamma(K_{\pi ee}^-)}$ | $(-2.2 \pm 1.6) \times 10^{-2}$ |
| $\Delta(K_{\pi \mu \mu}^{\pm}) = \frac{\Gamma(K_{\pi \mu \mu}^+) - \Gamma(K_{\pi \mu \mu}^-)}{\Gamma(K_{\pi \mu \mu}^+) + \Gamma(K_{\pi \mu \mu}^-)}$ | 0.010 ± 0.023 |
| $\Delta(K_{\pi \pi \gamma}^{\pm}) = \frac{\Gamma(K_{\pi \pi \gamma}^+) - \Gamma(K_{\pi \pi \gamma}^-)}{\Gamma(K_{\pi \pi \gamma}^+) + \Gamma(K_{\pi \pi \gamma}^-)}$ | $(0.0 \pm 1.2) \times 10^{-3}$ |
| $A_S = [\Gamma(K_S^0 \rightarrow \pi^- e^+ \nu_e) - \Gamma(K_S^0 \rightarrow \pi^+ e^- \bar{\nu}_e)] / \text{SUM}$ | $(2 \pm 10) \times 10^{-3}$ |
| $\text{Im}(\eta_{+-0}) = \text{Im}(A(K_S^0 \rightarrow \pi^+ \pi^- \pi^0, \text{CP-violating}) / A(K_L^0 \rightarrow \pi^+ \pi^- \pi^0))$ | -0.002 ± 0.009 |
| $\text{Im}(\eta_{000}) = \text{Im}(A(K_S^0 \rightarrow \pi^0 \pi^0 \pi^0) / A(K_L^0 \rightarrow \pi^0 \pi^0 \pi^0))$ | $(-0.1 \pm 1.6) \times 10^{-2}$ |
| $ \eta_{000} = A(K_S^0 \rightarrow 3\pi^0) / A(K_L^0 \rightarrow 3\pi^0) $ | $<0.0088, \text{ CL} = 90\%$ |
| CP asymmetry A in $K_S^0 \rightarrow \pi^+ \pi^- e^+ e^-$ | $(-0.4 \pm 0.8)\%$ |
| $\Gamma(K_S^0 \rightarrow 3\pi^0) / \Gamma_{\text{total}}$ | $<2.6 \times 10^{-8}, \text{ CL} = 90\%$ |
| linear coefficient j for $K_L^0 \rightarrow \pi^+ \pi^- \pi^0$ | 0.0012 ± 0.0008 |
| quadratic coefficient f for $K_L^0 \rightarrow \pi^+ \pi^- \pi^0$ | 0.004 ± 0.006 |
| $ \epsilon'_{+-\gamma} / \epsilon$ for $K_L^0 \rightarrow \pi^+ \pi^- \gamma$ | $<0.3, \text{ CL} = 90\%$ |
| $ g_{E1} $ for $K_L^0 \rightarrow \pi^+ \pi^- \gamma$ | $<0.21, \text{ CL} = 90\%$ |
| $\Gamma(K_L^0 \rightarrow \pi^0 \mu^+ \mu^-) / \Gamma_{\text{total}}$ | [e] $<3.8 \times 10^{-10}, \text{ CL} = 90\%$ |
| $\Gamma(K_L^0 \rightarrow \pi^0 e^+ e^-) / \Gamma_{\text{total}}$ | [e] $<2.8 \times 10^{-10}, \text{ CL} = 90\%$ |
| $\Gamma(K_L^0 \rightarrow \pi^0 \nu \bar{\nu}) / \Gamma_{\text{total}}$ | [f] $<2.6 \times 10^{-8}, \text{ CL} = 90\%$ |
| $A_{CP}(D^{\pm} \rightarrow \mu^{\pm} \nu)$ | $(8 \pm 8)\%$ |
| $A_{CP}(D^{\pm} \rightarrow K_S^0 \pi^{\pm})$ | $(-0.41 \pm 0.09)\%$ |
| $A_{CP}(D^{\pm} \rightarrow K^{\mp} 2\pi^{\pm})$ | $(-0.1 \pm 1.0)\%$ |
| $A_{CP}(D^{\pm} \rightarrow K^{\mp} \pi^{\pm} \pi^{\pm} \pi^0)$ | $(1.0 \pm 1.3)\%$ |

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| $A_{CP}(D^\pm \rightarrow K_S^0 \pi^\pm \pi^0)$ | $(0.3 \pm 0.9)\%$ |
| $A_{CP}(D^\pm \rightarrow K_S^0 \pi^\pm \pi^+ \pi^-)$ | $(0.1 \pm 1.3)\%$ |
| $A_{CP}(D^\pm \rightarrow \pi^\pm \pi^0)$ | $(2.9 \pm 2.9)\%$ |
| $A_{CP}(D^\pm \rightarrow \pi^\pm \eta)$ | $(1.0 \pm 1.5)\% (S = 1.4)$ |
| $A_{CP}(D^\pm \rightarrow \pi^\pm \eta'(958))$ | $(-0.5 \pm 1.2)\% (S = 1.1)$ |
| $A_{CP}(D^\pm \rightarrow K_S^0 K^\pm)$ | $(-0.11 \pm 0.25)\%$ |
| $A_{CP}(D^\pm \rightarrow K^+ K^- \pi^\pm)$ | $(0.36 \pm 0.29)\%$ |
| $A_{CP}(D^\pm \rightarrow K^\pm K^{*0})$ | $(-0.3 \pm 0.4)\%$ |
| $A_{CP}(D^\pm \rightarrow \phi \pi^\pm)$ | $(0.09 \pm 0.19)\% (S = 1.2)$ |
| $A_{CP}(D^\pm \rightarrow K^\pm K_0^*(1430)^0)$ | $(8_{-6}^{+7})\%$ |
| $A_{CP}(D^\pm \rightarrow K^\pm K_2^*(1430)^0)$ | $(43_{-26}^{+20})\%$ |
| $A_{CP}(D^\pm \rightarrow K^\pm K_0^*(800))$ | $(-12_{-13}^{+18})\%$ |
| $A_{CP}(D^\pm \rightarrow a_0(1450)^0 \pi^\pm)$ | $(-19_{-16}^{+14})\%$ |
| $A_{CP}(D^\pm \rightarrow \phi(1680) \pi^\pm)$ | $(-9 \pm 26)\%$ |
| $A_{CP}(D^\pm \rightarrow \pi^+ \pi^- \pi^\pm)$ | $(-2 \pm 4)\%$ |
| $A_{CP}(D^\pm \rightarrow K_S^0 K^\pm \pi^+ \pi^-)$ | $(-4 \pm 7)\%$ |
| $A_{CP}(D^\pm \rightarrow K^\pm \pi^0)$ | $(-4 \pm 11)\%$ |
| $ q/p $ of D^0 - \bar{D}^0 mixing | $0.92_{-0.09}^{+0.12}$ |
| A_Γ of D^0 - \bar{D}^0 mixing | $(-0.125 \pm 0.526) \times 10^{-3}$ |

Where there is ambiguity, the CP test is labelled by the D^0 decay mode.

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| $A_{CP}(D^0 \rightarrow K^+ K^-)$ | $(-0.21 \pm 0.17)\%$ |
| $A_{CP}(D^0 \rightarrow K_S^0 K_S^0)$ | $(-23 \pm 19)\%$ |
| $A_{CP}(D^0 \rightarrow \pi^+ \pi^-)$ | $(0.22 \pm 0.21)\%$ |
| $A_{CP}(D^0 \rightarrow \pi^0 \pi^0)$ | $(0 \pm 5)\%$ |
| $A_{CP}(D^0 \rightarrow \pi^+ \pi^- \pi^0)$ | $(0.3 \pm 0.4)\%$ |
| $A_{CP}(D^0 \rightarrow \rho(770)^+ \pi^- \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(1.2 \pm 0.9)\%$ |
| $A_{CP}(D^0 \rightarrow \rho(770)^0 \pi^0 \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(-3.1 \pm 3.0)\%$ |
| $A_{CP}(D^0 \rightarrow \rho(770)^- \pi^+ \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(-1.0 \pm 1.7)\%$ |
| $A_{CP}(D^0 \rightarrow \rho(1450)^+ \pi^- \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(0 \pm 70)\%$ |
| $A_{CP}(D^0 \rightarrow \rho(1450)^0 \pi^0 \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(-20 \pm 40)\%$ |
| $A_{CP}(D^0 \rightarrow \rho(1450)^- \pi^+ \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(6 \pm 9)\%$ |
| $A_{CP}(D^0 \rightarrow \rho(1700)^+ \pi^- \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(-5 \pm 14)\%$ |
| $A_{CP}(D^0 \rightarrow \rho(1700)^0 \pi^0 \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(13 \pm 9)\%$ |
| $A_{CP}(D^0 \rightarrow \rho(1700)^- \pi^+ \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(8 \pm 11)\%$ |
| $A_{CP}(D^0 \rightarrow f_0(980) \pi^0 \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(0 \pm 35)\%$ |
| $A_{CP}(D^0 \rightarrow f_0(1370) \pi^0 \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(25 \pm 18)\%$ |
| $A_{CP}(D^0 \rightarrow f_0(1500) \pi^0 \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(0 \pm 18)\%$ |
| $A_{CP}(D^0 \rightarrow f_0(1710) \pi^0 \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(0 \pm 24)\%$ |
| $A_{CP}(D^0 \rightarrow f_2(1270) \pi^0 \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(-4 \pm 6)\%$ |
| $A_{CP}(D^0 \rightarrow \sigma(400) \pi^0 \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(6 \pm 8)\%$ |

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| $A_{CP}(\text{nonresonant } D^0 \rightarrow \pi^+ \pi^- \pi^0)$ | [g] $(-13 \pm 23)\%$ |
| $A_{CP}(D^0 \rightarrow K^+ K^- \pi^0)$ | $(-1.0 \pm 1.7)\%$ |
| $A_{CP}(D^0 \rightarrow K^*(892)^+ K^- \rightarrow K^+ K^- \pi^0)$ | [g] $(-0.9 \pm 1.3)\%$ |
| $A_{CP}(D^0 \rightarrow K^*(1410)^+ K^- \rightarrow K^+ K^- \pi^0)$ | [g] $(-21 \pm 24)\%$ |
| $A_{CP}(D^0 \rightarrow (K^+ \pi^0)_S K^- \rightarrow K^+ K^- \pi^0)$ | [g] $(7 \pm 15)\%$ |
| $A_{CP}(D^0 \rightarrow \phi(1020) \pi^0 \rightarrow K^+ K^- \pi^0)$ | [g] $(1.1 \pm 2.2)\%$ |
| $A_{CP}(D^0 \rightarrow f_0(980) \pi^0 \rightarrow K^+ K^- \pi^0)$ | [g] $(-3 \pm 19)\%$ |
| $A_{CP}(D^0 \rightarrow a_0(980)^0 \pi^0 \rightarrow K^+ K^- \pi^0)$ | [g] $(-5 \pm 16)\%$ |
| $A_{CP}(D^0 \rightarrow f'_2(1525) \pi^0 \rightarrow K^+ K^- \pi^0)$ | [g] $(0 \pm 160)\%$ |
| $A_{CP}(D^0 \rightarrow K^*(892)^- K^+ \rightarrow K^+ K^- \pi^0)$ | [g] $(-5 \pm 4)\%$ |
| $A_{CP}(D^0 \rightarrow K^*(1410)^- K^+ \rightarrow K^+ K^- \pi^0)$ | [g] $(-17 \pm 29)\%$ |
| $A_{CP}(D^0 \rightarrow (K^- \pi^0)_{S\text{-wave}} K^+ \rightarrow K^+ K^- \pi^0)$ | [g] $(-10 \pm 40)\%$ |
| $A_{CP}(D^0 \rightarrow K_S^0 \pi^0)$ | $(-0.27 \pm 0.21)\%$ |
| $A_{CP}(D^0 \rightarrow K_S^0 \eta)$ | $(0.5 \pm 0.5)\%$ |
| $A_{CP}(D^0 \rightarrow K_S^0 \eta')$ | $(1.0 \pm 0.7)\%$ |
| $A_{CP}(D^0 \rightarrow K_S^0 \phi)$ | $(-3 \pm 9)\%$ |
| $A_{CP}(D^0 \rightarrow K^- \pi^+)$ | $(0.1 \pm 0.7)\%$ |
| $A_{CP}(D^0 \rightarrow K^+ \pi^-)$ | $(0.0 \pm 1.6)\%$ |
| $A_{CP}(D^0 \rightarrow K^- \pi^+ \pi^0)$ | $(0.2 \pm 0.9)\%$ |
| $A_{CP}(D^0 \rightarrow K^+ \pi^- \pi^0)$ | $(0 \pm 5)\%$ |
| $A_{CP}(D^0 \rightarrow K_S^0 \pi^+ \pi^-)$ | $(-0.1 \pm 0.8)\%$ |
| $A_{CP}(D^0 \rightarrow K^*(892)^- \pi^+ \rightarrow K_S^0 \pi^+ \pi^-)$ | $(0.4 \pm 0.5)\%$ |
| $A_{CP}(D^0 \rightarrow K^*(892)^+ \pi^- \rightarrow K_S^0 \pi^+ \pi^-)$ | $(1 \pm 6)\%$ |
| $A_{CP}(D^0 \rightarrow K_S^0 \rho^0 \rightarrow K_S^0 \pi^+ \pi^-)$ | $(-0.1 \pm 0.5)\%$ |
| $A_{CP}(D^0 \rightarrow K_S^0 \omega \rightarrow K_S^0 \pi^+ \pi^-)$ | $(-13 \pm 7)\%$ |
| $A_{CP}(D^0 \rightarrow K_S^0 f_0(980) \rightarrow K_S^0 \pi^+ \pi^-)$ | $(-0.4 \pm 2.7)\%$ |
| $A_{CP}(D^0 \rightarrow K_S^0 f_2(1270) \rightarrow K_S^0 \pi^+ \pi^-)$ | $(-4 \pm 5)\%$ |
| $A_{CP}(D^0 \rightarrow K_S^0 f_0(1370) \rightarrow K_S^0 \pi^+ \pi^-)$ | $(-1 \pm 9)\%$ |
| $A_{CP}(D^0 \rightarrow \bar{K}^0 \rho^0(1450) \rightarrow K_S^0 \pi^+ \pi^-)$ | $(-4 \pm 10)\%$ |
| $A_{CP}(D^0 \rightarrow \bar{K}^0 f_0(600) \rightarrow K_S^0 \pi^+ \pi^-)$ | $(-3 \pm 5)\%$ |
| $A_{CP}(D^0 \rightarrow K^*(1410)^- \pi^+ \rightarrow K_S^0 \pi^+ \pi^-)$ | $(-2 \pm 9)\%$ |
| $A_{CP}(D^0 \rightarrow K_0^*(1430)^- \pi^+ \rightarrow K_S^0 \pi^+ \pi^-)$ | $(4 \pm 4)\%$ |
| $A_{CP}(D^0 \rightarrow K_0^*(1430)^- \pi^+ \rightarrow K_S^0 \pi^+ \pi^-)$ | $(12 \pm 15)\%$ |
| $A_{CP}(D^0 \rightarrow K_2^*(1430)^- \pi^+ \rightarrow K_S^0 \pi^+ \pi^-)$ | $(3 \pm 6)\%$ |
| $A_{CP}(D^0 \rightarrow K_2^*(1430)^+ \pi^- \rightarrow K_S^0 \pi^+ \pi^-)$ | $(-10 \pm 32)\%$ |
| $A_{CP}(D^0 \rightarrow K^- \pi^+ \pi^+ \pi^-)$ | $(0.7 \pm 1.0)\%$ |
| $A_{CP}(D^0 \rightarrow K^+ \pi^- \pi^+ \pi^-)$ | $(-2 \pm 4)\%$ |
| $A_{CP}(D^0 \rightarrow K^+ K^- \pi^+ \pi^-)$ | $(-8 \pm 7)\%$ |
| $A_{CP}(D^0 \rightarrow K_1^*(1270)^+ K^- \rightarrow K^{*0} \pi^+ K^-)$ | $(-1 \pm 10)\%$ |
| $A_{CP}(D^0 \rightarrow K_1^*(1270)^- K^+ \rightarrow \bar{K}^{*0} \pi^- K^+)$ | $(-10 \pm 32)\%$ |

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| $A_{CP}(D^0 \rightarrow K_1^*(1270)^+ K^- \rightarrow \rho^0 K^+ K^-)$ | $(-7 \pm 17)\%$ |
| $A_{CP}(D^0 \rightarrow K_1^*(1270)^- K^+ \rightarrow \rho^0 K^- K^+)$ | $(10 \pm 13)\%$ |
| $A_{CP}(D^0 \rightarrow K^*(1410)^+ K^- \rightarrow K^{*0} \pi^+ K^-)$ | $(-20 \pm 17)\%$ |
| $A_{CP}(D^0 \rightarrow K^*(1410)^- K^+ \rightarrow \bar{K}^{*0} \pi^- K^+)$ | $(-1 \pm 14)\%$ |
| $A_{CP}(D^0 \rightarrow K^{*0} \bar{K}^{*0} \text{ S-wave})$ | $(10 \pm 14)\%$ |
| $A_{CP}(D^0 \rightarrow \phi \rho^0 \text{ S-wave})$ | $(-3 \pm 5)\%$ |
| $A_{CP}(D^0 \rightarrow \phi \rho^0 \text{ D-wave})$ | $(-37 \pm 19)\%$ |
| $A_{CP}(D^0 \rightarrow \phi(\pi^+ \pi^-)_{\text{S-wave}})$ | $(-9 \pm 10)\%$ |
| $\Delta A_{CP}^{D^0} = A_{CP}(K^+ K^-) - A_{CP}(\pi^+ \pi^-)$ | $(-0.46 \pm 0.25)\% \text{ (S} = 1.8)$ |
| $A_{CP}(D_s^\pm \rightarrow \mu^\pm \nu)$ | $(5 \pm 6)\%$ |
| $A_{CP}(D_s^\pm \rightarrow K^\pm K_S^0)$ | $(0.08 \pm 0.26)\%$ |
| $A_{CP}(D_s^\pm \rightarrow K^+ K^- \pi^\pm)$ | $(-0.5 \pm 0.9)\%$ |
| $A_{CP}(D_s^\pm \rightarrow K^+ K^- \pi^\pm \pi^0)$ | $(0.0 \pm 3.0)\%$ |
| $A_{CP}(D_s^\pm \rightarrow K_S^0 K^\mp 2\pi^\pm)$ | $(4.1 \pm 2.8)\%$ |
| $A_{CP}(D_s^\pm \rightarrow \pi^+ \pi^- \pi^\pm)$ | $(-0.7 \pm 3.1)\%$ |
| $A_{CP}(D_s^\pm \rightarrow \pi^\pm \eta)$ | $(1.1 \pm 3.1)\%$ |
| $A_{CP}(D_s^\pm \rightarrow \pi^\pm \eta')$ | $(-2.2 \pm 2.3)\%$ |
| $A_{CP}(D_s^\pm \rightarrow K^\pm \pi^0)$ | $(-27 \pm 24)\%$ |
| $A_{CP}(D_s^\pm \rightarrow K_S^0 \pi^\pm)$ | $(1.2 \pm 1.0)\% \text{ (S} = 1.3)$ |
| $A_{CP}(D_s^\pm \rightarrow K^\pm \pi^+ \pi^-)$ | $(4 \pm 5)\%$ |
| $A_{CP}(D_s^\pm \rightarrow K^\pm \eta)$ | $(9 \pm 15)\%$ |
| $A_{CP}(D_s^\pm \rightarrow K^\pm \eta'(958))$ | $(6 \pm 19)\%$ |
| $A_{CP}(B^+ \rightarrow J/\psi(1S) K^+)$ | $0.003 \pm 0.006 \text{ (S} = 1.8)$ |
| $A_{CP}(B^+ \rightarrow J/\psi(1S) \pi^+)$ | $(0.1 \pm 2.8) \times 10^{-2} \text{ (S} = 1.2)$ |
| $A_{CP}(B^+ \rightarrow J/\psi \rho^+)$ | -0.11 ± 0.14 |
| $A_{CP}(B^+ \rightarrow J/\psi K^*(892)^+)$ | -0.048 ± 0.033 |
| $A_{CP}(B^+ \rightarrow \eta_c K^+)$ | $-0.02 \pm 0.10 \text{ (S} = 2.0)$ |
| $A_{CP}(B^+ \rightarrow \psi(2S) \pi^+)$ | 0.03 ± 0.06 |
| $A_{CP}(B^+ \rightarrow \psi(2S) K^+)$ | -0.024 ± 0.023 |
| $A_{CP}(B^+ \rightarrow \psi(2S) K^*(892)^+)$ | 0.08 ± 0.21 |
| $A_{CP}(B^+ \rightarrow \chi_{c1}(1P) \pi^+)$ | 0.07 ± 0.18 |
| $A_{CP}(B^+ \rightarrow \chi_{c0} K^+)$ | $-0.20 \pm 0.18 \text{ (S} = 1.5)$ |
| $A_{CP}(B^+ \rightarrow \chi_{c1} K^+)$ | -0.009 ± 0.033 |
| $A_{CP}(B^+ \rightarrow \chi_{c1} K^*(892)^+)$ | 0.5 ± 0.5 |
| $A_{CP}(B^+ \rightarrow \bar{D}^0 \pi^+)$ | -0.007 ± 0.007 |
| $A_{CP}(B^+ \rightarrow D_{CP(+1)} \pi^+)$ | 0.035 ± 0.024 |
| $A_{CP}(B^+ \rightarrow D_{CP(-1)} \pi^+)$ | 0.017 ± 0.026 |
| $A_{CP}(B^+ \rightarrow \bar{D}^0 K^+)$ | $0.01 \pm 0.05 \text{ (S} = 2.1)$ |
| $r_B(B^+ \rightarrow D^0 K^+)$ | 0.096 ± 0.008 |
| $\delta_B(B^+ \rightarrow D^0 K^+)$ | $(115 \pm 13)^\circ$ |

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| $r_B(B^+ \rightarrow \bar{D}^0 K^{*+})$ | 0.17 ± 0.11 ($S = 2.3$) |
| $\delta_B(B^+ \rightarrow D^0 K^{*+})$ | $(155 \pm 70)^\circ$ ($S = 2.0$) |
| $A_{CP}(B^+ \rightarrow [K^- \pi^+]_D K^+)$ | -0.58 ± 0.21 |
| $A_{CP}(B^+ \rightarrow [K^- \pi^+]_{\bar{D}} K^*(892)^+)$ | -0.3 ± 0.5 |
| $A_{CP}(B^+ \rightarrow [K^- \pi^+]_D \pi^+)$ | 0.00 ± 0.09 |
| $A_{CP}(B^+ \rightarrow [K^- \pi^+]_{(D\pi)} \pi^+)$ | -0.09 ± 0.27 |
| $A_{CP}(B^+ \rightarrow [K^- \pi^+]_{(D\gamma)} \pi^+)$ | -0.7 ± 0.6 |
| $A_{CP}(B^+ \rightarrow [K^- \pi^+]_{(D\pi)} K^+)$ | 0.8 ± 0.4 |
| $A_{CP}(B^+ \rightarrow [K^- \pi^+]_{(D\gamma)} K^+)$ | 0.4 ± 1.0 |
| $A_{CP}(B^+ \rightarrow [\pi^+ \pi^- \pi^0]_D K^+)$ | -0.02 ± 0.15 |
| $A_{ADS}(B^+ \rightarrow D \pi^+)$ | 0.14 ± 0.06 |
| $A_{CP}(B^+ \rightarrow D_{CP(-1)} K^+)$ | -0.10 ± 0.07 |
| $A_{CP}(B^+ \rightarrow \bar{D}^{*0} \pi^+)$ | -0.014 ± 0.015 |
| $A_{CP}(B^+ \rightarrow (D_{CP(+1)}^*)^0 \pi^+)$ | -0.02 ± 0.05 |
| $A_{CP}(B^+ \rightarrow (D_{CP(-1)}^*)^0 \pi^+)$ | -0.09 ± 0.05 |
| $A_{CP}(B^+ \rightarrow D^{*0} K^+)$ | -0.07 ± 0.04 |
| $r_B^*(B^+ \rightarrow D^{*0} K^+)$ | $0.114^{+0.023}_{-0.040}$ ($S = 1.2$) |
| $\delta_B^*(B^+ \rightarrow D^{*0} K^+)$ | $(310^{+22}_{-28})^\circ$ ($S = 1.3$) |
| $A_{CP}(B^+ \rightarrow D_{CP(+1)}^{*0} K^+)$ | -0.12 ± 0.08 |
| $A_{CP}(B^+ \rightarrow D_{CP(-1)}^* K^+)$ | 0.07 ± 0.10 |
| $A_{CP}(B^+ \rightarrow D_{CP(+1)} K^*(892)^+)$ | 0.09 ± 0.14 |
| $A_{CP}(B^+ \rightarrow D_{CP(-1)} K^*(892)^+)$ | -0.23 ± 0.22 |
| $A_{CP}(B^+ \rightarrow D_S^+ \phi)$ | 0.0 ± 0.4 |
| $A_{CP}(B^+ \rightarrow D^{*+} \bar{D}^{*0})$ | -0.15 ± 0.11 |
| $A_{CP}(B^+ \rightarrow D^{*+} \bar{D}^0)$ | -0.06 ± 0.13 |
| $A_{CP}(B^+ \rightarrow D^+ \bar{D}^{*0})$ | 0.13 ± 0.18 |
| $A_{CP}(B^+ \rightarrow D^+ \bar{D}^0)$ | -0.03 ± 0.07 |
| $A_{CP}(B^+ \rightarrow K_S^0 \pi^+)$ | -0.017 ± 0.016 |
| $A_{CP}(B^+ \rightarrow K^+ \pi^0)$ | 0.037 ± 0.021 |
| $A_{CP}(B^+ \rightarrow \eta' K^+)$ | 0.013 ± 0.017 |
| $A_{CP}(B^+ \rightarrow \eta' K^*(892)^+)$ | -0.26 ± 0.27 |
| $A_{CP}(B^+ \rightarrow \eta' K_0^*(1430)^+)$ | 0.06 ± 0.20 |
| $A_{CP}(B^+ \rightarrow \eta' K_2^*(1430)^+)$ | 0.15 ± 0.13 |
| $A_{CP}(B^+ \rightarrow \eta K^*(892)^+)$ | 0.02 ± 0.06 |
| $A_{CP}(B^+ \rightarrow \eta K_0^*(1430)^+)$ | 0.05 ± 0.13 |
| $A_{CP}(B^+ \rightarrow \eta K_2^*(1430)^+)$ | -0.45 ± 0.30 |
| $A_{CP}(B^+ \rightarrow \omega K^+)$ | 0.02 ± 0.05 |
| $A_{CP}(B^+ \rightarrow \omega K^{*+})$ | 0.29 ± 0.35 |

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| $A_{CP}(B^+ \rightarrow \omega(K\pi)_0^{*+})$ | -0.10 ± 0.09 |
| $A_{CP}(B^+ \rightarrow \omega K_2^*(1430)^+)$ | 0.14 ± 0.15 |
| $A_{CP}(B^+ \rightarrow K^{*0}\pi^+)$ | -0.04 ± 0.09 (S = 2.1) |
| $A_{CP}(B^+ \rightarrow K^*(892)^+\pi^0)$ | -0.06 ± 0.24 |
| $A_{CP}(B^+ \rightarrow K^+\pi^-\pi^+)$ | 0.033 ± 0.010 |
| $A_{CP}(B^+ \rightarrow K^+K^-K^+ \text{ nonresonant})$ | 0.06 ± 0.05 |
| $A_{CP}(B^+ \rightarrow f(980)^0 K^+)$ | -0.08 ± 0.09 |
| $A_{CP}(B^+ \rightarrow f_0(1500) K^+)$ | 0.28 ± 0.30 |
| $A_{CP}(B^+ \rightarrow f_2'(1525)^0 K^+)$ | $-0.08^{+0.05}_{-0.04}$ |
| $A_{CP}(B^+ \rightarrow K_0^*(1430)^0 \pi^+)$ | 0.055 ± 0.033 |
| $A_{CP}(B^+ \rightarrow K_2^*(1430)^0 \pi^+)$ | $0.05^{+0.29}_{-0.24}$ |
| $A_{CP}(B^+ \rightarrow K^+\pi^0\pi^0)$ | -0.06 ± 0.07 |
| $A_{CP}(B^+ \rightarrow K^0\rho^+)$ | -0.12 ± 0.17 |
| $A_{CP}(B^+ \rightarrow K^{*+}\pi^+\pi^-)$ | 0.07 ± 0.08 |
| $A_{CP}(B^+ \rightarrow \rho^0 K^*(892)^+)$ | 0.31 ± 0.13 |
| $A_{CP}(B^+ \rightarrow K^*(892)^+ f_0(980))$ | -0.15 ± 0.12 |
| $A_{CP}(B^+ \rightarrow a_1^+ K^0)$ | 0.12 ± 0.11 |
| $A_{CP}(B^+ \rightarrow b_1^+ K^0)$ | -0.03 ± 0.15 |
| $A_{CP}(B^+ \rightarrow K^*(892)^0 \rho^+)$ | -0.01 ± 0.16 |
| $A_{CP}(B^+ \rightarrow b_1^0 K^+)$ | -0.46 ± 0.20 |
| $A_{CP}(B^+ \rightarrow K^0 K^+)$ | 0.04 ± 0.14 |
| $A_{CP}(B^+ \rightarrow K^+ K_S^0 K_S^0)$ | $0.04^{+0.04}_{-0.05}$ |
| $A_{CP}(B^+ \rightarrow K^+ K^- \pi^+)$ | -0.12 ± 0.05 (S = 1.2) |
| $A_{CP}(B^+ \rightarrow K^+ K^- K^+)$ | -0.036 ± 0.012 (S = 1.1) |
| $A_{CP}(B^+ \rightarrow \phi K^+)$ | 0.04 ± 0.04 (S = 2.1) |
| $A_{CP}(B^+ \rightarrow X_0(1550) K^+)$ | -0.04 ± 0.07 |
| $A_{CP}(B^+ \rightarrow K^{*+} K^+ K^-)$ | 0.11 ± 0.09 |
| $A_{CP}(B^+ \rightarrow \phi K^*(892)^+)$ | -0.01 ± 0.08 |
| $A_{CP}(B^+ \rightarrow \phi(K\pi)_0^{*+})$ | 0.04 ± 0.16 |
| $A_{CP}(B^+ \rightarrow \phi K_1(1270)^+)$ | 0.15 ± 0.20 |
| $A_{CP}(B^+ \rightarrow \phi K_2^*(1430)^+)$ | -0.23 ± 0.20 |
| $A_{CP}(B^+ \rightarrow K^+ \phi \phi)$ | -0.10 ± 0.08 |
| $A_{CP}(B^+ \rightarrow K^+[\phi\phi]_{\eta_c})$ | 0.09 ± 0.10 |
| $A_{CP}(B^+ \rightarrow K^*(892)^+ \gamma)$ | 0.018 ± 0.029 |
| $A_{CP}(B^+ \rightarrow \eta K^+ \gamma)$ | -0.12 ± 0.07 |
| $A_{CP}(B^+ \rightarrow \phi K^+ \gamma)$ | -0.13 ± 0.11 (S = 1.1) |
| $A_{CP}(B^+ \rightarrow \rho^+ \gamma)$ | -0.11 ± 0.33 |
| $A_{CP}(B^+ \rightarrow \pi^+ \pi^0)$ | 0.03 ± 0.04 |
| $A_{CP}(B^+ \rightarrow \pi^+ \pi^- \pi^+)$ | 0.105 ± 0.029 (S = 1.3) |
| $A_{CP}(B^+ \rightarrow \rho^0 \pi^+)$ | $0.18^{+0.09}_{-0.17}$ |

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| $A_{CP}(B^+ \rightarrow f_2(1270)\pi^+)$ | 0.41 ± 0.30 |
| $A_{CP}(B^+ \rightarrow \rho^0(1450)\pi^+)$ | $-0.1^{+0.4}_{-0.5}$ |
| $A_{CP}(B^+ \rightarrow \pi^+\pi^-\pi^+ \text{ nonresonant})$ | $-0.14^{+0.23}_{-0.16}$ |
| $A_{CP}(B^+ \rightarrow \rho^+\pi^0)$ | 0.02 ± 0.11 |
| $A_{CP}(B^+ \rightarrow \rho^+\rho^0)$ | -0.05 ± 0.05 |
| $A_{CP}(B^+ \rightarrow \omega\pi^+)$ | -0.04 ± 0.06 |
| $A_{CP}(B^+ \rightarrow \omega\rho^+)$ | -0.20 ± 0.09 |
| $A_{CP}(B^+ \rightarrow \eta\pi^+)$ | -0.14 ± 0.07 (S = 1.4) |
| $A_{CP}(B^+ \rightarrow \eta\rho^+)$ | 0.11 ± 0.11 |
| $A_{CP}(B^+ \rightarrow \eta'\pi^+)$ | 0.06 ± 0.16 |
| $A_{CP}(B^+ \rightarrow \eta'\rho^+)$ | 0.26 ± 0.17 |
| $A_{CP}(B^+ \rightarrow b_1^0\pi^+)$ | 0.05 ± 0.16 |
| $A_{CP}(B^+ \rightarrow p\bar{p}\pi^+)$ | 0.00 ± 0.04 |
| $A_{CP}(B^+ \rightarrow p\bar{p}K^+)$ | -0.08 ± 0.04 (S = 1.1) |
| $A_{CP}(B^+ \rightarrow p\bar{p}K^*(892)^+)$ | 0.21 ± 0.16 (S = 1.4) |
| $A_{CP}(B^+ \rightarrow p\bar{\Lambda}\gamma)$ | 0.17 ± 0.17 |
| $A_{CP}(B^+ \rightarrow p\bar{\Lambda}\pi^0)$ | 0.01 ± 0.17 |
| $A_{CP}(B^+ \rightarrow K^+\ell^+\ell^-)$ | -0.02 ± 0.08 |
| $A_{CP}(B^+ \rightarrow K^+e^+e^-)$ | 0.14 ± 0.14 |
| $A_{CP}(B^+ \rightarrow K^+\mu^+\mu^-)$ | -0.003 ± 0.033 |
| $A_{CP}(B^+ \rightarrow K^{*+}\ell^+\ell^-)$ | -0.09 ± 0.14 |
| $A_{CP}(B^+ \rightarrow K^{*+}e^+e^-)$ | -0.14 ± 0.23 |
| $A_{CP}(B^+ \rightarrow K^{*+}\mu^+\mu^-)$ | -0.12 ± 0.24 |
| $\text{Re}(\epsilon_{B^0})/(1+ \epsilon_{B^0} ^2)$ | $(0.1 \pm 0.8) \times 10^{-3}$ |
| $A_{T/CP}$ | 0.005 ± 0.018 |
| $A_{CP}(B^0 \rightarrow D^*(2010)^+D^-)$ | 0.037 ± 0.034 |
| $A_{CP}(B^0 \rightarrow [K^+K^-]_D K^*(892)^0)$ | -0.45 ± 0.23 |
| $A_{CP}(B^0 \rightarrow [K^+\pi^-]_D K^*(892)^0)$ | -0.08 ± 0.08 |
| $A_{CP}(B^0 \rightarrow \eta' K^*(892)^0)$ | 0.02 ± 0.23 |
| $A_{CP}(B^0 \rightarrow \eta' K_0^*(1430)^0)$ | -0.19 ± 0.17 |
| $A_{CP}(B^0 \rightarrow \eta' K_2^*(1430)^0)$ | 0.14 ± 0.18 |
| $A_{CP}(B^0 \rightarrow \eta K_0^*(1430)^0)$ | 0.06 ± 0.13 |
| $A_{CP}(B^0 \rightarrow \eta K_2^*(1430)^0)$ | -0.07 ± 0.19 |
| $A_{CP}(B^0 \rightarrow b_1 K^+)$ | -0.07 ± 0.12 |
| $A_{CP}(B^0 \rightarrow \omega K^{*0})$ | 0.45 ± 0.25 |
| $A_{CP}(B^0 \rightarrow \omega(K\pi)_0^{*0})$ | -0.07 ± 0.09 |
| $A_{CP}(B^0 \rightarrow \omega K_2^*(1430)^0)$ | -0.37 ± 0.17 |
| $A_{CP}(B^0 \rightarrow K^+\pi^-\pi^0)$ | $(0 \pm 6) \times 10^{-2}$ |
| $A_{CP}(B^0 \rightarrow \rho^- K^+)$ | 0.20 ± 0.11 |
| $A_{CP}(B^0 \rightarrow \rho(1450)^- K^+)$ | -0.10 ± 0.33 |

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| $A_{CP}(B^0 \rightarrow \rho(1700)^- K^+)$ | -0.4 ± 0.6 |
| $A_{CP}(B^0 \rightarrow K^+ \pi^- \pi^0 \text{ nonresonant})$ | 0.10 ± 0.18 |
| $A_{CP}(B^0 \rightarrow K^0 \pi^+ \pi^-)$ | -0.01 ± 0.05 |
| $A_{CP}(B^0 \rightarrow K^*(892)^+ \pi^-)$ | -0.22 ± 0.06 |
| $A_{CP}(B^0 \rightarrow (K\pi)_0^{*+} \pi^-)$ | 0.09 ± 0.07 |
| $A_{CP}(B^0 \rightarrow (K\pi)_0^{*0} \pi^0)$ | -0.15 ± 0.11 |
| $A_{CP}(B^0 \rightarrow K^{*0} \pi^0)$ | -0.15 ± 0.13 |
| $A_{CP}(B^0 \rightarrow K^*(892)^0 \pi^+ \pi^-)$ | 0.07 ± 0.05 |
| $A_{CP}(B^0 \rightarrow K^*(892)^0 \rho^0)$ | -0.06 ± 0.09 |
| $A_{CP}(B^0 \rightarrow K^{*0} f_0(980))$ | 0.07 ± 0.10 |
| $A_{CP}(B^0 \rightarrow K^{*+} \rho^-)$ | 0.21 ± 0.15 |
| $A_{CP}(B^0 \rightarrow K^*(892)^0 K^+ K^-)$ | 0.01 ± 0.05 |
| $A_{CP}(B^0 \rightarrow a_1^- K^+)$ | -0.16 ± 0.12 |
| $A_{CP}(B^0 \rightarrow K^0 K^0)$ | -0.6 ± 0.7 |
| $A_{CP}(B^0 \rightarrow K^*(892)^0 \phi)$ | $(0 \pm 4) \times 10^{-2}$ |
| $A_{CP}(B^0 \rightarrow K^*(892)^0 K^- \pi^+)$ | 0.2 ± 0.4 |
| $A_{CP}(B^0 \rightarrow \phi(K\pi)_0^{*0})$ | 0.12 ± 0.08 |
| $A_{CP}(B^0 \rightarrow \phi K_2^*(1430)^0)$ | -0.11 ± 0.10 |
| $A_{CP}(B^0 \rightarrow K^*(892)^0 \gamma)$ | -0.002 ± 0.015 |
| $A_{CP}(B^0 \rightarrow K_2^*(1430)^0 \gamma)$ | -0.08 ± 0.15 |
| $A_{CP}(B^0 \rightarrow \rho^+ \pi^-)$ | 0.13 ± 0.06 ($S = 1.1$) |
| $A_{CP}(B^0 \rightarrow \rho^- \pi^+)$ | -0.08 ± 0.08 |
| $A_{CP}(B^0 \rightarrow a_1(1260)^\pm \pi^\mp)$ | -0.07 ± 0.06 |
| $A_{CP}(B^0 \rightarrow b_1^- \pi^+)$ | -0.05 ± 0.10 |
| $A_{CP}(B^0 \rightarrow p\bar{p}K^*(892)^0)$ | 0.05 ± 0.12 |
| $A_{CP}(B^0 \rightarrow p\bar{\Lambda}\pi^-)$ | 0.04 ± 0.07 |
| $A_{CP}(B^0 \rightarrow K^{*0} \ell^+ \ell^-)$ | -0.05 ± 0.10 |
| $A_{CP}(B^0 \rightarrow K^{*0} e^+ e^-)$ | -0.21 ± 0.19 |
| $A_{CP}(B^0 \rightarrow K^{*0} \mu^+ \mu^-)$ | -0.07 ± 0.04 |
| $C_{D^*(2010)^- D^+} (B^0 \rightarrow D^*(2010)^- D^+)$ | -0.01 ± 0.11 |
| $C_{D^*(2010)^+ D^-} (B^0 \rightarrow D^*(2010)^+ D^-)$ | 0.00 ± 0.13 ($S = 1.3$) |
| $C_{D^{*+} D^{*-}} (B^0 \rightarrow D^{*+} D^{*-})$ | 0.01 ± 0.09 ($S = 1.6$) |
| $C_+ (B^0 \rightarrow D^{*+} D^{*-})$ | 0.00 ± 0.10 ($S = 1.6$) |
| $C_- (B^0 \rightarrow D^{*+} D^{*-})$ | 0.19 ± 0.31 |
| $S_- (B^0 \rightarrow D^{*+} D^{*-})$ | 0.1 ± 1.6 ($S = 3.5$) |
| $C (B^0 \rightarrow D^*(2010)^+ D^*(2010)^- K_S^0)$ | 0.01 ± 0.29 |
| $S (B^0 \rightarrow D^*(2010)^+ D^*(2010)^- K_S^0)$ | 0.1 ± 0.4 |
| $C_{D^+ D^-} (B^0 \rightarrow D^+ D^-)$ | -0.46 ± 0.21 ($S = 1.8$) |
| $C_{J/\psi(1S)\pi^0} (B^0 \rightarrow J/\psi(1S)\pi^0)$ | -0.13 ± 0.13 |

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| $C_{D_{CP}^{(*)}h^0}(B^0 \rightarrow D_{CP}^{(*)}h^0)$ | -0.23 ± 0.16 |
| $S_{D_{CP}^{(*)}h^0}(B^0 \rightarrow D_{CP}^{(*)}h^0)$ | -0.56 ± 0.24 |
| $C_{K^0\pi^0}(B^0 \rightarrow K^0\pi^0)$ | 0.00 ± 0.13 ($S = 1.4$) |
| $C_{\eta'(958)K_S^0}(B^0 \rightarrow \eta'(958)K_S^0)$ | -0.04 ± 0.20 ($S = 2.5$) |
| $S_{\eta'(958)K_S^0}(B^0 \rightarrow \eta'(958)K_S^0)$ | 0.43 ± 0.17 ($S = 1.5$) |
| $C_{\eta'K^0}(B^0 \rightarrow \eta'K^0)$ | -0.05 ± 0.05 |
| $C_{\omega K_S^0}(B^0 \rightarrow \omega K_S^0)$ | -0.30 ± 0.28 ($S = 1.6$) |
| $S_{\omega K_S^0}(B^0 \rightarrow \omega K_S^0)$ | 0.43 ± 0.24 |
| $C(B^0 \rightarrow K_S^0\pi^0\pi^0)$ | 0.2 ± 0.5 |
| $S(B^0 \rightarrow K_S^0\pi^0\pi^0)$ | 0.7 ± 0.7 |
| $C_{\rho^0 K_S^0}(B^0 \rightarrow \rho^0 K_S^0)$ | -0.04 ± 0.20 |
| $S_{\rho^0 K_S^0}(B^0 \rightarrow \rho^0 K_S^0)$ | $0.50^{+0.17}_{-0.21}$ |
| $C_{f_0(980)K_S^0}(B^0 \rightarrow f_0(980)K_S^0)$ | 0.29 ± 0.20 |
| $S_{f_0(980)K_S^0}(B^0 \rightarrow f_0(980)K_S^0)$ | -0.50 ± 0.16 |
| $S_{f_2(1270)K_S^0}(B^0 \rightarrow f_2(1270)K_S^0)$ | -0.5 ± 0.5 |
| $C_{f_2(1270)K_S^0}(B^0 \rightarrow f_2(1270)K_S^0)$ | 0.3 ± 0.4 |
| $S_{f_x(1300)K_S^0}(B^0 \rightarrow f_x(1300)K_S^0)$ | -0.2 ± 0.5 |
| $C_{f_x(1300)K_S^0}(B^0 \rightarrow f_x(1300)K_S^0)$ | 0.13 ± 0.35 |
| $S_{K^0\pi^+\pi^-}(B^0 \rightarrow K^0\pi^+\pi^- \text{ nonresonant})$ | -0.01 ± 0.33 |
| $C_{K^0\pi^+\pi^-}(B^0 \rightarrow K^0\pi^+\pi^- \text{ nonresonant})$ | 0.01 ± 0.26 |
| $C_{K_S^0K_S^0}(B^0 \rightarrow K_S^0K_S^0)$ | 0.0 ± 0.4 ($S = 1.4$) |
| $S_{K_S^0K_S^0}(B^0 \rightarrow K_S^0K_S^0)$ | -0.8 ± 0.5 |
| $C_{K^+K^-K_S^0}(B^0 \rightarrow K^+K^-K_S^0 \text{ nonresonant})$ | 0.06 ± 0.08 |
| $C_{K^+K^-K_S^0}(B^0 \rightarrow K^+K^-K_S^0 \text{ inclusive})$ | 0.01 ± 0.09 |
| $C_{\phi K_S^0}(B^0 \rightarrow \phi K_S^0)$ | 0.01 ± 0.14 |
| $S_{\phi K_S^0}(B^0 \rightarrow \phi K_S^0)$ | 0.59 ± 0.14 |
| $C_{K_S K_S K_S}(B^0 \rightarrow K_S K_S K_S)$ | -0.23 ± 0.14 |
| $S_{K_S K_S K_S}(B^0 \rightarrow K_S K_S K_S)$ | -0.5 ± 0.6 ($S = 3.0$) |
| $C_{K_S^0\pi^0\gamma}(B^0 \rightarrow K_S^0\pi^0\gamma)$ | 0.36 ± 0.33 |
| $S_{K_S^0\pi^0\gamma}(B^0 \rightarrow K_S^0\pi^0\gamma)$ | -0.8 ± 0.6 |
| $C_{K^*(892)^0\gamma}(B^0 \rightarrow K^*(892)^0\gamma)$ | -0.04 ± 0.16 ($S = 1.2$) |

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| $S_{K^*(892)^0\gamma} (B^0 \rightarrow K^*(892)^0\gamma)$ | -0.15 ± 0.22 |
| $C_{\eta K^0\gamma} (B^0 \rightarrow \eta K^0\gamma)$ | -0.3 ± 0.4 |
| $S_{\eta K^0\gamma} (B^0 \rightarrow \eta K^0\gamma)$ | -0.2 ± 0.5 |
| $C_{K^0\phi\gamma} (B^0 \rightarrow K^0\phi\gamma)$ | -0.3 ± 0.6 |
| $S_{K^0\phi\gamma} (B^0 \rightarrow K^0\phi\gamma)$ | $0.7^{+0.7}_{-1.1}$ |
| $C(B^0 \rightarrow K_S^0\rho^0\gamma)$ | -0.05 ± 0.19 |
| $S(B^0 \rightarrow K_S^0\rho^0\gamma)$ | 0.11 ± 0.34 |
| $C(B^0 \rightarrow \rho^0\gamma)$ | 0.4 ± 0.5 |
| $S(B^0 \rightarrow \rho^0\gamma)$ | -0.8 ± 0.7 |
| $C_{\pi\pi} (B^0 \rightarrow \pi^+\pi^-)$ | -0.31 ± 0.05 |
| $C_{\pi^0\pi^0} (B^0 \rightarrow \pi^0\pi^0)$ | -0.43 ± 0.24 |
| $C_{\rho\pi} (B^0 \rightarrow \rho^+\pi^-)$ | $-0.03 \pm 0.07 (S = 1.2)$ |
| $S_{\rho\pi} (B^0 \rightarrow \rho^+\pi^-)$ | 0.05 ± 0.07 |
| $\Delta S_{\rho\pi} (B^0 \rightarrow \rho^+\pi^-)$ | 0.01 ± 0.08 |
| $C_{\rho^0\pi^0} (B^0 \rightarrow \rho^0\pi^0)$ | 0.27 ± 0.24 |
| $S_{\rho^0\pi^0} (B^0 \rightarrow \rho^0\pi^0)$ | -0.23 ± 0.34 |
| $C_{a_1\pi} (B^0 \rightarrow a_1(1260)^+\pi^-)$ | -0.05 ± 0.11 |
| $S_{a_1\pi} (B^0 \rightarrow a_1(1260)^+\pi^-)$ | $-0.2 \pm 0.4 (S = 3.2)$ |
| $\Delta C_{a_1\pi} (B^0 \rightarrow a_1(1260)^+\pi^-)$ | $0.43 \pm 0.14 (S = 1.3)$ |
| $\Delta S_{a_1\pi} (B^0 \rightarrow a_1(1260)^+\pi^-)$ | -0.11 ± 0.12 |
| $C(B^0 \rightarrow b_1^-K^+)$ | -0.22 ± 0.24 |
| $\Delta C(B^0 \rightarrow b_1^-K^+)$ | -1.04 ± 0.24 |
| $C_{\rho^0\rho^0} (B^0 \rightarrow \rho^0\rho^0)$ | 0.2 ± 0.9 |
| $S_{\rho^0\rho^0} (B^0 \rightarrow \rho^0\rho^0)$ | 0.3 ± 0.7 |
| $C_{\rho\rho} (B^0 \rightarrow \rho^+\rho^-)$ | -0.05 ± 0.13 |
| $S_{\rho\rho} (B^0 \rightarrow \rho^+\rho^-)$ | -0.06 ± 0.17 |
| $ \lambda (B^0 \rightarrow J/\psi K^*(892)^0)$ | $<0.25, \text{CL} = 95\%$ |
| $\cos 2\beta (B^0 \rightarrow J/\psi K^*(892)^0)$ | $1.7^{+0.7}_{-0.9} (S = 1.6)$ |
| $\cos 2\beta (B^0 \rightarrow [K_S^0\pi^+\pi^-]_{D^{(*)}} h^0)$ | $1.0^{+0.6}_{-0.7} (S = 1.8)$ |
| $(S_+ + S_-)/2 (B^0 \rightarrow D^{*-}\pi^+)$ | -0.039 ± 0.011 |
| $(S_- - S_+)/2 (B^0 \rightarrow D^{*-}\pi^+)$ | -0.009 ± 0.015 |
| $(S_+ + S_-)/2 (B^0 \rightarrow D^-\pi^+)$ | -0.046 ± 0.023 |
| $(S_- - S_+)/2 (B^0 \rightarrow D^-\pi^+)$ | -0.022 ± 0.021 |
| $(S_+ + S_-)/2 (B^0 \rightarrow D^-\rho^+)$ | -0.024 ± 0.032 |
| $(S_- - S_+)/2 (B^0 \rightarrow D^-\rho^+)$ | -0.10 ± 0.06 |
| $C_{\eta_c K_S^0} (B^0 \rightarrow \eta_c K_S^0)$ | 0.08 ± 0.13 |
| $C_{c\bar{c}K^{(*)0}} (B^0 \rightarrow c\bar{c}K^{(*)0})$ | $(0.5 \pm 1.7) \times 10^{-2}$ |

| | |
|---|---|
| $C_{J/\psi(nS)K^0} (B^0 \rightarrow J/\psi(nS)K^0)$ | $(0.5 \pm 2.0) \times 10^{-2}$ |
| $C_{J/\psi K^{*0}} (B^0 \rightarrow J/\psi K^{*0})$ | 0.03 ± 0.10 |
| $S_{J/\psi K^{*0}} (B^0 \rightarrow J/\psi K^{*0})$ | 0.60 ± 0.25 |
| $C_{\chi_{c0} K_S^0} (B^0 \rightarrow \chi_{c0} K_S^0)$ | $-0.3^{+0.5}_{-0.4}$ |
| $S_{\chi_{c0} K_S^0} (B^0 \rightarrow \chi_{c0} K_S^0)$ | -0.7 ± 0.5 |
| $C_{\chi_{c1} K_S^0} (B^0 \rightarrow \chi_{c1} K_S^0)$ | 0.06 ± 0.07 |
| $\sin(2\beta_{\text{eff}})(B^0 \rightarrow \phi K^0)$ | 0.22 ± 0.30 |
| $\sin(2\beta_{\text{eff}})(B^0 \rightarrow \phi K_0^{*(1430)0})$ | $0.97^{+0.03}_{-0.52}$ |
| $\sin(2\beta_{\text{eff}})(B^0 \rightarrow [K_S^0 \pi^+ \pi^-]_{D^{(*)}} h^0)$ | 0.45 ± 0.28 |
| $ \lambda (B^0 \rightarrow [K_S^0 \pi^+ \pi^-]_{D^{(*)}} h^0)$ | 1.01 ± 0.08 |
| $ \sin(2\beta + \gamma) $ | $>0.40, \text{CL} = 90\%$ |
| $2\beta + \gamma$ | $(83 \pm 60)^\circ$ |
| $\gamma(B^0 \rightarrow D^0 K^{*0})$ | $(162 \pm 60)^\circ$ |
| $A_{CP}(B \rightarrow K^*(892)\gamma)$ | -0.003 ± 0.017 |
| $A_{CP}(b \rightarrow s\gamma)$ | -0.008 ± 0.029 |
| $A_{CP}(b \rightarrow (s+d)\gamma)$ | -0.01 ± 0.05 |
| $A_{CP}(B \rightarrow X_s \ell^+ \ell^-)$ | -0.22 ± 0.26 |
| $A_{CP}(B \rightarrow K^* e^+ e^-)$ | -0.18 ± 0.15 |
| $A_{CP}(B \rightarrow K^* \mu^+ \mu^-)$ | -0.03 ± 0.13 |
| $A_{CP}(B \rightarrow K^* \ell^+ \ell^-)$ | -0.04 ± 0.07 |
| $A_{CP}(B \rightarrow \eta \text{ anything})$ | $-0.13^{+0.04}_{-0.05}$ |
| $\text{Re}(\epsilon_{B_s^0}) / (1 + \epsilon_{B_s^0} ^2)$ | $(-1.9 \pm 1.0) \times 10^{-3}$ |
| CP Violation phase β_s | $(0.0 \pm 3.5) \times 10^{-2}$ |
| $A_{CP}(B_s \rightarrow \pi^+ K^-)$ | 0.28 ± 0.04 |
| $A_{CP}(B_s^0 \rightarrow [K^+ K^-]_D \bar{K}^*(892)^0)$ | 0.04 ± 0.16 |
| $\Gamma(\eta_c(1S) \rightarrow \pi^+ \pi^-) / \Gamma_{\text{total}}$ | $<1.1 \times 10^{-4}, \text{CL} = 90\%$ |
| $\Gamma(\eta_c(1S) \rightarrow \pi^0 \pi^0) / \Gamma_{\text{total}}$ | $<3.5 \times 10^{-5}, \text{CL} = 90\%$ |
| $\Gamma(\eta_c(1S) \rightarrow K^+ K^-) / \Gamma_{\text{total}}$ | $<6 \times 10^{-4}, \text{CL} = 90\%$ |
| $\Gamma(\eta_c(1S) \rightarrow K_S^0 K_S^0) / \Gamma_{\text{total}}$ | $<3.1 \times 10^{-4}, \text{CL} = 90\%$ |
| $(\alpha + \bar{\alpha}) / (\alpha - \bar{\alpha})$ in $\Lambda \rightarrow p\pi^-, \bar{\Lambda} \rightarrow \bar{p}\pi^+$ | 0.006 ± 0.021 |
| $\frac{[\alpha(\Xi^-)\alpha_-(\Lambda) - \alpha(\Xi^+)\alpha_+(\bar{\Lambda})]}{[\alpha(\Xi^-)\alpha_-(\Lambda) + \alpha(\Xi^+)\alpha_+(\bar{\Lambda})]}$ | $(0 \pm 7) \times 10^{-4}$ |
| $(\alpha + \bar{\alpha}) / (\alpha - \bar{\alpha})$ in $\Omega^- \rightarrow \Lambda K^-, \bar{\Omega}^+ \rightarrow \bar{\Lambda} K^+$ | -0.02 ± 0.13 |
| $(\alpha + \bar{\alpha}) / (\alpha - \bar{\alpha})$ in $\Lambda_c^+ \rightarrow \Lambda \pi^+, \bar{\Lambda}_c^- \rightarrow \bar{\Lambda} \pi^-$ | -0.07 ± 0.31 |
| $(\alpha + \bar{\alpha}) / (\alpha - \bar{\alpha})$ in $\Lambda_c^+ \rightarrow \Lambda e^+ \nu_e, \bar{\Lambda}_c^- \rightarrow \bar{\Lambda} e^- \bar{\nu}_e$ | 0.00 ± 0.04 |
| $A_{CP}(\Lambda_b \rightarrow p\pi^-)$ | 0.03 ± 0.18 |
| $A_{CP}(\Lambda_b \rightarrow pK^-)$ | 0.37 ± 0.17 |

CP VIOLATION OBSERVED

| | |
|---|--|
| Re(ϵ) | (1.596 ± 0.013) × 10 ⁻³ |
| charge asymmetry in $K_{\ell 3}^0$ decays | |
| A_L = weighted average of $A_L(\mu)$ and $A_L(e)$ | (0.332 ± 0.006)% |
| $A_L(\mu) = [\Gamma(\pi^- \mu^+ \nu_\mu) - \Gamma(\pi^+ \mu^- \bar{\nu}_\mu)]/\text{sum}$ | (0.304 ± 0.025)% |
| $A_L(e) = [\Gamma(\pi^- e^+ \nu_e) - \Gamma(\pi^+ e^- \bar{\nu}_e)]/\text{sum}$ | (0.334 ± 0.007)% |
| parameters for $K_L^0 \rightarrow 2\pi$ decay | |
| $ \eta_{00} = A(K_L^0 \rightarrow 2\pi^0) / A(K_S^0 \rightarrow 2\pi^0) $ | (2.220 ± 0.011) × 10 ⁻³ (S = 1.8) |
| $ \eta_{+-} = A(K_L^0 \rightarrow \pi^+ \pi^-) / A(K_S^0 \rightarrow \pi^+ \pi^-) $ | (2.232 ± 0.011) × 10 ⁻³ (S = 1.8) |
| $ \epsilon = (2 \eta_{+-} + \eta_{00})/3$ | (2.228 ± 0.011) × 10 ⁻³ (S = 1.8) |
| $ \eta_{00}/\eta_{+-} $ | [h] 0.9950 ± 0.0007 (S = 1.6) |
| $\text{Re}(\epsilon'/\epsilon) = (1 - \eta_{00}/\eta_{+-})/3$ | [h] (1.66 ± 0.23) × 10 ⁻³ (S = 1.6) |
| Assuming <i>CPT</i> | |
| ϕ_{+-} , phase of η_{+-} | (43.51 ± 0.05) ^o (S = 1.2) |
| ϕ_{00} , phase of η_{00} | (43.52 ± 0.05) ^o (S = 1.3) |
| $\phi_\epsilon = (2\phi_{+-} + \phi_{00})/3$ | (43.52 ± 0.05) ^o (S = 1.2) |
| Not assuming <i>CPT</i> | |
| ϕ_{+-} , phase of η_{+-} | (43.4 ± 0.5) ^o (S = 1.2) |
| ϕ_{00} , phase of η_{00} | (43.7 ± 0.6) ^o (S = 1.2) |
| $\phi_\epsilon = (2\phi_{+-} + \phi_{00})/3$ | (43.5 ± 0.5) ^o (S = 1.3) |
| CP asymmetry A in $K_L^0 \rightarrow \pi^+ \pi^- e^+ e^-$ | (13.7 ± 1.5)% |
| β_{CP} from $K_L^0 \rightarrow e^+ e^- e^+ e^-$ | -0.19 ± 0.07 |
| γ_{CP} from $K_L^0 \rightarrow e^+ e^- e^+ e^-$ | 0.01 ± 0.11 (S = 1.6) |
| parameters for $K_L^0 \rightarrow \pi^+ \pi^- \gamma$ decay | |
| $ \eta_{+-\gamma} = A(K_L^0 \rightarrow \pi^+ \pi^- \gamma, CP \text{ violating}) / A(K_S^0 \rightarrow \pi^+ \pi^- \gamma) $ | (2.35 ± 0.07) × 10 ⁻³ |
| $\phi_{+-\gamma}$ = phase of $\eta_{+-\gamma}$ | (44 ± 4) ^o |
| $\Gamma(K_L^0 \rightarrow \pi^+ \pi^-) / \Gamma_{\text{total}}$ | [j] (1.967 ± 0.010) × 10 ⁻³ (S = 1.5) |
| $\Gamma(K_L^0 \rightarrow \pi^0 \pi^0) / \Gamma_{\text{total}}$ | (8.64 ± 0.06) × 10 ⁻⁴ (S = 1.8) |
| $A_{CP}(B^+ \rightarrow D_{CP(+1)} K^+)$ | 0.170 ± 0.033 (S = 1.2) |
| $A_{ADS}(B^+ \rightarrow DK^+)$ | -0.52 ± 0.15 |
| $A_{CP}(B^+ \rightarrow \eta K^+)$ | -0.37 ± 0.08 |
| $A_{CP}(B^+ \rightarrow f_2(1270) K^+)$ | -0.68 ^{+0.19} _{-0.17} |
| $A_{CP}(B^+ \rightarrow \rho^0 K^+)$ | 0.37 ± 0.10 |
| $A_{CP}(B^+ \rightarrow f_0(1370) \pi^+)$ | 0.72 ± 0.22 |
| $\gamma(B^+ \rightarrow D^{(*)0} K^{(*)+})$ | (73 ⁺⁷ ₋₉) ^o |
| $A_{CP}(B^0 \rightarrow K^+ \pi^-)$ | -0.082 ± 0.006 |

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|--|--------------------------------|
| $A_{CP}(B^0 \rightarrow \eta K^*(892)^0)$ | 0.19 ± 0.05 |
| $S_{D^*(2010)^- D^+}(B^0 \rightarrow D^*(2010)^- D^+)$ | -0.72 ± 0.15 |
| $S_{D^*(2010)^+ D^-}(B^0 \rightarrow D^*(2010)^+ D^-)$ | -0.73 ± 0.14 |
| $S_{D^{*+} D^{*-}}(B^0 \rightarrow D^{*+} D^{*-})$ | -0.59 ± 0.14 (S = 1.8) |
| $S_+(B^0 \rightarrow D^{*+} D^{*-})$ | -0.73 ± 0.09 |
| $S_{D^+ D^-}(B^0 \rightarrow D^+ D^-)$ | $-0.99^{+0.17}_{-0.14}$ |
| $S_{J/\psi(1S)\pi^0}(B^0 \rightarrow J/\psi(1S)\pi^0)$ | -0.94 ± 0.29 (S = 1.9) |
| $S_{K^0\pi^0}(B^0 \rightarrow K^0\pi^0)$ | 0.58 ± 0.17 |
| $S_{\eta' K^0}(B^0 \rightarrow \eta' K^0)$ | 0.60 ± 0.07 |
| $S_{K^+ K^- K_S^0}(B^0 \rightarrow K^+ K^- K_S^0 \text{ nonresonant})$ | -0.66 ± 0.11 |
| $S_{K^+ K^- K_S^0}(B^0 \rightarrow K^+ K^- K_S^0 \text{ inclusive})$ | -0.65 ± 0.12 |
| $S_{\pi\pi}(B^0 \rightarrow \pi^+ \pi^-)$ | -0.67 ± 0.06 |
| $\Delta C_{\rho\pi}(B^0 \rightarrow \rho^+ \pi^-)$ | 0.27 ± 0.06 |
| $S_{\eta_c K_S^0}(B^0 \rightarrow \eta_c K_S^0)$ | 0.93 ± 0.17 |
| $\sin(2\beta)(B^0 \rightarrow J/\psi K_S^0)$ | 0.682 ± 0.019 |
| $S_{J/\psi(nS)K^0}(B^0 \rightarrow J/\psi(nS)K^0)$ | 0.676 ± 0.021 |
| $S_{\chi_{c1} K_S^0}(B^0 \rightarrow \chi_{c1} K_S^0)$ | 0.63 ± 0.10 |
| $\sin(2\beta_{\text{eff}})(B^0 \rightarrow K^+ K^- K_S^0)$ | $0.77^{+0.13}_{-0.12}$ |
| α | $(90 \pm 5)^\circ$ |
| $\text{Re}(\epsilon_b) / (1 + \epsilon_b ^2)$ | $(1.2 \pm 0.4) \times 10^{-3}$ |

CPT INVARIANCE

| | |
|---|--------------------------------------|
| $(m_{W^+} - m_{W^-}) / m_{\text{average}}$ | -0.002 ± 0.007 |
| $(m_{e^+} - m_{e^-}) / m_{\text{average}}$ | $< 8 \times 10^{-9}$, CL = 90% |
| $ q_{e^+} + q_{e^-} /e$ | $< 4 \times 10^{-8}$ |
| $(g_{e^+} - g_{e^-}) / g_{\text{average}}$ | $(-0.5 \pm 2.1) \times 10^{-12}$ |
| $(\tau_{\mu^+} - \tau_{\mu^-}) / \tau_{\text{average}}$ | $(2 \pm 8) \times 10^{-5}$ |
| $(g_{\mu^+} - g_{\mu^-}) / g_{\text{average}}$ | $(-0.11 \pm 0.12) \times 10^{-8}$ |
| $(m_{\tau^+} - m_{\tau^-}) / m_{\text{average}}$ | $< 2.8 \times 10^{-4}$, CL = 90% |
| $m_t - m_{\bar{t}}$ | $-0.2 \pm 0.5 \text{ GeV}$ (S = 1.1) |
| $(m_{\pi^+} - m_{\pi^-}) / m_{\text{average}}$ | $(2 \pm 5) \times 10^{-4}$ |
| $(\tau_{\pi^+} - \tau_{\pi^-}) / \tau_{\text{average}}$ | $(6 \pm 7) \times 10^{-4}$ |
| $(m_{K^+} - m_{K^-}) / m_{\text{average}}$ | $(-0.6 \pm 1.8) \times 10^{-4}$ |
| $(\tau_{K^+} - \tau_{K^-}) / \tau_{\text{average}}$ | $(0.10 \pm 0.09)\%$ (S = 1.2) |
| $K^\pm \rightarrow \mu^\pm \nu_\mu$ rate difference/average | $(-0.5 \pm 0.4)\%$ |

| | |
|---|---|
| $K^\pm \rightarrow \pi^\pm \pi^0$ rate difference/average | [j] $(0.8 \pm 1.2)\%$ |
| δ in $K^0 - \bar{K}^0$ mixing | |
| real part of δ | $(2.5 \pm 2.3) \times 10^{-4}$ |
| imaginary part of δ | $(-1.5 \pm 1.6) \times 10^{-5}$ |
| Re(y), K_{e3} parameter | $(0.4 \pm 2.5) \times 10^{-3}$ |
| Re(x ₋), K_{e3} parameter | $(-2.9 \pm 2.0) \times 10^{-3}$ |
| $ m_{K^0} - m_{\bar{K}^0} / m_{\text{average}}$ | [k] $< 6 \times 10^{-19}$, CL = 90% |
| $(\Gamma_{K^0} - \Gamma_{\bar{K}^0}) / m_{\text{average}}$ | $(8 \pm 8) \times 10^{-18}$ |
| phase difference $\phi_{00} - \phi_{+-}$ | $(0.34 \pm 0.32)^\circ$ |
| $\text{Re}(\frac{2}{3}\eta_{+-} + \frac{1}{3}\eta_{00}) - \frac{A_I}{2}$ | $(-3 \pm 35) \times 10^{-6}$ |
| $A_{CPT}(D^0 \rightarrow K^- \pi^+)$ | 0.008 ± 0.008 |
| $\Delta S_{CPT}^+(S_{\ell^+, K_S^0}^- - S_{\ell^+, K_S^0}^+)$ | 0.16 ± 0.23 |
| $\Delta S_{CPT}^-(S_{\ell^+, K_S^0}^+ - S_{\ell^+, K_S^0}^-)$ | -0.03 ± 0.14 |
| $\Delta C_{CPT}^+(C_{\ell^+, K_S^0}^- - C_{\ell^+, K_S^0}^+)$ | 0.14 ± 0.17 |
| $\Delta C_{CPT}^-(C_{\ell^+, K_S^0}^+ - C_{\ell^+, K_S^0}^-)$ | 0.03 ± 0.14 |
| $ m_p - m_{\bar{p}} / m_p$ | [l] $< 7 \times 10^{-10}$, CL = 90% |
| $(\frac{q_{\bar{p}}}{m_{\bar{p}}} - \frac{q_p}{m_p}) / \frac{q_p}{m_p}$ | $(-9 \pm 9) \times 10^{-11}$ |
| $ q_p + q_{\bar{p}} / e$ | [l] $< 7 \times 10^{-10}$, CL = 90% |
| $(\mu_p + \mu_{\bar{p}}) / \mu_p$ | $(0 \pm 5) \times 10^{-6}$ |
| $(m_n - m_{\bar{n}}) / m_n$ | $(9 \pm 6) \times 10^{-5}$ |
| $(m_\Lambda - m_{\bar{\Lambda}}) / m_\Lambda$ | $(-0.1 \pm 1.1) \times 10^{-5}$ (S = 1.6) |
| $(\tau_\Lambda - \tau_{\bar{\Lambda}}) / \tau_\Lambda$ | -0.001 ± 0.009 |
| $(\tau_{\Sigma^+} - \tau_{\bar{\Sigma}^-}) / \tau_{\Sigma^+}$ | $(-0.6 \pm 1.2) \times 10^{-3}$ |
| $(\mu_{\Sigma^+} + \mu_{\bar{\Sigma}^-}) / \mu_{\Sigma^+}$ | 0.014 ± 0.015 |
| $(m_{\Xi^-} - m_{\bar{\Xi}^+}) / m_{\Xi^-}$ | $(-3 \pm 9) \times 10^{-5}$ |
| $(\tau_{\Xi^-} - \tau_{\bar{\Xi}^+}) / \tau_{\Xi^-}$ | -0.01 ± 0.07 |
| $(\mu_{\Xi^-} + \mu_{\bar{\Xi}^+}) / \mu_{\Xi^-} $ | $+0.01 \pm 0.05$ |
| $(m_{\Omega^-} - m_{\bar{\Omega}^+}) / m_{\Omega^-}$ | $(-1 \pm 8) \times 10^{-5}$ |
| $(\tau_{\Omega^-} - \tau_{\bar{\Omega}^+}) / \tau_{\Omega^-}$ | 0.00 ± 0.05 |

TESTS OF NUMBER CONSERVATION LAWS

LEPTON FAMILY NUMBER

Lepton family number conservation means separate conservation of each of L_e , L_μ , L_τ .

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|--|---|
| $\Gamma(Z \rightarrow e^\pm \mu^\mp) / \Gamma_{\text{total}}$ | [n] $< 1.7 \times 10^{-6}$, CL = 95% |
| $\Gamma(Z \rightarrow e^\pm \tau^\mp) / \Gamma_{\text{total}}$ | [n] $< 9.8 \times 10^{-6}$, CL = 95% |
| $\Gamma(Z \rightarrow \mu^\pm \tau^\mp) / \Gamma_{\text{total}}$ | [n] $< 1.2 \times 10^{-5}$, CL = 95% |
| $\sigma(e^+ e^- \rightarrow e^\pm \tau^\mp) / \sigma(e^+ e^- \rightarrow \mu^+ \mu^-)$ | $< 8.9 \times 10^{-6}$, CL = 95% |
| $\sigma(e^+ e^- \rightarrow \mu^\pm \tau^\mp) / \sigma(e^+ e^- \rightarrow \mu^+ \mu^-)$ | $< 4.0 \times 10^{-6}$, CL = 95% |
| limit on $\mu^- \rightarrow e^-$ conversion | |
| $\sigma(\mu^- {}^{32}\text{S} \rightarrow e^- {}^{32}\text{S}) /$ $\sigma(\mu^- {}^{32}\text{S} \rightarrow \nu_\mu {}^{32}\text{P}^*)$ | $< 7 \times 10^{-11}$, CL = 90% |
| $\sigma(\mu^- \text{Ti} \rightarrow e^- \text{Ti}) /$ $\sigma(\mu^- \text{Ti} \rightarrow \text{capture})$ | $< 4.3 \times 10^{-12}$, CL = 90% |
| $\sigma(\mu^- \text{Pb} \rightarrow e^- \text{Pb}) /$ $\sigma(\mu^- \text{Pb} \rightarrow \text{capture})$ | $< 4.6 \times 10^{-11}$, CL = 90% |
| limit on muonium \rightarrow antimuonium conversion $R_g =$ G_C / G_F | < 0.0030 , CL = 90% |
| $\Gamma(\mu^- \rightarrow e^- \nu_e \bar{\nu}_\mu) / \Gamma_{\text{total}}$ | [o] $< 1.2 \times 10^{-2}$, CL = 90% |
| $\Gamma(\mu^- \rightarrow e^- \gamma) / \Gamma_{\text{total}}$ | $< 5.7 \times 10^{-13}$, CL = 90% |
| $\Gamma(\mu^- \rightarrow e^- e^+ e^-) / \Gamma_{\text{total}}$ | $< 1.0 \times 10^{-12}$, CL = 90% |
| $\Gamma(\mu^- \rightarrow e^- 2\gamma) / \Gamma_{\text{total}}$ | $< 7.2 \times 10^{-11}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \gamma) / \Gamma_{\text{total}}$ | $< 3.3 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \gamma) / \Gamma_{\text{total}}$ | $< 4.4 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \pi^0) / \Gamma_{\text{total}}$ | $< 8.0 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \pi^0) / \Gamma_{\text{total}}$ | $< 1.1 \times 10^{-7}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- K_S^0) / \Gamma_{\text{total}}$ | $< 2.6 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- K_S^0) / \Gamma_{\text{total}}$ | $< 2.3 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \eta) / \Gamma_{\text{total}}$ | $< 9.2 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \eta) / \Gamma_{\text{total}}$ | $< 6.5 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \rho^0) / \Gamma_{\text{total}}$ | $< 1.8 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \rho^0) / \Gamma_{\text{total}}$ | $< 1.2 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \omega) / \Gamma_{\text{total}}$ | $< 4.8 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \omega) / \Gamma_{\text{total}}$ | $< 4.7 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- K^*(892)^0) / \Gamma_{\text{total}}$ | $< 3.2 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- K^*(892)^0) / \Gamma_{\text{total}}$ | $< 5.9 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \bar{K}^*(892)^0) / \Gamma_{\text{total}}$ | $< 3.4 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \bar{K}^*(892)^0) / \Gamma_{\text{total}}$ | $< 7.0 \times 10^{-8}$, CL = 90% |

| | |
|---|----------------------------------|
| $\Gamma(\tau^- \rightarrow e^- \eta'(958))/\Gamma_{\text{total}}$ | $<1.6 \times 10^{-7}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \eta'(958))/\Gamma_{\text{total}}$ | $<1.3 \times 10^{-7}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- f_0(980) \rightarrow e^- \pi^+ \pi^-)/\Gamma_{\text{total}}$ | $<3.2 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- f_0(980) \rightarrow \mu^- \pi^+ \pi^-)/\Gamma_{\text{total}}$ | $<3.4 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \phi)/\Gamma_{\text{total}}$ | $<3.1 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \phi)/\Gamma_{\text{total}}$ | $<8.4 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- e^+ e^-)/\Gamma_{\text{total}}$ | $<2.7 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<2.7 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^+ \mu^- \mu^-)/\Gamma_{\text{total}}$ | $<1.7 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- e^+ e^-)/\Gamma_{\text{total}}$ | $<1.8 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^+ e^- e^-)/\Gamma_{\text{total}}$ | $<1.5 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<2.1 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \pi^+ \pi^-)/\Gamma_{\text{total}}$ | $<2.3 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \pi^+ \pi^-)/\Gamma_{\text{total}}$ | $<2.1 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \pi^+ K^-)/\Gamma_{\text{total}}$ | $<3.7 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \pi^- K^+)/\Gamma_{\text{total}}$ | $<3.1 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- K_S^0 K_S^0)/\Gamma_{\text{total}}$ | $<7.1 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- K^+ K^-)/\Gamma_{\text{total}}$ | $<3.4 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \pi^+ K^-)/\Gamma_{\text{total}}$ | $<8.6 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \pi^- K^+)/\Gamma_{\text{total}}$ | $<4.5 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- K_S^0 K_S^0)/\Gamma_{\text{total}}$ | $<8.0 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- K^+ K^-)/\Gamma_{\text{total}}$ | $<4.4 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \pi^0 \pi^0)/\Gamma_{\text{total}}$ | $<6.5 \times 10^{-6}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \pi^0 \pi^0)/\Gamma_{\text{total}}$ | $<1.4 \times 10^{-5}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \eta \eta)/\Gamma_{\text{total}}$ | $<3.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \eta \eta)/\Gamma_{\text{total}}$ | $<6.0 \times 10^{-5}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \pi^0 \eta)/\Gamma_{\text{total}}$ | $<2.4 \times 10^{-5}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^- \pi^0 \eta)/\Gamma_{\text{total}}$ | $<2.2 \times 10^{-5}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^- \text{light boson})/\Gamma_{\text{total}}$ | $<2.7 \times 10^{-3}$, CL = 95% |
| $\Gamma(\tau^- \rightarrow \mu^- \text{light boson})/\Gamma_{\text{total}}$ | $<5 \times 10^{-3}$, CL = 95% |

LEPTON FAMILY NUMBER VIOLATION IN NEUTRINOS

| | |
|---|---|
| $\sin^2(2\theta_{12})$ | 0.846 ± 0.021 |
| Δm_{21}^2 | $(7.53 \pm 0.18) \times 10^{-5} \text{ eV}^2$ |
| $\sin^2(2\theta_{23})$ (normal mass hierarchy) | $0.999^{+0.001}_{-0.018}$ |
| $\sin^2(2\theta_{23})$ (inverted mass hierarchy) | $1.000^{+0.000}_{-0.017}$ |
| Δm_{32}^2 (normal mass hierarchy) | [p] $(2.44 \pm 0.06) \times 10^{-3} \text{ eV}^2$ |
| Δm_{32}^2 (inverted mass hierarchy) | [p] $(2.52 \pm 0.07) \times 10^{-3} \text{ eV}^2$ |
| $\sin^2(2\theta_{13})$ | $(9.3 \pm 0.8) \times 10^{-2}$ |
| $\Gamma(\pi^+ \rightarrow \mu^+ \nu_e)/\Gamma_{\text{total}}$ | [q] $<8.0 \times 10^{-3}$, CL = 90% |
| $\Gamma(\pi^+ \rightarrow \mu^- e^+ e^+ \nu)/\Gamma_{\text{total}}$ | $<1.6 \times 10^{-6}$, CL = 90% |
| $\Gamma(\pi^0 \rightarrow \mu^+ e^-)/\Gamma_{\text{total}}$ | $<3.8 \times 10^{-10}$, CL = 90% |

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| $\Gamma(\pi^0 \rightarrow \mu^- e^+)/\Gamma_{\text{total}}$ | $<3.4 \times 10^{-9}$, CL = 90% |
| $\Gamma(\pi^0 \rightarrow \mu^+ e^- + \mu^- e^+)/\Gamma_{\text{total}}$ | $<3.6 \times 10^{-10}$, CL = 90% |
| $\Gamma(\eta \rightarrow \mu^+ e^- + \mu^- e^+)/\Gamma_{\text{total}}$ | $<6 \times 10^{-6}$, CL = 90% |
| $\Gamma(\eta'(958) \rightarrow e\mu)/\Gamma_{\text{total}}$ | $<4.7 \times 10^{-4}$, CL = 90% |
| $\Gamma(\phi(1020) \rightarrow e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<2 \times 10^{-6}$, CL = 90% |
| $\Gamma(K^+ \rightarrow \mu^- \nu e^+ e^+)/\Gamma_{\text{total}}$ | $<2.1 \times 10^{-8}$, CL = 90% |
| $\Gamma(K^+ \rightarrow \mu^+ \nu_e)/\Gamma_{\text{total}}$ | [q] $<4 \times 10^{-3}$, CL = 90% |
| $\Gamma(K^+ \rightarrow \pi^+ \mu^+ e^-)/\Gamma_{\text{total}}$ | $<1.3 \times 10^{-11}$, CL = 90% |
| $\Gamma(K^+ \rightarrow \pi^+ \mu^- e^+)/\Gamma_{\text{total}}$ | $<5.2 \times 10^{-10}$, CL = 90% |
| $\Gamma(K_L^0 \rightarrow e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<4.7 \times 10^{-12}$, CL = 90% |
| $\Gamma(K_L^0 \rightarrow e^\pm e^\pm \mu^\mp \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<4.12 \times 10^{-11}$, CL = 90% |
| $\Gamma(K_L^0 \rightarrow \pi^0 \mu^\pm e^\mp)/\Gamma_{\text{total}}$ | [n] $<7.6 \times 10^{-11}$, CL = 90% |
| $\Gamma(K_L^0 \rightarrow \pi^0 \pi^0 \mu^\pm e^\mp)/\Gamma_{\text{total}}$ | $<1.7 \times 10^{-10}$, CL = 90% |
| $\Gamma(D^+ \rightarrow \pi^+ e^+ \mu^-)/\Gamma_{\text{total}}$ | $<2.9 \times 10^{-6}$, CL = 90% |
| $\Gamma(D^+ \rightarrow \pi^+ e^- \mu^+)/\Gamma_{\text{total}}$ | $<3.6 \times 10^{-6}$, CL = 90% |
| $\Gamma(D^+ \rightarrow K^+ e^+ \mu^-)/\Gamma_{\text{total}}$ | $<1.2 \times 10^{-6}$, CL = 90% |
| $\Gamma(D^+ \rightarrow K^+ e^- \mu^+)/\Gamma_{\text{total}}$ | $<2.8 \times 10^{-6}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \mu^\pm e^\mp)/\Gamma_{\text{total}}$ | [n] $<2.6 \times 10^{-7}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \pi^0 e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<8.6 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \eta e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<1.0 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \pi^+ \pi^- e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<1.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \rho^0 e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<4.9 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \omega e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<1.2 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow K^- K^+ e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<1.8 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \phi e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<3.4 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \bar{K}^0 e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<1.0 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow K^- \pi^+ e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<5.53 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \bar{K}^*(892)^0 e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [n] $<8.3 \times 10^{-5}$, CL = 90% |
| $\Gamma(D_s^+ \rightarrow \pi^+ e^+ \mu^-)/\Gamma_{\text{total}}$ | $<1.2 \times 10^{-5}$, CL = 90% |
| $\Gamma(D_s^+ \rightarrow \pi^+ e^- \mu^+)/\Gamma_{\text{total}}$ | $<2.0 \times 10^{-5}$, CL = 90% |
| $\Gamma(D_s^+ \rightarrow K^+ e^+ \mu^-)/\Gamma_{\text{total}}$ | $<1.4 \times 10^{-5}$, CL = 90% |
| $\Gamma(D_s^+ \rightarrow K^+ e^- \mu^+)/\Gamma_{\text{total}}$ | $<9.7 \times 10^{-6}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ e^+ \mu^-)/\Gamma_{\text{total}}$ | $<6.4 \times 10^{-3}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ e^- \mu^+)/\Gamma_{\text{total}}$ | $<6.4 \times 10^{-3}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<1.7 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ e^+ \tau^-)/\Gamma_{\text{total}}$ | $<7.4 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ e^- \tau^+)/\Gamma_{\text{total}}$ | $<2.0 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ e^\pm \tau^\mp)/\Gamma_{\text{total}}$ | $<7.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ \mu^+ \tau^-)/\Gamma_{\text{total}}$ | $<6.2 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ \mu^- \tau^+)/\Gamma_{\text{total}}$ | $<4.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ \mu^\pm \tau^\mp)/\Gamma_{\text{total}}$ | $<7.2 \times 10^{-5}$, CL = 90% |

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| $\Gamma(B^+ \rightarrow K^+ e^+ \mu^-)/\Gamma_{\text{total}}$ | $<9.1 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^+ e^- \mu^+)/\Gamma_{\text{total}}$ | $<1.3 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^+ e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<9.1 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^+ e^+ \tau^-)/\Gamma_{\text{total}}$ | $<4.3 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^+ e^- \tau^+)/\Gamma_{\text{total}}$ | $<1.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^+ e^\pm \tau^\mp)/\Gamma_{\text{total}}$ | $<3.0 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^+ \mu^+ \tau^-)/\Gamma_{\text{total}}$ | $<4.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^+ \mu^- \tau^+)/\Gamma_{\text{total}}$ | $<2.8 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^+ \mu^\pm \tau^\mp)/\Gamma_{\text{total}}$ | $<4.8 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^*(892)^+ e^+ \mu^-)/\Gamma_{\text{total}}$ | $<1.3 \times 10^{-6}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^*(892)^+ e^- \mu^+)/\Gamma_{\text{total}}$ | $<9.9 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^*(892)^+ e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<1.4 \times 10^{-6}$, CL = 90% |
| $\Gamma(B^0 \rightarrow e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [<i>n</i>] $<2.8 \times 10^{-9}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \pi^0 e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<1.4 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^0 \rightarrow K^0 e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<2.7 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^0 \rightarrow K^*(892)^0 e^+ \mu^-)/\Gamma_{\text{total}}$ | $<5.3 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^0 \rightarrow K^*(892)^0 e^- \mu^+)/\Gamma_{\text{total}}$ | $<3.4 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^0 \rightarrow K^*(892)^0 e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<5.8 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^0 \rightarrow e^\pm \tau^\mp)/\Gamma_{\text{total}}$ | [<i>n</i>] $<2.8 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \mu^\pm \tau^\mp)/\Gamma_{\text{total}}$ | [<i>n</i>] $<2.2 \times 10^{-5}$, CL = 90% |
| $\Gamma(B \rightarrow s e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [<i>n</i>] $<2.2 \times 10^{-5}$, CL = 90% |
| $\Gamma(B \rightarrow \pi e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<9.2 \times 10^{-8}$, CL = 90% |
| $\Gamma(B \rightarrow \rho e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<3.2 \times 10^{-6}$, CL = 90% |
| $\Gamma(B \rightarrow K e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<3.8 \times 10^{-8}$, CL = 90% |
| $\Gamma(B \rightarrow K^*(892) e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<5.1 \times 10^{-7}$, CL = 90% |
| $\Gamma(B_s^0 \rightarrow e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | [<i>n</i>] $<1.1 \times 10^{-8}$, CL = 90% |
| $\Gamma(J/\psi(1S) \rightarrow e^\pm \mu^\mp)/\Gamma_{\text{total}}$ | $<1.6 \times 10^{-7}$, CL = 90% |
| $\Gamma(J/\psi(1S) \rightarrow e^\pm \tau^\mp)/\Gamma_{\text{total}}$ | $<8.3 \times 10^{-6}$, CL = 90% |
| $\Gamma(J/\psi(1S) \rightarrow \mu^\pm \tau^\mp)/\Gamma_{\text{total}}$ | $<2.0 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Upsilon(1S) \rightarrow \mu^\pm \tau^\mp)/\Gamma_{\text{total}}$ | $<6.0 \times 10^{-6}$, CL = 95% |
| $\Gamma(\Upsilon(2S) \rightarrow e^\pm \tau^\mp)/\Gamma_{\text{total}}$ | $<3.2 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Upsilon(2S) \rightarrow \mu^\pm \tau^\mp)/\Gamma_{\text{total}}$ | $<3.3 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Upsilon(3S) \rightarrow e^\pm \tau^\mp)/\Gamma_{\text{total}}$ | $<4.2 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Upsilon(3S) \rightarrow \mu^\pm \tau^\mp)/\Gamma_{\text{total}}$ | $<3.1 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Lambda_c^+ \rightarrow p e^+ \mu^-)/\Gamma_{\text{total}}$ | $<9.9 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Lambda_c^+ \rightarrow p e^- \mu^+)/\Gamma_{\text{total}}$ | $<1.9 \times 10^{-5}$, CL = 90% |

TOTAL LEPTON NUMBER

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

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| $\Gamma(Z \rightarrow \rho e)/\Gamma_{\text{total}}$ | $<1.8 \times 10^{-6}$, CL = 95% |
| $\Gamma(Z \rightarrow \rho \mu)/\Gamma_{\text{total}}$ | $<1.8 \times 10^{-6}$, CL = 95% |
| limit on $\mu^- \rightarrow e^+$ conversion | |
| $\sigma(\mu^- {}^{32}\text{S} \rightarrow e^+ {}^{32}\text{Si}^*) /$ $\sigma(\mu^- {}^{32}\text{S} \rightarrow \nu_\mu {}^{32}\text{P}^*)$ | $<9 \times 10^{-10}$, CL = 90% |
| $\sigma(\mu^- {}^{127}\text{I} \rightarrow e^+ {}^{127}\text{Sb}^*) /$ $\sigma(\mu^- {}^{127}\text{I} \rightarrow \text{anything})$ | $<3 \times 10^{-10}$, CL = 90% |
| $\sigma(\mu^- \text{Ti} \rightarrow e^+ \text{Ca}) /$ $\sigma(\mu^- \text{Ti} \rightarrow \text{capture})$ | $<3.6 \times 10^{-11}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^+ \pi^- \pi^-)/\Gamma_{\text{total}}$ | $<2.0 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^+ \pi^- \pi^-)/\Gamma_{\text{total}}$ | $<3.9 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^+ \pi^- K^-)/\Gamma_{\text{total}}$ | $<3.2 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow e^+ K^- K^-)/\Gamma_{\text{total}}$ | $<3.3 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^+ \pi^- K^-)/\Gamma_{\text{total}}$ | $<4.8 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \mu^+ K^- K^-)/\Gamma_{\text{total}}$ | $<4.7 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \rho \mu^- \mu^-)/\Gamma_{\text{total}}$ | $<4.4 \times 10^{-7}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{\rho} \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<3.3 \times 10^{-7}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{\rho} \gamma)/\Gamma_{\text{total}}$ | $<3.5 \times 10^{-6}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{\rho} \pi^0)/\Gamma_{\text{total}}$ | $<1.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{\rho} 2\pi^0)/\Gamma_{\text{total}}$ | $<3.3 \times 10^{-5}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{\rho} \eta)/\Gamma_{\text{total}}$ | $<8.9 \times 10^{-6}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{\rho} \pi^0 \eta)/\Gamma_{\text{total}}$ | $<2.7 \times 10^{-5}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \Lambda \pi^-)/\Gamma_{\text{total}}$ | $<7.2 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{\Lambda} \pi^-)/\Gamma_{\text{total}}$ | $<1.4 \times 10^{-7}$, CL = 90% |
| $t_{1/2}({}^{76}\text{Ge} \rightarrow {}^{76}\text{Se} + 2 e^-)$ | $>1.9 \times 10^{25}$ yr, CL = 90% |
| $\Gamma(\pi^+ \rightarrow \mu^+ \bar{\nu}_e)/\Gamma_{\text{total}}$ | [q] $<1.5 \times 10^{-3}$, CL = 90% |
| $\Gamma(K^+ \rightarrow \pi^- \mu^+ e^+)/\Gamma_{\text{total}}$ | $<5.0 \times 10^{-10}$, CL = 90% |
| $\Gamma(K^+ \rightarrow \pi^- e^+ e^+)/\Gamma_{\text{total}}$ | $<6.4 \times 10^{-10}$, CL = 90% |
| $\Gamma(K^+ \rightarrow \pi^- \mu^+ \mu^+)/\Gamma_{\text{total}}$ | [q] $<1.1 \times 10^{-9}$, CL = 90% |
| $\Gamma(K^+ \rightarrow \mu^+ \bar{\nu}_e)/\Gamma_{\text{total}}$ | [q] $<3.3 \times 10^{-3}$, CL = 90% |
| $\Gamma(K^+ \rightarrow \pi^0 e^+ \bar{\nu}_e)/\Gamma_{\text{total}}$ | $<3 \times 10^{-3}$, CL = 90% |
| $\Gamma(D^+ \rightarrow \pi^- 2e^+)/\Gamma_{\text{total}}$ | $<1.1 \times 10^{-6}$, CL = 90% |
| $\Gamma(D^+ \rightarrow \pi^- 2\mu^+)/\Gamma_{\text{total}}$ | $<2.2 \times 10^{-8}$, CL = 90% |
| $\Gamma(D^+ \rightarrow \pi^- e^+ \mu^+)/\Gamma_{\text{total}}$ | $<2.0 \times 10^{-6}$, CL = 90% |
| $\Gamma(D^+ \rightarrow \rho^- 2\mu^+)/\Gamma_{\text{total}}$ | $<5.6 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^+ \rightarrow K^- 2e^+)/\Gamma_{\text{total}}$ | $<9 \times 10^{-7}$, CL = 90% |
| $\Gamma(D^+ \rightarrow K^- 2\mu^+)/\Gamma_{\text{total}}$ | $<1.0 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^+ \rightarrow K^- e^+ \mu^+)/\Gamma_{\text{total}}$ | $<1.9 \times 10^{-6}$, CL = 90% |

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| $\Gamma(D^+ \rightarrow K^*(892)^- 2\mu^+)/\Gamma_{\text{total}}$ | $<8.5 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow 2\pi^- 2e^+ + \text{c.c.})/\Gamma_{\text{total}}$ | $<1.12 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow 2\pi^- 2\mu^+ + \text{c.c.})/\Gamma_{\text{total}}$ | $<2.9 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow K^- \pi^- 2e^+ + \text{c.c.})/\Gamma_{\text{total}}$ | $<2.06 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow K^- \pi^- 2\mu^+ + \text{c.c.})/\Gamma_{\text{total}}$ | $<3.9 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow 2K^- 2e^+ + \text{c.c.})/\Gamma_{\text{total}}$ | $<1.52 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow 2K^- 2\mu^+ + \text{c.c.})/\Gamma_{\text{total}}$ | $<9.4 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \pi^- \pi^- e^+ \mu^+ + \text{c.c.})/\Gamma_{\text{total}}$ | $<7.9 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow K^- \pi^- e^+ \mu^+ + \text{c.c.})/\Gamma_{\text{total}}$ | $<2.18 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow 2K^- e^+ \mu^+ + \text{c.c.})/\Gamma_{\text{total}}$ | $<5.7 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow p e^-)/\Gamma_{\text{total}}$ | [r] $<1.0 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \bar{p} e^+)/\Gamma_{\text{total}}$ | [s] $<1.1 \times 10^{-5}$, CL = 90% |
| $\Gamma(D_s^+ \rightarrow \pi^- 2e^+)/\Gamma_{\text{total}}$ | $<4.1 \times 10^{-6}$, CL = 90% |
| $\Gamma(D_s^+ \rightarrow \pi^- 2\mu^+)/\Gamma_{\text{total}}$ | $<1.2 \times 10^{-7}$, CL = 90% |
| $\Gamma(D_s^+ \rightarrow \pi^- e^+ \mu^+)/\Gamma_{\text{total}}$ | $<8.4 \times 10^{-6}$, CL = 90% |
| $\Gamma(D_s^+ \rightarrow K^- 2e^+)/\Gamma_{\text{total}}$ | $<5.2 \times 10^{-6}$, CL = 90% |
| $\Gamma(D_s^+ \rightarrow K^- 2\mu^+)/\Gamma_{\text{total}}$ | $<1.3 \times 10^{-5}$, CL = 90% |
| $\Gamma(D_s^+ \rightarrow K^- e^+ \mu^+)/\Gamma_{\text{total}}$ | $<6.1 \times 10^{-6}$, CL = 90% |
| $\Gamma(D_s^+ \rightarrow K^*(892)^- 2\mu^+)/\Gamma_{\text{total}}$ | $<1.4 \times 10^{-3}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^- e^+ e^+)/\Gamma_{\text{total}}$ | $<2.3 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^- \mu^+ \mu^+)/\Gamma_{\text{total}}$ | $<1.3 \times 10^{-8}$, CL = 95% |
| $\Gamma(B^+ \rightarrow \pi^- e^+ \mu^+)/\Gamma_{\text{total}}$ | $<1.5 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \rho^- e^+ e^+)/\Gamma_{\text{total}}$ | $<1.7 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \rho^- \mu^+ \mu^+)/\Gamma_{\text{total}}$ | $<4.2 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \rho^- e^+ \mu^+)/\Gamma_{\text{total}}$ | $<4.7 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^- e^+ e^+)/\Gamma_{\text{total}}$ | $<3.0 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^- \mu^+ \mu^+)/\Gamma_{\text{total}}$ | $<4.1 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^- e^+ \mu^+)/\Gamma_{\text{total}}$ | $<1.6 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^*(892)^- e^+ e^+)/\Gamma_{\text{total}}$ | $<4.0 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^*(892)^- \mu^+ \mu^+)/\Gamma_{\text{total}}$ | $<5.9 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^*(892)^- e^+ \mu^+)/\Gamma_{\text{total}}$ | $<3.0 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^+ \rightarrow D^- e^+ e^+)/\Gamma_{\text{total}}$ | $<2.6 \times 10^{-6}$, CL = 90% |
| $\Gamma(B^+ \rightarrow D^- e^+ \mu^+)/\Gamma_{\text{total}}$ | $<1.8 \times 10^{-6}$, CL = 90% |
| $\Gamma(B^+ \rightarrow D^- \mu^+ \mu^+)/\Gamma_{\text{total}}$ | $<6.9 \times 10^{-7}$, CL = 95% |
| $\Gamma(B^+ \rightarrow D^{*-} \mu^+ \mu^+)/\Gamma_{\text{total}}$ | $<2.4 \times 10^{-6}$, CL = 95% |
| $\Gamma(B^+ \rightarrow D_s^- \mu^+ \mu^+)/\Gamma_{\text{total}}$ | $<5.8 \times 10^{-7}$, CL = 95% |
| $\Gamma(B^+ \rightarrow \bar{D}^0 \pi^- \mu^+ \mu^+)/\Gamma_{\text{total}}$ | $<1.5 \times 10^{-6}$, CL = 95% |
| $\Gamma(B^+ \rightarrow \Lambda^0 \mu^+)/\Gamma_{\text{total}}$ | $<6 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \Lambda^0 e^+)/\Gamma_{\text{total}}$ | $<3.2 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \bar{\Lambda}^0 \mu^+)/\Gamma_{\text{total}}$ | $<6 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \bar{\Lambda}^0 e^+)/\Gamma_{\text{total}}$ | $<8 \times 10^{-8}$, CL = 90% |

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| $\Gamma(B^0 \rightarrow \Lambda_c^+ \mu^-)/\Gamma_{\text{total}}$ | $<1.8 \times 10^{-6}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \Lambda_c^+ e^-)/\Gamma_{\text{total}}$ | $<5 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Xi^- \rightarrow p \mu^- \mu^-)/\Gamma_{\text{total}}$ | $<4 \times 10^{-8}$, CL = 90% |
| $\Gamma(\Lambda_c^+ \rightarrow \bar{p} 2e^+)/\Gamma_{\text{total}}$ | $<2.7 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Lambda_c^+ \rightarrow \bar{p} 2\mu^+)/\Gamma_{\text{total}}$ | $<9.4 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Lambda_c^+ \rightarrow \bar{p} e^+ \mu^+)/\Gamma_{\text{total}}$ | $<1.6 \times 10^{-5}$, CL = 90% |
| $\Gamma(\Lambda_c^+ \rightarrow \Sigma^- \mu^+ \mu^+)/\Gamma_{\text{total}}$ | $<7.0 \times 10^{-4}$, CL = 90% |

BARYON NUMBER

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| $\Gamma(Z \rightarrow pe)/\Gamma_{\text{total}}$ | $<1.8 \times 10^{-6}$, CL = 95% |
| $\Gamma(Z \rightarrow p\mu)/\Gamma_{\text{total}}$ | $<1.8 \times 10^{-6}$, CL = 95% |
| $\Gamma(\tau^- \rightarrow p \mu^- \mu^-)/\Gamma_{\text{total}}$ | $<4.4 \times 10^{-7}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{p} \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<3.3 \times 10^{-7}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{p} \gamma)/\Gamma_{\text{total}}$ | $<3.5 \times 10^{-6}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{p} \pi^0)/\Gamma_{\text{total}}$ | $<1.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{p} 2\pi^0)/\Gamma_{\text{total}}$ | $<3.3 \times 10^{-5}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{p} \eta)/\Gamma_{\text{total}}$ | $<8.9 \times 10^{-6}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{p} \pi^0 \eta)/\Gamma_{\text{total}}$ | $<2.7 \times 10^{-5}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \Lambda \pi^-)/\Gamma_{\text{total}}$ | $<7.2 \times 10^{-8}$, CL = 90% |
| $\Gamma(\tau^- \rightarrow \bar{\Lambda} \pi^-)/\Gamma_{\text{total}}$ | $<1.4 \times 10^{-7}$, CL = 90% |
| $\Gamma(D^0 \rightarrow pe^-)/\Gamma_{\text{total}}$ | [r] $<1.0 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \bar{p} e^+)/\Gamma_{\text{total}}$ | [s] $<1.1 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \Lambda^0 \mu^+)/\Gamma_{\text{total}}$ | $<6 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \Lambda^0 e^+)/\Gamma_{\text{total}}$ | $<3.2 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \bar{\Lambda}^0 \mu^+)/\Gamma_{\text{total}}$ | $<6 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \bar{\Lambda}^0 e^+)/\Gamma_{\text{total}}$ | $<8 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \Lambda_c^+ \mu^-)/\Gamma_{\text{total}}$ | $<1.8 \times 10^{-6}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \Lambda_c^+ e^-)/\Gamma_{\text{total}}$ | $<5 \times 10^{-6}$, CL = 90% |

p mean life [t] $>2.1 \times 10^{29}$ years, CL = 90%

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

| | |
|---|---|
| $\tau(N \rightarrow e^+ \pi)$ | $> 2000 (n), > 8200 (p) \times 10^{30}$ years, CL = 90% |
| $\tau(N \rightarrow \mu^+ \pi)$ | $> 1000 (n), > 6600 (p) \times 10^{30}$ years, CL = 90% |
| $\tau(N \rightarrow e^+ K)$ | $> 17 (n), > 1000 (p) \times 10^{30}$ years, CL = 90% |
| $\tau(N \rightarrow \mu^+ K)$ | $> 26 (n), > 1600 (p) \times 10^{30}$ years, CL = 90% |
| limit on $n\bar{n}$ oscillations (free n) | $>0.86 \times 10^8$ s, CL = 90% |
| limit on $n\bar{n}$ oscillations (bound n) | [u] $>1.3 \times 10^8$ s, CL = 90% |

| | |
|---|----------------------------------|
| $\Gamma(\Lambda_c^+ \rightarrow \bar{p}2e^+)/\Gamma_{\text{total}}$ | $<2.7 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Lambda_c^+ \rightarrow \bar{p}2\mu^+)/\Gamma_{\text{total}}$ | $<9.4 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Lambda_c^+ \rightarrow \bar{p}e^+\mu^+)/\Gamma_{\text{total}}$ | $<1.6 \times 10^{-5}$, CL = 90% |

ELECTRIC CHARGE (Q)

| | |
|---|--|
| $e \rightarrow \nu_e \gamma$ and astrophysical limits | [ν] $>4.6 \times 10^{26}$ yr, CL = 90% |
| $\Gamma(n \rightarrow p\nu_e\bar{\nu}_e)/\Gamma_{\text{total}}$ | $<8 \times 10^{-27}$, CL = 68% |

$\Delta S = \Delta Q$ RULE

Violations allowed in second-order weak interactions.

| | |
|--|----------------------------------|
| $\Gamma(K^+ \rightarrow \pi^+\pi^+e^-\bar{\nu}_e)/\Gamma_{\text{total}}$ | $<1.3 \times 10^{-8}$, CL = 90% |
| $\Gamma(K^+ \rightarrow \pi^+\pi^+\mu^-\bar{\nu}_\mu)/\Gamma_{\text{total}}$ | $<3.0 \times 10^{-6}$, CL = 95% |
| Re(x_+), K_{e3} parameter | $(-0.9 \pm 3.0) \times 10^{-3}$ |
| $x = A(\bar{K}^0 \rightarrow \pi^-\ell^+\nu)/A(K^0 \rightarrow \pi^-\ell^+\nu) = A(\Delta S = -\Delta Q)/A(\Delta S = \Delta Q)$ | |
| real part of x | -0.002 ± 0.006 |
| imaginary part of x | 0.0012 ± 0.0021 |
| $\Gamma(\Sigma^+ \rightarrow n\ell^+\nu)/\Gamma(\Sigma^- \rightarrow n\ell^-\bar{\nu})$ | <0.043 |
| $\Gamma(\Sigma^+ \rightarrow ne^+\nu_e)/\Gamma_{\text{total}}$ | $<5 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Sigma^+ \rightarrow n\mu^+\nu_\mu)/\Gamma_{\text{total}}$ | $<3.0 \times 10^{-5}$, CL = 90% |
| $\Gamma(\Xi^0 \rightarrow \Sigma^-e^+\nu_e)/\Gamma_{\text{total}}$ | $<9 \times 10^{-4}$, CL = 90% |
| $\Gamma(\Xi^0 \rightarrow \Sigma^-\mu^+\nu_\mu)/\Gamma_{\text{total}}$ | $<9 \times 10^{-4}$, CL = 90% |

$\Delta S = 2$ FORBIDDEN

Allowed in second-order weak interactions.

| | |
|--|----------------------------------|
| $\Gamma(\Xi^0 \rightarrow p\pi^-)/\Gamma_{\text{total}}$ | $<8 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Xi^0 \rightarrow pe^-\bar{\nu}_e)/\Gamma_{\text{total}}$ | $<1.3 \times 10^{-3}$ |
| $\Gamma(\Xi^0 \rightarrow p\mu^-\bar{\nu}_\mu)/\Gamma_{\text{total}}$ | $<1.3 \times 10^{-3}$ |
| $\Gamma(\Xi^- \rightarrow n\pi^-)/\Gamma_{\text{total}}$ | $<1.9 \times 10^{-5}$, CL = 90% |
| $\Gamma(\Xi^- \rightarrow ne^-\bar{\nu}_e)/\Gamma_{\text{total}}$ | $<3.2 \times 10^{-3}$, CL = 90% |
| $\Gamma(\Xi^- \rightarrow n\mu^-\bar{\nu}_\mu)/\Gamma_{\text{total}}$ | $<1.5 \times 10^{-2}$, CL = 90% |
| $\Gamma(\Xi^- \rightarrow p\pi^-\pi^-)/\Gamma_{\text{total}}$ | $<4 \times 10^{-4}$, CL = 90% |
| $\Gamma(\Xi^- \rightarrow p\pi^-e^-\bar{\nu}_e)/\Gamma_{\text{total}}$ | $<4 \times 10^{-4}$, CL = 90% |
| $\Gamma(\Xi^- \rightarrow p\pi^-\mu^-\bar{\nu}_\mu)/\Gamma_{\text{total}}$ | $<4 \times 10^{-4}$, CL = 90% |
| $\Gamma(\Omega^- \rightarrow \Lambda\pi^-)/\Gamma_{\text{total}}$ | $<2.9 \times 10^{-6}$, CL = 90% |

$\Delta S = 2$ VIA MIXING

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

$$m_{K_L^0} - m_{K_S^0} \quad (0.5293 \pm 0.0009) \times 10^{10} \hbar \text{ s}^{-1} \quad (S = 1.3)$$

$$m_{K_L^0} - m_{K_S^0} \quad (3.484 \pm 0.006) \times 10^{-12} \text{ MeV}$$

 $\Delta C = 2$ VIA MIXING

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

$$|m_{D_1^0} - m_{D_2^0}| = x\Gamma \quad (0.95^{+0.41}_{-0.44}) \times 10^{10} \hbar \text{ s}^{-1}$$

$$(\Gamma_{D_1^0} - \Gamma_{D_2^0})/\Gamma = 2y \quad (1.29^{+0.14}_{-0.18}) \times 10^{-2}$$

 $\Delta B = 2$ VIA MIXING

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

$$\chi_d \quad 0.1874 \pm 0.0018$$

$$\Delta m_{B^0} = m_{B_H^0} - m_{B_L^0} \quad (0.510 \pm 0.003) \times 10^{12} \hbar \text{ s}^{-1}$$

$$x_d = \Delta m_{B^0}/\Gamma_{B^0} \quad 0.774 \pm 0.006$$

$$\Delta m_{B_s^0} = m_{B_{sH}^0} - m_{B_{sL}^0} \quad (17.761 \pm 0.022) \times 10^{12} \hbar \text{ s}^{-1}$$

$$x_s = \Delta m_{B_s^0}/\Gamma_{B_s^0} \quad 26.85 \pm 0.13$$

$$\chi_s \quad 0.499311 \pm 0.000007$$

 $\Delta S = 1$ WEAK NEUTRAL CURRENT FORBIDDEN

Allowed by higher-order electroweak interactions.

$$\Gamma(K^+ \rightarrow \pi^+ e^+ e^-)/\Gamma_{\text{total}} \quad (3.00 \pm 0.09) \times 10^{-7}$$

$$\Gamma(K^+ \rightarrow \pi^+ \mu^+ \mu^-)/\Gamma_{\text{total}} \quad (9.4 \pm 0.6) \times 10^{-8} \quad (S = 2.6)$$

$$\Gamma(K^+ \rightarrow \pi^+ \nu \bar{\nu})/\Gamma_{\text{total}} \quad (1.7 \pm 1.1) \times 10^{-10}$$

$$\Gamma(K^+ \rightarrow \pi^+ \pi^0 \nu \bar{\nu})/\Gamma_{\text{total}} \quad < 4.3 \times 10^{-5}, \text{ CL} = 90\%$$

$$\Gamma(K_S^0 \rightarrow \mu^+ \mu^-)/\Gamma_{\text{total}} \quad < 9 \times 10^{-9}, \text{ CL} = 90\%$$

$$\Gamma(K_S^0 \rightarrow e^+ e^-)/\Gamma_{\text{total}} \quad < 9 \times 10^{-9}, \text{ CL} = 90\%$$

$$\Gamma(K_S^0 \rightarrow \pi^0 e^+ e^-)/\Gamma_{\text{total}} \quad [x] \quad (3.0^{+1.5}_{-1.2}) \times 10^{-9}$$

$$\Gamma(K_S^0 \rightarrow \pi^0 \mu^+ \mu^-)/\Gamma_{\text{total}} \quad (2.9^{+1.5}_{-1.2}) \times 10^{-9}$$

$$\Gamma(K_L^0 \rightarrow \mu^+ \mu^-)/\Gamma_{\text{total}} \quad (6.84 \pm 0.11) \times 10^{-9}$$

| | |
|---|---|
| $\Gamma(K_L^0 \rightarrow e^+ e^-)/\Gamma_{\text{total}}$ | $(9_{-4}^{+6}) \times 10^{-12}$ |
| $\Gamma(K_L^0 \rightarrow \pi^+ \pi^- e^+ e^-)/\Gamma_{\text{total}}$ | [γ] $(3.11 \pm 0.19) \times 10^{-7}$ |
| $\Gamma(K_L^0 \rightarrow \pi^0 \pi^0 e^+ e^-)/\Gamma_{\text{total}}$ | $<6.6 \times 10^{-9}$, CL = 90% |
| $\Gamma(K_L^0 \rightarrow \pi^0 \pi^0 \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<9.2 \times 10^{-11}$, CL = 90% |
| $\Gamma(K_L^0 \rightarrow \mu^+ \mu^- e^+ e^-)/\Gamma_{\text{total}}$ | $(2.69 \pm 0.27) \times 10^{-9}$ |
| $\Gamma(K_L^0 \rightarrow e^+ e^- e^+ e^-)/\Gamma_{\text{total}}$ | $(3.56 \pm 0.21) \times 10^{-8}$ |
| $\Gamma(K_L^0 \rightarrow \pi^0 \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<3.8 \times 10^{-10}$, CL = 90% |
| $\Gamma(K_L^0 \rightarrow \pi^0 e^+ e^-)/\Gamma_{\text{total}}$ | $<2.8 \times 10^{-10}$, CL = 90% |
| $\Gamma(K_L^0 \rightarrow \pi^0 \nu \bar{\nu})/\Gamma_{\text{total}}$ | $<2.6 \times 10^{-8}$, CL = 90% |
| $\Gamma(K_L^0 \rightarrow \pi^0 \pi^0 \nu \bar{\nu})/\Gamma_{\text{total}}$ | $<8.1 \times 10^{-7}$, CL = 90% |
| $\Gamma(\Sigma^+ \rightarrow p e^+ e^-)/\Gamma_{\text{total}}$ | $<7 \times 10^{-6}$ |
| $\Gamma(\Sigma^+ \rightarrow p \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $(9_{-8}^{+9}) \times 10^{-8}$ |

$\Delta C = 1$ WEAK NEUTRAL CURRENT FORBIDDEN

Allowed by higher-order electroweak interactions.

| | |
|---|-----------------------------------|
| $\Gamma(D^+ \rightarrow \pi^+ e^+ e^-)/\Gamma_{\text{total}}$ | $<1.1 \times 10^{-6}$, CL = 90% |
| $\Gamma(D^+ \rightarrow \pi^+ \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<7.3 \times 10^{-8}$, CL = 90% |
| $\Gamma(D^+ \rightarrow \rho^+ \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<5.6 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \gamma\gamma)/\Gamma_{\text{total}}$ | $<2.2 \times 10^{-6}$, CL = 90% |
| $\Gamma(D^0 \rightarrow e^+ e^-)/\Gamma_{\text{total}}$ | $<7.9 \times 10^{-8}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<6.2 \times 10^{-9}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \pi^0 e^+ e^-)/\Gamma_{\text{total}}$ | $<4.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \pi^0 \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<1.8 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \eta e^+ e^-)/\Gamma_{\text{total}}$ | $<1.1 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \eta \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<5.3 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \pi^+ \pi^- e^+ e^-)/\Gamma_{\text{total}}$ | $<3.73 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \rho^0 e^+ e^-)/\Gamma_{\text{total}}$ | $<1.0 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \pi^+ \pi^- \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<5.5 \times 10^{-7}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \rho^0 \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<2.2 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \omega e^+ e^-)/\Gamma_{\text{total}}$ | $<1.8 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \omega \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<8.3 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow K^- K^+ e^+ e^-)/\Gamma_{\text{total}}$ | $<3.15 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \phi e^+ e^-)/\Gamma_{\text{total}}$ | $<5.2 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow K^- K^+ \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<3.3 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \phi \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<3.1 \times 10^{-5}$, CL = 90% |
| $\Gamma(D^0 \rightarrow K^- \pi^+ e^+ e^-)/\Gamma_{\text{total}}$ | $<3.85 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow K^- \pi^+ \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<3.59 \times 10^{-4}$, CL = 90% |
| $\Gamma(D^0 \rightarrow \pi^+ \pi^- \pi^0 \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<8.1 \times 10^{-4}$, CL = 90% |

| | |
|--|----------------------------------|
| $\Gamma(D_S^+ \rightarrow K^+ e^+ e^-)/\Gamma_{\text{total}}$ | $<3.7 \times 10^{-6}$, CL = 90% |
| $\Gamma(D_S^+ \rightarrow K^+ \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<2.1 \times 10^{-5}$, CL = 90% |
| $\Gamma(D_S^+ \rightarrow K^*(892)^+ \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<1.4 \times 10^{-3}$, CL = 90% |
| $\Gamma(\Lambda_c^+ \rightarrow p e^+ e^-)/\Gamma_{\text{total}}$ | $<5.5 \times 10^{-6}$, CL = 90% |
| $\Gamma(\Lambda_c^+ \rightarrow p \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<4.4 \times 10^{-5}$, CL = 90% |

$\Delta B = 1$ WEAK NEUTRAL CURRENT FORBIDDEN

Allowed by higher-order electroweak interactions.

| | |
|--|--|
| $\Gamma(B^+ \rightarrow \pi^+ \ell^+ \ell^-)/\Gamma_{\text{total}}$ | $<4.9 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ e^+ e^-)/\Gamma_{\text{total}}$ | $<8.0 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<5.5 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \pi^+ \nu \bar{\nu})/\Gamma_{\text{total}}$ | $<9.8 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^+ \ell^+ \ell^-)/\Gamma_{\text{total}}$ | [z] $(4.51 \pm 0.23) \times 10^{-7}$ (S = 1.1) |
| $\Gamma(B^+ \rightarrow K^+ e^+ e^-)/\Gamma_{\text{total}}$ | $(5.5 \pm 0.7) \times 10^{-7}$ |
| $\Gamma(B^+ \rightarrow K^+ \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $(4.49 \pm 0.23) \times 10^{-7}$ (S = 1.1) |
| $\Gamma(B^+ \rightarrow K^+ \bar{\nu} \nu)/\Gamma_{\text{total}}$ | $<1.6 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^+ \rightarrow \rho^+ \nu \bar{\nu})/\Gamma_{\text{total}}$ | $<2.13 \times 10^{-4}$, CL = 90% |
| $\Gamma(B^+ \rightarrow K^*(892)^+ \ell^+ \ell^-)/\Gamma_{\text{total}}$ | [z] $(1.29 \pm 0.21) \times 10^{-6}$ |
| $\Gamma(B^+ \rightarrow K^*(892)^+ e^+ e^-)/\Gamma_{\text{total}}$ | $(1.55^{+0.40}_{-0.31}) \times 10^{-6}$ |
| $\Gamma(B^+ \rightarrow K^*(892)^+ \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $(1.12 \pm 0.15) \times 10^{-6}$ |
| $\Gamma(B^+ \rightarrow K^*(892)^+ \nu \bar{\nu})/\Gamma_{\text{total}}$ | $<4.0 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \gamma \gamma)/\Gamma_{\text{total}}$ | $<3.2 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^0 \rightarrow e^+ e^-)/\Gamma_{\text{total}}$ | $<8.3 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^0 \rightarrow e^+ e^- \gamma)/\Gamma_{\text{total}}$ | $<1.2 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<6.3 \times 10^{-10}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \mu^+ \mu^- \gamma)/\Gamma_{\text{total}}$ | $<1.6 \times 10^{-7}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \tau^+ \tau^-)/\Gamma_{\text{total}}$ | $<4.1 \times 10^{-3}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \pi^0 \ell^+ \ell^-)/\Gamma_{\text{total}}$ | $<5.3 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \pi^0 e^+ e^-)/\Gamma_{\text{total}}$ | $<8.4 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \pi^0 \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $<6.9 \times 10^{-8}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \pi^0 \nu \bar{\nu})/\Gamma_{\text{total}}$ | $<6.9 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^0 \rightarrow K^0 \ell^+ \ell^-)/\Gamma_{\text{total}}$ | [z] $(3.1^{+0.8}_{-0.7}) \times 10^{-7}$ |
| $\Gamma(B^0 \rightarrow K^0 e^+ e^-)/\Gamma_{\text{total}}$ | $(1.6^{+1.0}_{-0.8}) \times 10^{-7}$ |
| $\Gamma(B^0 \rightarrow K^0 \mu^+ \mu^-)/\Gamma_{\text{total}}$ | $(3.4 \pm 0.5) \times 10^{-7}$ |
| $\Gamma(B^0 \rightarrow K^0 \nu \bar{\nu})/\Gamma_{\text{total}}$ | $<4.9 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \rho^0 \nu \bar{\nu})/\Gamma_{\text{total}}$ | $<2.08 \times 10^{-4}$, CL = 90% |
| $\Gamma(B^0 \rightarrow K^*(892)^0 \ell^+ \ell^-)/\Gamma_{\text{total}}$ | [z] $(9.9^{+1.2}_{-1.1}) \times 10^{-7}$ |
| $\Gamma(B^0 \rightarrow K^*(892)^0 e^+ e^-)/\Gamma_{\text{total}}$ | $(1.03^{+0.19}_{-0.17}) \times 10^{-6}$ |

| | |
|--|--|
| $\Gamma(B^0 \rightarrow K^*(892)^0 \mu^+ \mu^-) / \Gamma_{\text{total}}$ | $(1.05 \pm 0.10) \times 10^{-6}$ |
| $\Gamma(B^0 \rightarrow K^*(892)^0 \nu \bar{\nu}) / \Gamma_{\text{total}}$ | $< 5.5 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \phi \nu \bar{\nu}) / \Gamma_{\text{total}}$ | $< 1.27 \times 10^{-4}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \text{invisible}) / \Gamma_{\text{total}}$ | $< 2.4 \times 10^{-5}$, CL = 90% |
| $\Gamma(B^0 \rightarrow \nu \bar{\nu} \gamma) / \Gamma_{\text{total}}$ | $< 1.7 \times 10^{-5}$, CL = 90% |
| $\Gamma(B \rightarrow s e^+ e^-) / \Gamma_{\text{total}}$ | $(4.7 \pm 1.3) \times 10^{-6}$ |
| $\Gamma(B \rightarrow s \mu^+ \mu^-) / \Gamma_{\text{total}}$ | $(4.3 \pm 1.2) \times 10^{-6}$ |
| $\Gamma(B \rightarrow s \ell^+ \ell^-) / \Gamma_{\text{total}}$ | [z] $(4.5 \pm 1.0) \times 10^{-6}$ |
| $\Gamma(B \rightarrow \pi \ell^+ \ell^-) / \Gamma_{\text{total}}$ | $< 5.9 \times 10^{-8}$, CL = 90% |
| $\Gamma(B \rightarrow K e^+ e^-) / \Gamma_{\text{total}}$ | $(4.4 \pm 0.6) \times 10^{-7}$ |
| $\Gamma(B \rightarrow K^*(892) e^+ e^-) / \Gamma_{\text{total}}$ | $(1.19 \pm 0.20) \times 10^{-6}$ (S = 1.2) |
| $\Gamma(B \rightarrow K \mu^+ \mu^-) / \Gamma_{\text{total}}$ | $(4.4 \pm 0.4) \times 10^{-7}$ |
| $\Gamma(B \rightarrow K^*(892) \mu^+ \mu^-) / \Gamma_{\text{total}}$ | $(1.06 \pm 0.09) \times 10^{-6}$ |
| $\Gamma(B \rightarrow K \ell^+ \ell^-) / \Gamma_{\text{total}}$ | $(4.8 \pm 0.4) \times 10^{-7}$ |
| $\Gamma(B \rightarrow K^*(892) \ell^+ \ell^-) / \Gamma_{\text{total}}$ | $(1.05 \pm 0.10) \times 10^{-6}$ |
| $\Gamma(B \rightarrow K \nu \bar{\nu}) / \Gamma_{\text{total}}$ | $< 1.7 \times 10^{-5}$, CL = 90% |
| $\Gamma(B \rightarrow K^* \nu \bar{\nu}) / \Gamma_{\text{total}}$ | $< 7.6 \times 10^{-5}$, CL = 90% |
| $\Gamma(\bar{b} \rightarrow \bar{s} \nu \nu) / \Gamma_{\text{total}}$ | $< 6.4 \times 10^{-4}$, CL = 90% |
| $\Gamma(\bar{b} \rightarrow e^+ e^- \text{ anything}) / \Gamma_{\text{total}}$ | — |
| $\Gamma(\bar{b} \rightarrow \mu^+ \mu^- \text{ anything}) / \Gamma_{\text{total}}$ | $< 3.2 \times 10^{-4}$, CL = 90% |
| $\Gamma(\bar{b} \rightarrow \nu \bar{\nu} \text{ anything}) / \Gamma_{\text{total}}$ | — |
| $\Gamma(B_s^0 \rightarrow \gamma \gamma) / \Gamma_{\text{total}}$ | $< 8.7 \times 10^{-6}$, CL = 90% |
| $\Gamma(B_s^0 \rightarrow \mu^+ \mu^-) / \Gamma_{\text{total}}$ | $(3.1 \pm 0.7) \times 10^{-9}$ |
| $\Gamma(B_s^0 \rightarrow e^+ e^-) / \Gamma_{\text{total}}$ | $< 2.8 \times 10^{-7}$, CL = 90% |
| $\Gamma(B_s^0 \rightarrow \phi(1020) \mu^+ \mu^-) / \Gamma_{\text{total}}$ | $(7.6 \pm 1.5) \times 10^{-7}$ |
| $\Gamma(B_s^0 \rightarrow \phi \nu \bar{\nu}) / \Gamma_{\text{total}}$ | $< 5.4 \times 10^{-3}$, CL = 90% |

$\Delta T = 1$ WEAK NEUTRAL CURRENT FORBIDDEN

Allowed by higher-order electroweak interactions.

| | |
|---|--|
| $\Gamma(t \rightarrow Z q (q=u,c)) / \Gamma_{\text{total}}$ | [aa] $< 2.1 \times 10^{-3}$, CL = 95% |
|---|--|

NOTES

- [a] C parity forbids this to occur as a single-photon process.
- [b] See the Particle Listings for the (complicated) definition of this quantity.
- [c] Time-reversal invariance requires this to be 0° or 180° .
- [d] This coefficient is zero if time invariance is not violated.
- [e] Allowed by higher-order electroweak interactions.
- [f] Violates CP in leading order. Test of direct CP violation since the indirect CP -violating and CP -conserving contributions are expected to be suppressed.
- [g] In the 2010 *Review*, the values for these quantities were given using a measure of the asymmetry that was inconsistent with the usual definition.
- [h] $\text{Re}(\epsilon'/\epsilon) = \epsilon'/\epsilon$ to a very good approximation provided the phases satisfy CPT invariance.
- [i] This mode includes gammas from inner bremsstrahlung but not the direct emission mode $K_L^0 \rightarrow \pi^+ \pi^- \gamma(\text{DE})$.
- [j] Neglecting photon channels. See, e.g., A. Pais and S.B. Treiman, *Phys. Rev.* **D12**, 2744 (1975).
- [k] Derived from measured values of ϕ_{+-} , ϕ_{00} , $|\eta|$, $|m_{K_L^0} - m_{K_S^0}|$, and $\tau_{K_S^0}$, as described in the introduction to "Tests of Conservation Laws."
- [l] The $|m_p - m_{\bar{p}}|/m_p$ and $|q_p + q_{\bar{p}}|/e$ are not independent, and both use the more precise measurement of $|q_{\bar{p}}/m_{\bar{p}}|/(q_p/m_p)$.
- [n] The value is for the sum of the charge states or particle/antiparticle states indicated.
- [o] A test of additive vs. multiplicative lepton family number conservation.
- [p] The sign of Δm_{32}^2 is not known at this time. The range quoted is for the absolute value.
- [q] Derived from an analysis of neutrino-oscillation experiments.
- [r] This limit is for either D^0 or \bar{D}^0 to $p e^-$.
- [s] This limit is for either D^0 or \bar{D}^0 to $\bar{p} e^+$.
- [t] The first limit is for $p \rightarrow$ anything or "disappearance" modes of a bound proton. The second entry, a rough range of limits, assumes the dominant decay modes are among those investigated. For antiprotons the best limit, inferred from the observation of cosmic ray \bar{p} 's is $\tau_{\bar{p}} > 10^7$ yr, the cosmic-ray storage time, but this limit depends on a number of assumptions. The best direct observation of stored antiprotons gives $\tau_{\bar{p}}/B(\bar{p} \rightarrow e^- \gamma) > 7 \times 10^5$ yr.
- [u] There is some controversy about whether nuclear physics and model dependence complicate the analysis for bound neutrons (from which the

best limit comes). The first limit here is from reactor experiments with free neutrons.

[v] This is the best limit for the mode $e^- \rightarrow \nu \gamma$. The best limit for “electron disappearance” is 6.4×10^{24} yr.

[x] See the K_S^0 Particle Listings for the energy limits used in this measurement.

[y] See the K_L^0 Particle Listings for the energy limits used in this measurement.

[z] An ℓ indicates an e or a μ mode, not a sum over these modes.

[aa] This limit is for $\Gamma(t \rightarrow Z q)/\Gamma(t \rightarrow W b)$.