

NOTES

- [a] See the “Note on $\pi^\pm \rightarrow \ell^\pm \nu \gamma$ and $K^\pm \rightarrow \ell^\pm \nu \gamma$ Form Factors” in the π^\pm Particle Listings for definitions and details.
- [b] Measurements of $\Gamma(e^+ \nu_e)/\Gamma(\mu^+ \nu_\mu)$ always include decays with γ 's, and measurements of $\Gamma(e^+ \nu_e \gamma)$ and $\Gamma(\mu^+ \nu_\mu \gamma)$ never include low-energy γ 's. Therefore, since no clean separation is possible, we consider the modes with γ 's to be subreactions of the modes without them, and let $[\Gamma(e^+ \nu_e) + \Gamma(\mu^+ \nu_\mu)]/\Gamma_{\text{total}} = 100\%$.
- [c] See the π^\pm Particle Listings for the energy limits used in this measurement; low-energy γ 's are not included.
- [d] Derived from an analysis of neutrino-oscillation experiments.
- [e] Astrophysical and cosmological arguments give limits of order 10^{-13} ; see the π^0 Particle Listings.
- [f] See the “Note on the Decay Width $\Gamma(\eta \rightarrow \gamma \gamma)$ ” in our 1994 edition, Phys. Rev. **D50**, 1 August 1994, Part I, p. 1451.
- [g] C parity forbids this to occur as a single-photon process.
- [h] See the “Note on scalar mesons” in the $f_0(1370)$ Particle Listings . The interpretation of this entry as a particle is controversial.
- [i] See the “Note on $\rho(770)$ ” in the $\rho(770)$ Particle Listings .
- [j] The $e^+ e^-$ branching fraction is from $e^+ e^- \rightarrow \pi^+ \pi^-$ experiments only. The $\omega \rho$ interference is then due to $\omega \rho$ mixing only, and is expected to be small. If $e \mu$ universality holds, $\Gamma(\rho^0 \rightarrow \mu^+ \mu^-) = \Gamma(\rho^0 \rightarrow e^+ e^-) \times 0.99785$.
- [k] See the “Note on scalar mesons” in the $f_0(1370)$ Particle Listings .
- [l] See the “Note on $a_1(1260)$ ” in the $a_1(1260)$ Particle Listings .
- [m] This is only an educated guess; the error given is larger than the error on the average of the published values. See the Particle Listings for details.
- [n] See the “Note on the $f_1(1420)$ ” in the $\eta(1440)$ Particle Listings.
- [o] See also the $\omega(1600)$ Particle Listings.
- [p] See the “Note on the $\eta(1440)$ ” in the $\eta(1440)$ Particle Listings.
- [q] See the “Note on the $\rho(1450)$ and the $\rho(1700)$ ” in the $\rho(1700)$ Particle Listings.
- [r] See the “Note on non- $q\bar{q}$ mesons” in the Particle Listings (see the index for the page number).
- [s] See also the $\omega(1420)$ Particle Listings.
- [t] See the “Note on $f_J(1710)$ ” in the $f_J(1710)$ Particle Listings .
- [u] See the note in the K^\pm Particle Listings.

[v] The definition of the slope parameter g of the $K \rightarrow 3\pi$ Dalitz plot is as follows (see also “Note on Dalitz Plot Parameters for $K \rightarrow 3\pi$ Decays” in the K^\pm Particle Listings):

$$|M|^2 = 1 + g(s_3 - s_0)/m_{\pi^+}^2 + \dots$$

[w] For more details and definitions of parameters see the Particle Listings.

[x] See the K^\pm Particle Listings for the energy limits used in this measurement.

[y] Most of this radiative mode, the low-momentum γ part, is also included in the parent mode listed without γ 's.

[z] Direct-emission branching fraction.

[aa] Structure-dependent part.

[bb] 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.”

[cc] The CP -violation parameters are defined as follows (see also “Note on CP Violation in $K_S \rightarrow 3\pi$ ” and “Note on CP Violation in K_L^0 Decay” in the Particle Listings):

$$\eta_{+-} = |\eta_{+-}|e^{i\phi_{+-}} = \frac{A(K_L^0 \rightarrow \pi^+\pi^-)}{A(K_S^0 \rightarrow \pi^+\pi^-)} = \epsilon + \epsilon'$$

$$\eta_{00} = |\eta_{00}|e^{i\phi_{00}} = \frac{A(K_L^0 \rightarrow \pi^0\pi^0)}{A(K_S^0 \rightarrow \pi^0\pi^0)} = \epsilon - 2\epsilon'$$

$$\delta = \frac{\Gamma(K_L^0 \rightarrow \pi^-\ell^+\nu) - \Gamma(K_L^0 \rightarrow \pi^+\ell^-\nu)}{\Gamma(K_L^0 \rightarrow \pi^-\ell^+\nu) + \Gamma(K_L^0 \rightarrow \pi^+\ell^-\nu)},$$

$$\text{Im}(\eta_{+-0})^2 = \frac{\Gamma(K_S^0 \rightarrow \pi^+\pi^-\pi^0)^{CP \text{ viol.}}}{\Gamma(K_L^0 \rightarrow \pi^+\pi^-\pi^0)},$$

$$\text{Im}(\eta_{000})^2 = \frac{\Gamma(K_S^0 \rightarrow \pi^0\pi^0\pi^0)}{\Gamma(K_L^0 \rightarrow \pi^0\pi^0\pi^0)}.$$

where for the last two relations CPT is assumed valid, *i.e.*, $\text{Re}(\eta_{+-0}) \simeq 0$ and $\text{Re}(\eta_{000}) \simeq 0$.

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

[ee] Calculated from K_L^0 semileptonic rates and the K_S^0 lifetime assuming $\Delta S = \Delta Q$.

[ff] ϵ'/ϵ is derived from $|\eta_{00}/\eta_{+-}|$ measurements using theoretical input on phases.

- [*gg*] The value is for the sum of the charge states of particle/antiparticle states indicated.
- [*hh*] See the K_L^0 Particle Listings for the energy limits used in this measurement.
- [*ii*] Allowed by higher-order electroweak interactions.
- [*jj*] Violates CP in leading order. Test of direct CP violation since the indirect CP -violating and CP -conserving contributions are expected to be suppressed.
- [*kk*] See the "Note on $f_0(1370)$ " in the $f_0(1370)$ Particle Listings and in the 1994 edition.
- [*ll*] See the note in the $L(1770)$ Particle Listings in Reviews of Modern Physics **56** No. 2 Pt. II (1984), p. S200. See also the "Note on $K_2(1770)$ and the $K_2(1820)$ " in the $K_2(1770)$ Particle Listings .
- [*mm*] See the "Note on $K_2(1770)$ and the $K_2(1820)$ " in the $K_2(1770)$ Particle Listings .
- [*nn*] This is a weighted average of D^\pm (44%) and D^0 (56%) branching fractions. See " D^+ and $D^0 \rightarrow (\eta \text{ anything}) / (\text{total } D^+ \text{ and } D^0)$ " under " D^+ Branching Ratios" in the Particle Listings.
- [*oo*] This value averages the e^+ and μ^+ branching fractions, after making a small phase-space adjustment to the μ^+ fraction to be able to use it as an e^+ fraction; hence our ℓ^+ here is really an e^+ .
- [*pp*] An ℓ indicates an e or a μ mode, not a sum over these modes.
- [*qq*] The branching fraction for this mode may differ from the sum of the submodes that contribute to it, due to interference effects. See the relevant papers in the Particle Listings.
- [*rr*] The two experiments measuring this fraction are in serious disagreement. See the Particle Listings.
- [*ss*] This mode is not a useful test for a $\Delta C=1$ weak neutral current because both quarks must change flavor in this decay.
- [*tt*] The D_1^0 - D_2^0 limits are inferred from the D^0 - \bar{D}^0 mixing ratio $\Gamma(K^+ \ell^- \bar{\nu}_\ell \text{ (via } \bar{D}^0)) / \Gamma(K^- \ell^+ \nu_\ell)$.
- [*uu*] The larger limit (from E791) allows interference between the doubly Cabibbo-suppressed and mixing amplitudes; the smaller limit (from E691) doesn't. See the papers for details.
- [*vv*] The experiments on the division of this charge mode amongst its submodes disagree, and the submode branching fractions here add up to considerably more than the charged-mode fraction.
- [*ww*] However, these upper limits are in serious disagreement with values obtained in another experiment.

- [xx] For now, we average together measurements of the $X e^+ \nu_e$ and $X \mu^+ \nu_\mu$ branching fractions. This is the *average*, not the *sum*.
- [yy] This branching fraction includes all the decay modes of the final-state resonance.
- [zz] This value includes only $K^+ K^-$ decays of the $f_J(1710)$, because branching fractions of this resonance are not known.
- [aaa] This value includes only $\pi^+ \pi^-$ decays of the $f_0(1500)$, because branching fractions of this resonance are not known.
- [bbb] B^0 and B_s^0 contributions not separated. Limit is on weighted average of the two decay rates.
- [ccc] These values are model dependent. See 'Note on Semileptonic Decays' in the B^+ Particle Listings.
- [ddd] D^{**} stands for the sum of the $D(1^1P_1)$, $D(1^3P_0)$, $D(1^3P_1)$, $D(1^3P_2)$, $D(2^1S_0)$, and $D(2^1S_1)$ resonances.
- [eee] Inclusive branching fractions have a multiplicity definition and can be greater than 100%.
- [fff] D_j represents an unresolved mixture of pseudoscalar and tensor D^{**} (P -wave) states.
- [ggg] Not a pure measurement. See note at head of B_s^0 Decay Modes.
- [hhh] Includes $p\bar{p}\pi^+\pi^-\gamma$ and excludes $p\bar{p}\eta$, $p\bar{p}\omega$, $p\bar{p}\eta'$.
- [iii] J^{PC} known by production in e^+e^- via single photon annihilation. I^G is not known; interpretation of this state as a single resonance is unclear because of the expectation of substantial threshold effects in this energy region.
- [jjj] Spectroscopic labeling for these states is theoretical, pending experimental information.