$K^{\pm}$ – THIS IS PART 3 OF 3

To reduce the size of this section's PostScript file, we have divided it into three PostScript files. We present the following index:

PART 1

PART 2

PART 3

DALITZ PLOT PARAMETERS FOR $K \to 3\pi$ DECAYS

Revised 1994 by T.G. Trippe (LBNL).

The Dalitz plot distribution for $K^\pm \to \pi^\pm\pi^\pm\pi^\mp$, $K^\pm \to \pi^0\pi^0\pi^\pm$, and $K_L^0 \to \pi^+\pi^-\pi^0$ can be parameterized by a series expansion such as that introduced by Weinberg [1]. We use the form

$$\left|M\right|^2 \propto 1 + g\frac{(s_3 - s_0)}{am^2_{\pi^+}} + h\left[\frac{s_3 - s_0}{m^2_{\pi^+}}\right]^2 + j\ \frac{(s_2 - s_1)}{m^2_{\pi^+}} + k\left[\frac{s_2 - s_1}{m^2_{\pi^+}}\right]^2 + \cdots\ , \quad (1)$$

where $m^2_{\pi^+}$ has been introduced to make the coefficients g, h, j, and k dimensionless, and

$$s_i = (P_K - P_i)^2 = (m_K - m_i)^2 - 2m_K T_i\ ,\ i = 1, 2, 3,$$

$$s_0 = \frac{1}{3}\sum_i s_i = \frac{1}{3}(m_K^2 + m_1^2 + m_2^2 + m_3^2)$$

Here the P_i are four-vectors, m_i and T_i are the mass and kinetic energy of the i^{th} pion, and the index 3 is used for the odd pion.

The coefficient g is a measure of the slope in the variable s_3 (or T_3) of the Dalitz plot, while h and k measure the quadratic dependence on s_3 and $(s_2 - s_1)$, respectively. The coefficient j is related to the asymmetry of the plot and must be zero if CP invariance holds. Note also that if CP is good, g, h, and k must be the same for $K^+ \to \pi^+\pi^+\pi^-$ as for $K^- \to \pi^-\pi^-\pi^+$.

Since different experiments use different forms for $\left|M\right|^2$, in order to compare the experiments we have converted to g, h, j, and k whatever coefficients have been measured. Where such conversions have been done, the measured coefficient a_y, a_t, a_u, or a_v is given in the comment at the right. For definitions of these coefficients, details of this conversion, and discussion of the data, see the April 1982 version of this note [2].

References

1. S. Weinberg, Phys. Rev. Lett. **4**, 87 (1960).
2. Particle Data Group, Phys. Lett. **111B**, 69 (1982).

ENERGY DEPENDENCE OF $K^{\pm}$ DALITZ PLOT

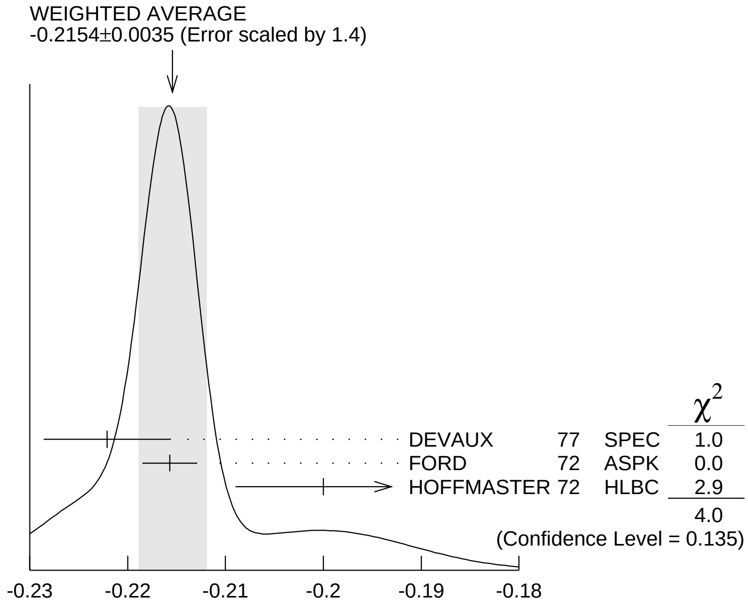
$|\text{matrix element}|^2 = 1 + gu + hu^2 + kv^2$
where $u = (s_3 - s_0) / m_\pi^2$ and $v = (s_1 - s_2) / m_\pi^2$

LINEAR COEFFICIENT g_{τ^+} FOR $K^+ \rightarrow \pi^+\pi^+\pi^-$

Some experiments use Dalitz variables x and y. In the comments we give a_y = coefficient of y term. See note above on "Dalitz Plot Parameters for $K \rightarrow 3\pi$ Decays." For discussion of the conversion of a_y to g, see the earlier version of the same note in the *Review* published in Physics Letters **111B** 70 (1982).

VALUE	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
−0.2154±0.0035 OUR AVERAGE		Error includes scale factor of 1.4. See the ideogram below.				
−0.2221±0.0065	225k	DEVAUX	77	SPEC	+	a_y=.2814 ± .0082
−0.2157±0.0028	750k	FORD	72	ASPK	+	a_y=.2734 ± .0035
−0.200 ±0.009	39819	[69] HOFFMASTER	72	HLBC	+	
• • • We do not use the following data for averages, fits, limits, etc. • • •						
−0.196 ±0.012	17898	[70] GRAUMAN	70	HLBC	+	a_y=0.228 ± 0.030
−0.218 ±0.016	9994	[71] BUTLER	68	HBC	+	a_y=0.277 ± 0.020
−0.22 ±0.024	5428	[71,72] ZINCHENKO	67	HBC	+	a_y=0.28 ± 0.03

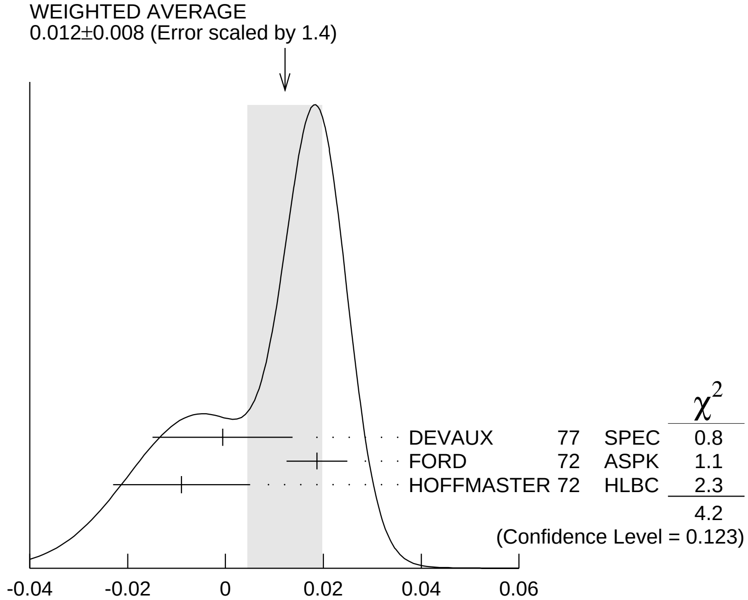
[69] HOFFMASTER 72 includes GRAUMAN 70 data.
[70] Emulsion data added — all events included by HOFFMASTER 72.
[71] Experiments with large errors not included in average.
[72] Also includes DBC events.



Linear energy dependence for $K^+ \rightarrow \pi^+ \pi^+ \pi^-$

QUADRATIC COEFFICIENT *h* FOR $K^+ \rightarrow \pi^+ \pi^+ \pi^-$

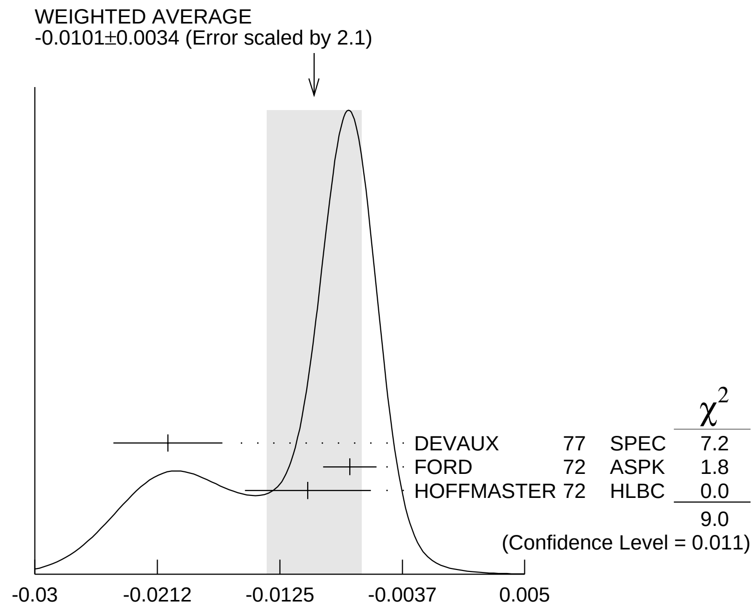
VALUE	EVTS	DOCUMENT ID		TECN	CHG
0.012 ±0.008 OUR AVERAGE		Error includes scale factor of 1.4. See the ideogram below.			
−0.0006±0.0143	225k	DEVAUX	77	SPEC	+
0.0187±0.0062	750k	FORD	72	ASPK	+
−0.009 ±0.014	39819	HOFFMASTER	72	HLBC	+



Quadratic coefficient h for $K^+ \rightarrow \pi^+ \pi^+ \pi^-$

QUADRATIC COEFFICIENT k FOR $K^+ \rightarrow \pi^+ \pi^+ \pi^-$

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*
$-$0.0101$\pm$0.0034 OUR AVERAGE		Error includes scale factor of 2.1. See the ideogram below.			
$-$0.0205$\pm$0.0039	225k	DEVAUX	77	SPEC	+
$-$0.0075$\pm$0.0019	750k	FORD	72	ASPK	+
$-$0.0105$\pm$0.0045	39819	HOFFMASTER	72	HLBC	+



Quadratic coefficient k for $K^+ \rightarrow \pi^+\pi^+\pi^-$

LINEAR COEFFICIENT g_{τ^-} FOR $K^- \rightarrow \pi^-\pi^-\pi^+$

Some experiments use Dalitz variables x and y. In the comments we give a_y = coefficient of y term. See note above on "Dalitz Plot Parameters for $K \rightarrow 3\pi$ Decays." For discussion of the conversion of a_y to g, see the earlier version of the same note in the *Review* published in Physics Letters **111B** 70 (1982).

VALUE	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
−0.217 ±0.007 OUR AVERAGE		Error includes scale factor of 2.5.				
−0.2186±0.0028	750k	FORD	72	ASPK	−	a_y=.2770 ± .0035
−0.193 ±0.010	50919	MAST	69	HBC	−	a_y=0.244 ± 0.013
• • • We do not use the following data for averages, fits, limits, etc. • • •						
−0.199 ±0.008	81k	[73] LUCAS	73	HBC	−	a_y=0.252 ± 0.011
−0.190 ±0.023	5778	[74,75] MOSCOSO	68	HBC	−	a_y=0.242 ± 0.029
−0.220 ±0.035	1347	[76] FERRO-LUZZI	61	HBC	−	a_y=0.28 ± 0.045

[73] Quadratic dependence is required by K^0_L experiments. For comparison we average only those $K^\pm$ experiments which quote quadratic fit values.
[74] Experiments with large errors not included in average.
[75] Also includes DBC events.
[76] No radiative corrections included.

QUADRATIC COEFFICIENT h FOR $K^- \rightarrow \pi^-\pi^-\pi^+$

VALUE	EVTS	DOCUMENT ID		TECN	CHG
0.010 ±0.006 OUR AVERAGE					
0.0125±0.0062	750k	FORD	72	ASPK	−
−0.001 ±0.012	50919	MAST	69	HBC	−

QUADRATIC COEFFICIENT k FOR $K^- \rightarrow \pi^- \pi^- \pi^+$

VALUE	EVTS	DOCUMENT ID		TECN	CHG
−0.0084±0.0019 OUR AVERAGE					
−0.0083±0.0019	750k	FORD	72	ASPK	−
−0.014 ±0.012	50919	MAST	69	HBC	−

$(g_{\tau^+} - g_{\tau^-}) / (g_{\tau^+} + g_{\tau^-})$ FOR $K^\pm \rightarrow \pi^\pm \pi^+ \pi^-$

A nonzero value for this quantity indicates *CP* violation.

VALUE (%)	EVTS	DOCUMENT ID		TECN
−0.70±0.53	3.2M	FORD	70	ASPK

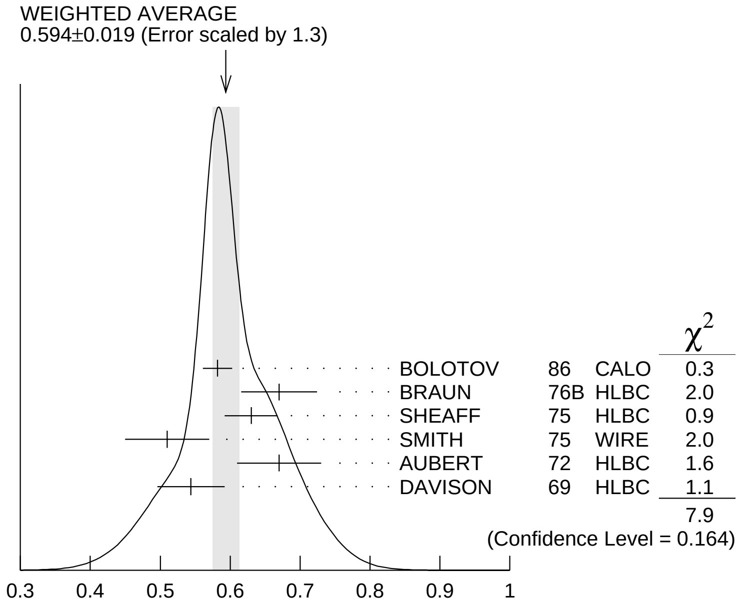
LINEAR COEFFICIENT g FOR $K^\pm \rightarrow \pi^\pm \pi^0 \pi^0$

Unless otherwise stated, all experiments include terms quadratic in $(s_3 - s_0) / m^2_{\pi^+}$. See mini-review above.

VALUE	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
0.594±0.019 OUR AVERAGE	Error includes scale factor of 1.3. See the ideogram below.					
0.582±0.021	43k	BOLOTOV	86	CALO	−	
0.670±0.054	3263	BRAUN	76B	HLBC	+	
0.630±0.038	5635	SHEAFF	75	HLBC	+	
0.510±0.060	27k	SMITH	75	WIRE	+	
0.67 ±0.06	1365	AUBERT	72	HLBC	+	
0.544±0.048	4048	DAVISON	69	HLBC	+	Also emulsion
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.806±0.220	4639	[77] BERTRAND	76	EMUL	+	
0.484±0.084	574	[78] LUCAS	73B	HBC	−	Dalitz pairs only
0.527±0.102	198	[77] PANDOULAS	70	EMUL	+	
0.586±0.098	1874	[78] BISI	65	HLBC	+	Also HBC
0.48 ±0.04	1792	[78] KALMUS	64	HLBC	+	

[77] Experiments with large errors not included in average.

[78] Authors give linear fit only.



Linear energy dependence for $K^{\pm} \rightarrow \pi^{\pm}\pi^{0}\pi^{0}$

QUADRATIC COEFFICIENT *h* FOR $K^{\pm} \rightarrow \pi^{\pm}\pi^{0}\pi^{0}$

See mini-review above.

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
0.035±0.015 OUR AVERAGE						
0.037±0.024	43k	BOLOTOV	86	CALO	−	
0.152±0.082	3263	BRAUN	76B	HLBC	+	
0.041±0.030	5635	SHEAFF	75	HLBC	+	
0.009±0.040	27k	SMITH	75	WIRE	+	
−0.01 ±0.08	1365	AUBERT	72	HLBC	+	
0.026±0.050	4048	DAVISON	69	HLBC	+	Also emulsion
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.164±0.121	4639	[79] BERTRAND	76	EMUL	+	
0.018±0.124	198	[79] PANDOULAS	70	EMUL	+	

[79] Experiments with large errors not included in average.

$K^{\pm}_{\ell 3}$ AND $K^{0}_{\ell 3}$ FORM FACTORS

Written by T.G. Trippe (LBNL).

Assuming that only the vector current contributes to $K \rightarrow \pi\ell\nu$ decays, we write the matrix element as

$$M \propto f_{+}(t) \left[(P_K + P_\pi)_\mu \overline{\ell}\gamma_\mu(1+\gamma_5)\nu\right] + f_{-}(t)\left[m_\ell \overline{\ell}(1+\gamma_5)\nu\right] \ , \qquad (1)$$

where P_K and P_π are the four-momenta of the K and π mesons, m_ℓ is the lepton mass, and f_+ and f_- are dimensionless form factors which can depend only on $t = (P_K - P_\pi)^2$, the square of the four-momentum transfer to the leptons. If time-reversal invariance holds, f_+ and f_- are relatively real. $K_{\mu 3}$ experiments measure f_+ and f_-, while K_{e3} experiments are sensitive only to f_+ because the small electron mass makes the f_- term negligible.

(a) $K_{\mu 3}$ *experiments*. Analyses of $K_{\mu 3}$ data frequently assume a linear dependence of f_+ and f_- on t, *i.e.*,

$$f_\pm(t) = f_\pm(0) \left[1 + \lambda_\pm (t/m_\pi^2)\right] \tag{2}$$

Most $K_{\mu 3}$ data are adequately described by Eq. (2) for f_+ and a constant f_- (*i.e.*, $\lambda_- = 0$). There are two equivalent parametrizations commonly used in these analyses:

(1) $\lambda_+, \xi(0)$ *parametrization*. Analyses of $K_{\mu 3}$ data often introduce the ratio of the two form factors

$$\xi(t) = f_-(t)/f_+(t) \ .$$

The $K_{\mu 3}$ decay distribution is then described by the two parameters λ_+ and $\xi(0)$ (assuming time reversal invariance and $\lambda_- = 0$). These parameters can be determined by three different methods:

Method A. By studying the Dalitz plot or the pion spectrum of $K_{\mu 3}$ decay. The Dalitz plot density is (see, *e.g.*, Chounet *et al.* [1]):

$$\rho(E_\pi, E_\mu) \propto f_+^2(t) \left[A + B\xi(t) + C\xi(t)^2\right] \ ,$$

where

$$A = m_K \left(2E_\mu E_\nu - m_K E'_\pi\right) + m_\mu^2 \left(\frac{1}{4}E'_\pi - E_\nu\right) ,$$

$$B = m_\mu^2 \left(E_\nu - \frac{1}{2}E'_\pi\right) ,$$

$$C = \frac{1}{4} m_\mu^2 E'_\pi ,$$

$$E'_\pi = E_\pi^{\max} - E_\pi = \left(m_K^2 + m_\pi^2 - m_\mu^2\right)/2m_K - E_\pi .$$

Here E_π, E_μ, and E_ν are, respectively, the pion, muon, and neutrino energies in the kaon center of mass. The density ρ is fit to the data to determine the values of $\lambda_+, \xi(0)$, and their correlation.

Method B. By measuring the $K_{\mu 3}/K_{e3}$ branching ratio and comparing it with the theoretical ratio (see, *e.g.*, Fearing *et al.* [2]) as given in terms of λ_+ and $\xi(0)$, assuming μ-e universality:

$$\Gamma(K^\pm_{\mu 3})/\Gamma(K^\pm_{e3}) = 0.6457 + 1.4115\lambda_+ + 0.1264\xi(0) + 0.0192\xi(0)^2 + 0.0080\lambda_+\xi(0) ,$$

$$\Gamma(K^0_{\mu 3})/\Gamma(K^0_{e3}) = 0.6452 + 1.3162\lambda_+ + 0.1264\xi(0) + 0.0186\xi(0)^2 + 0.0064\lambda_+\xi(0) .$$

This cannot determine λ_+ and $\xi(0)$ simultaneously but simply fixes a relationship between them.

Method C. By measuring the muon polarization in $K_{\mu 3}$ decay. In the rest frame of the K, the μ is expected to be polarized in the direction $\mathbf{A}$ with $\mathbf{P} = \mathbf{A}/\left|\mathbf{A}\right|$, where $\mathbf{A}$ is given (Cabibbo and Maksymowicz [3]) by

$$\begin{aligned}\mathbf{A} &= a_1(\xi)\mathbf{p}_\mu \\ &- a_2(\xi)\left[\frac{\mathbf{p}_\mu}{m_\mu}\left(m_K - E_\pi + \frac{\mathbf{p}_\pi\cdot\mathbf{p}_\mu}{\left|\mathbf{p}_\mu\right|^2}(E_\mu - m_\mu)\right) + \mathbf{p}_\pi\right] \\ &+ m_K \mathrm{Im}\xi(t)(\mathbf{p}_\pi \times \mathbf{p}_\mu)\ .\end{aligned}$$

If time-reversal invariance holds, ξ is real, and thus there is no polarization perpendicular to the K-decay plane. Polarization experiments measure the weighted average of $\xi(t)$ over the t range of the experiment, where the weighting accounts for the variation with t of the sensitivity to $\xi(t)$.

(2) λ_+, λ_0 *parametrization.* Most of the more recent $K_{\mu 3}$ analyses have parameterized in terms of the form factors f_+ and f_0 which are associated with vector and scalar exchange, respectively, to the lepton pair. f_0 is related to f_+ and f_- by

$$f_0(t) = f_+(t) + \left[t/(m_K^2 - m_\pi^2)\right] f_-(t)\ .$$

Here $f_0(0)$ must equal $f_+(0)$ unless $f_-(t)$ diverges at $t = 0$. The earlier assumption that f_+ is linear in t and f_- is constant leads to f_0 linear in t:

$$f_0(t) = f_0(0)\left[1 + \lambda_0(t/m_\pi^2)\right]\ .$$

With the assumption that $f_0(0) = f_+(0)$, the two parametrizations, $(\lambda_+, \xi(0))$ and (λ_+, λ_0) are equivalent as long as correlation information is retained. (λ_+, λ_0) correlations tend to be less strong than $(\lambda_+, \xi(0))$ correlations.

The experimental results for $\xi(0)$ and its correlation with λ_+ are listed in the $K^\pm$ and K_L^0 sections of the Particle Listings in section $\xi_{\rm A}$, $\xi_{\rm B}$, or $\xi_{\rm C}$ depending on whether method A, B, or C discussed above was used. The corresponding values of λ_+ are also listed.

Because recent experiments tend to use the (λ_+, λ_0) parametrization, we include a subsection for λ_0 results. Wherever possible we have converted $\xi(0)$ results into λ_0 results and vice versa.

See the 1982 version of this note [4] for additional discussion of the $K^0_{\mu 3}$ parameters, correlations, and conversion between parametrizations, and also for a comparison of the experimental results.

(b) K_{e3} *experiments*. Analysis of K_{e3} data is simpler than that of $K_{\mu 3}$ because the second term of the matrix element assuming a pure vector current [Eq. (1) above] can be neglected. Here f_+ is usually assumed to be linear in t, and the linear coefficient λ_+ of Eq. (2) is determined.

If we remove the assumption of a pure vector current, then the matrix element for the decay, in addition to the terms in Eq. (2), would contain

$$+2m_K\, f_S\, \overline{\ell}(1+\gamma_5)\nu$$
$$+(2f_T/m_K)(P_K)_\lambda (P_\pi)_\mu\, \overline{\ell}\, \sigma_{\lambda\mu}(1+\gamma_5)\nu\ ,$$

where f_S is the scalar form factor, and f_T is the tensor form factor. In the case of the K_{e3} decays where the f_- term can be neglected, experiments have yielded limits on $|f_S/f_+|$ and $|f_T/f_+|$.

References

1. L.M. Chounet, J.M. Gaillard, and M.K. Gaillard, Phys. Reports **4C**, 199 (1972).
2. H.W. Fearing, E. Fischbach, and J. Smith, Phys. Rev. **D2**, 542 (1970).

3. N. Cabibbo and A. Maksymowicz, Phys. Lett. **9**, 352 (1964).
4. Particle Data Group, Phys. Lett. **111B**, 73 (1982).

$K^{\pm}_{\ell 3}$ FORM FACTORS

In the form factor comments, the following symbols are used.

f_+ and f_- are form factors for the vector matrix element.

f_S and f_T refer to the scalar and tensor term.

$f_0 = f_+ + f_- t/(m^2_K - m^2_\pi)$.

λ_+, λ_-, and λ_0 are the linear expansion coefficients of f_+, f_-, and f_0.

λ_+ refers to the $K^{\pm}_{\mu 3}$ value except in the $K^{\pm}_{e3}$ sections.

$d\xi(0)/d\lambda_+$ is the correlation between $\xi(0)$ and λ_+ in $K^{\pm}_{\mu 3}$.

$d\lambda_0/d\lambda_+$ is the correlation between λ_0 and λ_+ in $K^{\pm}_{\mu 3}$.

t = momentum transfer to the π in units of m^2_π.

DP = Dalitz plot analysis.

PI = π spectrum analysis.

MU = μ spectrum analysis.

POL= μ polarization analysis.

BR = $K^{\pm}_{\mu 3}/K^{\pm}_{e3}$ branching ratio analysis.

E = positron or electron spectrum analysis.

RC = radiative corrections.

λ_+ (LINEAR ENERGY DEPENDENCE OF f_+ IN $K^{\pm}_{e3}$ DECAY)

For radiative correction of $K^{\pm}_{e3}$ Dalitz plot, see GINSBERG 67 and BECHERRAWY 70.

VALUE	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
0.0286±0.0022 OUR AVERAGE						
0.0284±0.0027±0.0020	32k	[80] AKIMENKO	91	SPEC		PI, no RC
0.029 ±0.004	62k	[81] BOLOTOV	88	SPEC		PI, no RC
0.027 ±0.008		[82] BRAUN	73B	HLBC	+	DP, no RC
0.029 ±0.011	4017	CHIANG	72	OSPK	+	DP, RC negligible
0.027 ±0.010	2707	STEINER	71	HLBC	+	DP, uses RC
0.045 ±0.015	1458	BOTTERILL	70	OSPK		PI, uses RC
0.08 ±0.04	960	BOTTERILL	68C	ASPK	+	e^+, uses RC
$-0.02\ ^{+0.08}_{-0.12}$	90	EISLER	68	HLBC	+	PI, uses RC
$0.045\ ^{+0.017}_{-0.018}$	854	BELLOTTI	67B	FBC	+	DP, uses RC
+0.016 ±0.016	1393	IMLAY	67	OSPK	+	DP, no RC
$+0.028\ ^{+0.013}_{-0.014}$	515	KALMUS	67	FBC	+	e^+, PI, no RC
−0.04 ±0.05	230	BORREANI	64	HBC	+	e^+, no RC
−0.010 ±0.029	407	JENSEN	64	XEBC	+	PI, no RC
+0.036 ±0.045	217	BROWN	62B	XEBC	+	PI, no RC
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.025 ±0.007		[83] BRAUN	74	HLBC	+	$K_{\mu 3}/K_{e3}$ vs. t

[80] AKIMENKO 91 state that radiative corrections would raise λ_+ by 0.0013.

[81] BOLOTOV 88 state radiative corrections of GINSBERG 67 would raise λ_+ by 0.002.

[82] BRAUN 73B states that radiative corrections of GINSBERG 67 would lower λ_+^e by 0.002 but that radiative corrections of BECHERRAWY 70 disagrees and would raise λ_+^e by 0.005.

[83] BRAUN 74 is a combined $K_{\mu3}$-K_{e3} result. It is not independent of BRAUN 73C ($K_{\mu3}$) and BRAUN 73B (K_{e3}) form factor results.

$\xi_A = f_-/f_+$ (determined from $K^\pm_{\mu3}$ spectra)

The parameter ξ is redundant with λ_0 below and is not put into the Meson Summary Table.

VALUE	$d\xi(0)/d\lambda_+$	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
−0.33±0.14 OUR EVALUATION			Error includes scale factor of 1.6. Correlation is $d\xi(0)/d\lambda_+ = -14$. From a fit discussed in note on $K_{\ell3}$ form factors in 1982 edition, PL **111B** (April 1982).				
−0.27±0.25	−17	3973	WHITMAN	80	SPEC	+	DP
−0.8 ±0.8	−20	490	[84] ARNOLD	74	HLBC	+	DP
−0.57±0.24	−9	6527	[85] MERLAN	74	ASPK	+	DP
−0.36±0.40	−19	1897	[86] BRAUN	73C	HLBC	+	DP
−0.62±0.28	−12	4025	[87] ANKENBRA...	72	ASPK	+	PI
+0.45±0.28	−15	3480	[88] CHIANG	72	OSPK	+	DP
−1.1 ±0.56	−29	3240	[89] HAIDT	71	HLBC	+	DP
−0.5 ±0.8	−26	2041	[90] KIJEWSKI	69	OSPK	+	PI
+0.72±0.93	−17	444	CALLAHAN	66B	FBC	+	PI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
−0.5 ±0.9	none	78	EISLER	68	HLBC	+	PI, $\lambda_+=0$
$0.0\,^{+1.1}_{-0.9}$		2648	[91] CALLAHAN	66B	FBC	+	μ, $\lambda_+=0$
+0.7 ±0.5		87	GIACOMELLI	64	EMUL	+	MU+BR,$\lambda_+=0$
−0.08±0.7			[92] JENSEN	64	XEBC	+	DP+BR
+1.8 ±0.6		76	BROWN	62B	XEBC	+	DP+BR, $\lambda_+=0$

[84] ARNOLD 74 figure 4 was used to obtain ξ_A and $d\xi(0)/d\lambda_+$.

[85] MERLAN 74 figure 5 was used to obtain $d\xi(0)/d\lambda_+$.

[86] BRAUN 73C gives $\xi(t) = -0.34 \pm 0.20$, $d\xi(t)/d\lambda_+ = -14$ for $\lambda_+ = 0.027$, $t = 6.6$. We calculate above $\xi(0)$ and $d\xi(0)/d\lambda_+$ for their $\lambda_+ = 0.025 \pm 0.017$.

[87] ANKENBRANDT 72 figure 3 was used to obtain $d\xi(0)/d\lambda_+$.

[88] CHIANG 72 figure 10 was used to obtain $d\xi(0)/d\lambda_+$. Fit had $\lambda_- = \lambda_+$ but would not change for $\lambda_- = 0$. L.Pondrom, (private communication 74).

[89] HAIDT 71 table 8 (Dalitz plot analysis) gives $d\xi(0)/d\lambda_+ = (-1.1+0.5)/(0.050-0.029) = -29$, error raised from 0.50 to agree with $d\xi(0) = 0.20$ for fixed λ_+.

[90] KIJEWSKI 69 figure 17 was used to obtain $d\xi(0)/d\lambda_+$ and errors.

[91] CALLAHAN 66 table 1 (π analysis) gives $d\xi(0)/d\lambda_+ = (0.72–0.05)/(0–0.04) = -17$, error raised from 0.80 to agree with $d\xi(0) = 0.37$ for fixed λ_+. t unknown.

[92] JENSEN 64 gives $\lambda_+^\mu = \lambda_+^e = -0.020 \pm 0.027$. $d\xi(0)/d\lambda_+$ unknown. Includes SHAKLEE 64 $\xi_B(K_{\mu3}/K_{e3})$.

$\xi_B = f_-/f_+$ (determined from $K^\pm_{\mu 3}/K^\pm_{e3}$)

The $K^\pm_{\mu 3}/K^\pm_{e3}$ branching ratio fixes a relationship between $\xi(0)$ and λ_+. We quote the author's $\xi(0)$ and associated λ_+ but do not average because the λ_+ values differ. The fit result and scale factor given below are not obtained from these ξ_B values. Instead they are obtained directly from the fitted $K^\pm_{\mu 3}/K^\pm_{e3}$ ratio $\Gamma(\pi^0\mu^+\nu_\mu)/\Gamma(\pi^0 e^+\nu_e)$, with the exception of HEINTZE 77. The parameter ξ is redundant with λ_0 below and is not put into the Meson Summary Table.

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
−0.33±0.14 OUR EVALUATION		Error includes scale factor of 1.6. Correlation is $d\xi(0)/d\lambda_+ = -14$. From a fit discussed in note on $K_{\ell 3}$ form factors in 1982 edition, PL **111B** (April 1982).				
−0.12±0.12	55k	[93] HEINTZE	77	CNTR	+	λ_+=0.029
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.0 ±0.15	5825	CHIANG	72	OSPK	+	λ_+=0.03, fig.10
−0.81±0.27	1505	[94] HAIDT	71	HLBC	+	λ_+=0.028, fig.8
−0.35±0.22		[95] BOTTERILL	70	OSPK	+	λ_+=0.045±0.015
+0.91±0.82		ZELLER	69	ASPK	+	λ_+=0.023
−0.08±0.15	5601	[95] BOTTERILL	68B	ASPK	+	λ_+=0.023±0.008
−0.60±0.20	1398	[94] EICHTEN	68	HLBC	+	See note
+1.0 ±0.6	986	GARLAND	68	OSPK	+	λ_+=0
+0.75±0.50	306	AUERBACH	67	OSPK	+	λ_+=0
+0.4 ±0.4	636	CALLAHAN	66B	FBC	+	λ_+=0
+0.6 ±0.5		BISI	65B	HBC	+	λ_+=0
+0.8 ±0.6	500	CUTTS	65	OSPK	+	λ_+=0
$-0.17^{+0.75}_{-0.99}$		SHAKLEE	64	XEBC	+	λ_+=0

[93] Calculated by us from λ_0 and λ_+ given below.

[94] EICHTEN 68 has $\lambda_+ = 0.023 \pm 0.008$, $t = 4$, independent of λ_-. Replaced by HAIDT 71.

[95] BOTTERILL 70 is re-evaluation of BOTTERILL 68B with different λ_+.

$\xi_C = f_-/f_+$ (determined from μ polarization in $K^\pm_{\mu 3}$)

The μ polarization is a measure of $\xi(t)$. No assumptions on λ_{+-} necessary, t (weighted by sensitivity to $\xi(t)$) should be specified. In λ_+, $\xi(0)$ parametrization this is $\xi(0)$ for λ_+=0. $d\xi/d\lambda = \xi t$. For radiative correction to muon polarization in $K^\pm_{\mu 3}$, see GINSBERG 71. The parameter ξ is redundant with λ_0 below and is not put into the Meson Summary Table.

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
−0.33±0.14 OUR EVALUATION		Error includes scale factor of 1.6. Correlation is $d\xi(0)/d\lambda_+ = -14$. From a fit discussed in note on $K_{\ell 3}$ form factors in 1982 edition, PL **111B** (April 1982).				
−0.25±1.20	1585	[96] BRAUN	75	HLBC	+	POL, t=4.2
−0.95±0.3	3133	[97] CUTTS	69	OSPK	+	Total pol. t=4.0
−1.0 ±0.3	6000	[98] BETTELS	68	HLBC	+	Total pol. t=4.9

• • • We do not use the following data for averages, fits, limits, etc. • • •

-0.64 ± 0.27	40k	[99] MERLAN	74	ASPK	+	POL, $d\xi(0)/d\lambda_+ = +1.7$
$-1.4\ \pm1.8$	397	[100] CALLAHAN	66B	FBC	+	Total pol.
$-0.7\ ^{+0.9}_{-3.3}$	2950	[100] CALLAHAN	66B	FBC	+	Long. pol.
$+1.2\ ^{+2.4}_{-1.8}$	2100	[100] BORREANI	65	HLBC	+	Polarization
-4.0 to $+1.7$	500	[100] CUTTS	65	OSPK	+	Long. pol.

[96] BRAUN 75 $d\xi(0)/d\lambda_+ = \xi t = -0.25\times4.2 = -1.0$.

[97] CUTTS 69 $t = 4.0$ was calculated from figure 8. $d\xi(0)/d\lambda_+ = \xi t = -0.95\times4 = -3.8$.

[98] BETTELS 68 $d\xi(0)/d\lambda_+ = \xi t = -1.0\times4.9 = -4.9$.

[99] MERLAN 74 polarization result (figure 5) not possible. See discussion of polarization experiments in note on "$K_{\ell3}$ Form Factors" in the 1982 edition of this *Review* [Physics Letters **111B** (1982)].

[100] t value not given.

Im(ξ) in $K^{\pm}_{\mu3}$ DECAY (from transverse μ pol.)

Test of T reversal invariance.

VALUE	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
-0.017 ± 0.025 OUR AVERAGE						
-0.016 ± 0.025	20M	CAMPBELL	81	CNTR	+	Pol.
$-0.3\ ^{+0.3}_{-0.4}$	3133	CUTTS	69	OSPK	+	Total pol. fig.7
$-0.1\ \pm0.3$	6000	BETTELS	68	HLBC	+	Total pol.
$0.0\ \pm1.0$	2648	CALLAHAN	66B	FBC	+	MU
$+1.6\ \pm1.3$	397	CALLAHAN	66B	FBC	+	Total pol.
$0.5\ ^{+1.4}_{-0.5}$	2950	CALLAHAN	66B	FBC	+	Long. pol.
• • • We do not use the following data for averages, fits, limits, etc. • • •						
-0.010 ± 0.019	32M	[101] BLATT	83	CNTR		Polarization

[101] Combined result of MORSE 80 ($K^0_{\mu3}$) and CAMPBELL 81 ($K^+_{\mu3}$).

λ_+ (LINEAR ENERGY DEPENDENCE OF f_+ IN $K^{\pm}_{\mu3}$ DECAY)

See also the corresponding entries and footnotes in sections ξ_A, ξ_C, and λ_0. For radiative correction of $K^{\pm}_{\mu3}$ Dalitz plot, see GINSBERG 70 and BECHERRAWY 70.

VALUE	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
0.032 ± 0.008 OUR EVALUATION		Error includes scale factor of 1.6. From a fit discussed in note on $K_{\ell3}$ form factors in 1982 edition, PL **111B** (April 1982).				
0.029 ± 0.024	3000	ARTEMOV	97	SPEC	−	DP
$+0.050\pm0.013$	3973	WHITMAN	80	SPEC	+	DP
0.025 ± 0.030	490	ARNOLD	74	HLBC	+	DP
0.027 ± 0.019	6527	MERLAN	74	ASPK	+	DP
0.025 ± 0.017	1897	BRAUN	73C	HLBC	+	DP
0.024 ± 0.019	4025	[102] ANKENBRA...	72	ASPK	+	PI
-0.006 ± 0.015	3480	CHIANG	72	OSPK	+	DP
0.050 ± 0.018	3240	HAIDT	71	HLBC	+	DP
0.009 ± 0.026	2041	KIJEWSKI	69	OSPK	+	PI
$0.0\ \pm0.05$	444	CALLAHAN	66B	FBC	+	PI

[102] ANKENBRANDT 72 λ_+ from figure 3 to match $d\xi(0)/d\lambda_+$. Text gives 0.024 ± 0.022.

λ_0 (LINEAR ENERGY DEPENDENCE OF f_0 IN $K^{\pm}_{\mu 3}$ DECAY)

Wherever possible, we have converted the above values of $\xi(0)$ into values of λ_0 using the associated λ_+^{μ} and $d\xi/d\lambda$.

VALUE	$d\lambda_0/d\lambda_+$	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
0.006±0.007 OUR EVALUATION			Error includes scale factor of 1.6. Correlation is $d\lambda_0/d\lambda_+ = -0.16$. From a fit discussed in note on $K_{\ell 3}$ form factors in 1982 edition, PL **111B** (April 1982).				
+0.062±0.024	0.0	3000	[103] ARTEMOV	97	SPEC	−	DP
+0.029±0.011	−0.37	3973	WHITMAN	80	SPEC	+	DP
+0.019±0.010	+0.03	55k	[104] HEINTZE	77	SPEC	+	BR
+0.008±0.097	+0.92	1585	[105] BRAUN	75	HLBC	+	POL
−0.040±0.040	−0.62	490	ARNOLD	74	HLBC	+	DP
−0.019±0.015	+0.27	6527	[106] MERLAN	74	ASPK	+	DP
−0.008±0.020	−0.53	1897	[107] BRAUN	73C	HLBC	+	DP
−0.026±0.013	+0.03	4025	[108] ANKENBRA...	72	ASPK	+	PI
+0.030±0.014	−0.21	3480	[108] CHIANG	72	OSPK	+	DP
−0.039±0.029	−1.34	3240	[108] HAIDT	71	HLBC	+	DP
−0.056±0.024	+0.69	3133	[105] CUTTS	69	OSPK	+	POL
−0.031±0.045	−1.10	2041	[108] KIJEWSKI	69	OSPK	+	PI
−0.063±0.024	+0.60	6000	[105] BETTELS	68	HLBC	+	POL
+0.058±0.036	−0.37	444	[108] CALLAHAN	66B	FBC	+	PI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
−0.017±0.011			[109] BRAUN	74	HLBC	+	$K_{\mu 3}/K_{e3}$ vs. t

[103] ARTEMOV 97 does not give $d\lambda_0/d\lambda_+$ so we take it to be zero.

[104] HEINTZE 77 uses $\lambda_+ = 0.029 \pm 0.003$. $d\lambda_0/d\lambda_+$ estimated by us.

[105] λ_0 value is for $\lambda_+ = 0.03$ calculated by us from $\xi(0)$ and $d\xi(0)/d\lambda_+$.

[106] MERLAN 74 λ_0 and $d\lambda_0/d\lambda_+$ were calculated by us from ξ_A, λ_+^{μ}, and $d\xi(0)/d\lambda_+$. Their figure 6 gives $\lambda_0 = -0.025 \pm 0.012$ and no $d\lambda_0/d\lambda_+$.

[107] This value and error are taken from BRAUN 75 but correspond to the BRAUN 73C λ_+^{μ} result. $d\lambda_0/d\lambda_+$ is from BRAUN 73C $d\xi(0)/d\lambda_+$ in ξ_A above.

[108] λ_0 calculated by us from $\xi(0)$, λ_+^{μ}, and $d\xi(0)/d\lambda_+$.

[109] BRAUN 74 is a combined $K_{\mu 3}$-K_{e3} result. It is not independent of BRAUN 73C ($K_{\mu 3}$) and BRAUN 73B (K_{e3}) form factor results.

$|f_S/f_+|$ FOR $K^{\pm}_{e3}$ DECAY

Ratio of scalar to f_+ couplings.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
0.084±0.023 OUR AVERAGE			Error includes scale factor of 1.2.				
0.070±0.016±0.016		32k	AKIMENKO	91	SPEC		λ_+, f_S, f_T, ϕ fit
0.00 ±0.10		2827	BRAUN	75	HLBC	+	
0.14 $^{+0.03}_{-0.04}$		2707	STEINER	71	HLBC	+	λ_+, f_S, f_T, ϕ fit

• • • We do not use the following data for averages, fits, limits, etc. • • •

<0.13	90	4017	CHIANG	72	OSPK	+
<0.23	90		BOTTERILL	68C	ASPK	
<0.18	90		BELLOTTI	67B	HLBC	
<0.30	95		KALMUS	67	HLBC	+

$|f_T/f_+|$ FOR $K^{\pm}_{e3}$ DECAY

Ratio of tensor to f_+ couplings.

VALUE	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
0.38±0.11 OUR AVERAGE	Error includes scale factor of 1.1.						
$0.53^{+0.09}_{-0.10}\pm0.10$		32k	AKIMENKO	91	SPEC		λ_+, f_S, f_T, ϕ fit
0.07±0.37		2827	BRAUN	75	HLBC	+	
$0.24^{+0.16}_{-0.14}$		2707	STEINER	71	HLBC	+	λ_+, f_S, f_T, ϕ fit

• • • We do not use the following data for averages, fits, limits, etc. • • •

<0.75	90	4017	CHIANG	72	OSPK	+
<0.58	90		BOTTERILL	68C	ASPK	
<0.58	90		BELLOTTI	67B	HLBC	
<1.1	95		KALMUS	67	HLBC	+

f_T/f_+ FOR $K^{\pm}_{\mu3}$ DECAY

Ratio of tensor to f_+ couplings.

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*
0.02±0.12	1585	BRAUN	75	HLBC

DECAY FORM FACTORS FOR $K^{\pm} \to \pi^+\pi^- e^{\pm}\nu_e$

Given in ROSSELET 77, BEIER 73, and BASILE 71C.

DECAY FORM FACTOR FOR $K^{\pm} \to \pi^0\pi^0 e^{\pm}\nu$

Given in BOLOTOV 86B and BARMIN 88B.

$K^{\pm} \to \ell^{\pm}\nu\gamma$ FORM FACTORS

For definitions of the axial-vector F_A and vector F_V form factor, see the "Note on $\pi^{\pm} \to \ell^{\pm}\nu\gamma$ and $K^{\pm} \to \ell^{\pm}\nu\gamma$ Form Factors" in the $\pi^{\pm}$ section. In the kaon literature, often different definitions $a_K = F_A/m_K$ and $v_K = F_V/m_K$ are used.

$F_A + F_V$, SUM OF AXIAL-VECTOR AND VECTOR FORM FACTOR FOR $K \to e\nu_e\gamma$

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.148±0.010 OUR AVERAGE					
0.147±0.011	51	[110] HEINTZE	79	SPEC	$K \to e\nu\gamma$
$0.150^{+0.018}_{-0.023}$	56	[111] HEARD	75	SPEC	$K \to e\nu\gamma$

[110] HEINTZE 79 quotes absolute value of $|F_A + F_V| \sin\theta_c$. We use $\sin\theta_c = V_{us} = 0.2205$.
[111] HEARD 75 quotes absolute value of $|F_A + F_V| \sin\theta_c$. We use $\sin\theta_c = V_{us} = 0.2205$.

$F_A + F_V$, SUM OF AXIAL-VECTOR AND VECTOR FORM FACTOR FOR $K \to \mu\nu_\mu\gamma$

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
< 0.23	90	[112] AKIBA	85	SPEC	$K \to \mu\nu\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
−1.2 to 1.1	90	DEMIDOV	90	XEBC	$K \to \mu\nu\gamma$

[112] AKIBA 85 quotes absolute value.

$F_A - F_V$, DIFFERENCE OF AXIAL-VECTOR AND VECTOR FORM FACTOR FOR $K \to e\nu_e\gamma$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
<0.49	90	[113] HEINTZE	79	SPEC	$K \to e\nu\gamma$

[113] HEINTZE 79 quotes $|F_A - F_V| < \sqrt{11}\,|F_A + F_V|$.

$F_A - F_V$, DIFFERENCE OF AXIAL-VECTOR AND VECTOR FORM FACTOR FOR $K \to \mu\nu_\mu\gamma$

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
−2.2 to 0.3 OUR EVALUATION					
−2.2 to 0.6	90	DEMIDOV	90	XEBC	$K \to \mu\nu\gamma$
−2.5 to 0.3	90	AKIBA	85	SPEC	$K \to \mu\nu\gamma$

$K^\pm$ REFERENCES

ADLER	97	PRL 79 2204	S. Adler+	(BNL 787 Collab.)
ADLER	97C	PRL 79 4756	S. Adler+	(BNL 787 Collab.)
ARTEMOV	97	PAN 60 218	V.M. Artemov+	(JINR)
		Translated from YAF 60 277.		
KITCHING	97	PRL 79 4079	P. Kitching+	(BNL 787 Collab.)
ADLER	96	PRL 76 1421	+Atiya, Chiang, Frank, Haggerty, Kycia+	(BNL 787 Collab.)
KOPTEV	95	JETPL 61 877	+Mikirtych'yants, Shcherbakov+	(PNPI)
		Translated from ZETFP 61 865.		
AOKI	94	PR D50 69	+Yamazaki, Imazato, Kawashima+	(INUS, KEK, TOKMS)
ATIYA	93	PRL 70 2521	+Chiang, Frank, Haggerty, Ito+	(BNL 787 Collab.)
Also	93C	PRL 71 305 (erratum)	Atiya, Chiang, Frank, Haggerty, Ito+	(BNL 787 Collab.)
ATIYA	93B	PR D48 R1	+Chiang, Frank, Haggerty, Ito+	(BNL 787 Collab.)
BIJNENS	93	NP B396 81	+Ecker, Gasser	(CERN, BERN)
ALLIEGRO	92	PRL 68 278	+Campagnari+	(BNL, FNAL, PSI, WASH, YALE)
BARMIN	92	SJNP 55 547	+Barylov, Chernukha, Davidenko+	(ITEP)
		Translated from YAF 55 976.		
IMAZATO	92	PRL 69 877	+Kawashima, Tanaka+	(KEK, INUS, TOKY, TOKMS)
IVANOV	92	THESIS		(PNPI)
LITTENBERG	92	PRL 68 443	+Shrock	(BNL, STON)
USHER	92	PR D45 3961	+Fero, Gee, Graf, Mandelkern, Schultz, Schultz	(UCI)
AKIMENKO	91	PL B259 225	+Beloussov+	(SERP, JINR, TBIL, CMNS, SOFU, KOSI)
BARMIN	91	SJNP 53 606	+Barylov, Davidenko, Demidov+	(ITEP)
		Translated from YAF 53 981.		
DENISOV	91	JETPL 54 558	+Zhelamkov, Ivanov, Lapina, Levchenko, Malakhov+	(PNPI)
		Translated from ZETFP 54 557.		
Also	92	THESIS	Ivanov	(PNPI)
ATIYA	90	PRL 64 21	+Chiang, Frank, Haggerty, Ito, Kycia+	(BNL 787 Collab.)
ATIYA	90B	PRL 65 1188	+Chiang, Frank, Haggerty, Ito, Kycia+	(BNL 787 Collab.)
DEMIDOV	90	SJNP 52 1006	+Dobrokhotov, Lyublev, Nikitenko+	(ITEP)
		Translated from YAF 52 1595.		
LEE	90	PRL 64 165	+Alliegro, Campagnari+	(BNL, FNAL, VILL, WASH, YALE)
ATIYA	89	PRL 63 2177	+Chiang, Frank, Haggerty, Ito, Kycia+	(BNL 787 Collab.)
BARMIN	89	SJNP 50 421	+Barylov, Davidenko, Demidov, Dolgolenko+	(ITEP)
		Translated from YAF 50 679.		
BARMIN	88	SJNP 47 643	+Barylov, Davidenko, Demidov, Dolgolenko+	(ITEP)
		Translated from YAF 47 1011.		
BARMIN	88B	SJNP 48 1032	+Barylov, Davidenko, Demidov, Dolgolenko+	(ITEP)
		Translated from YAF 48 1719.		
BOLOTOV	88	JETPL 47 7	+Gninenko, Dzhilkibaev, Isakov, Klubakov+	(ASCI)
		Translated from ZETFP 47 8.		

CAMPAGNARI 88 PRL 61 2062 +Alliegro, Chaloupka+ (BNL, FNAL, PSI, WASH, YALE)
GALL 88 PRL 60 186 +Austin+ (BOST, MIT, WILL, CIT, CMU, WYOM)
BARMIN 87 SJNP 45 62 +Barylov, Davidenko, Demidov+ (ITEP)
Translated from YAF 45 97.
BOLOTOV 87 SJNP 45 1023 +Gninenko, Dzhilkibaev, Isakov, Klubakov+ (INRM)
Translated from YAF 45 1652.
BOLOTOV 86 SJNP 44 73 +Gninenko, Dzhilkibaev, Isakov+ (INRM)
Translated from YAF 44 117.
BOLOTOV 86B SJNP 44 68 +Gninenko, Dzhilkibaev, Isakov+ (INRM)
Translated from YAF 44 108.
YAMANAKA 86 PR D34 85 +Hayano, Taniguchi, Ishikawa+ (KEK, TOKY)
Also 84 PRL 52 329 Hayano, Yamanaka, Taniguchi+ (TOKY, KEK)
AKIBA 85 PR D32 2911 +Ishikawa, Iwasaki+ (TOKY, TINT, TSUK, KEK)
BOLOTOV 85 JETPL 42 481 +Gninenko, Dzhilkibaev, Isakov+ (INRM)
Translated from ZETFP 42 390.
BLATT 83 PR D27 1056 +Adair, Black, Campbell+ (YALE, BNL)
ASANO 82 PL 113B 195 +Kikutani, Kurokawa, Miyachi+(KEK, TOKY, INUS, OSAK)
COOPER 82 PL 112B 97 +Guy, Michette, Tyndel, Venus (RL)
PDG 82 PL 111B Roos, Porter, Aguilar-Benitez+ (HELS, CIT, CERN)
PDG 82B PL 111B 70 Roos, Porter, Aguilar-Benitez+ (HELS, CIT, CERN)
ASANO 81B PL 107B 159 +Kikutani, Kurokawa, Miyachi+(KEK, TOKY, INUS, OSAK)
CAMPBELL 81 PRL 47 1032 +Black, Blatt, Kasha, Schmidt+ (YALE, BNL)
Also 83 PR D27 1056 Blatt, Adair, Black, Campbell+ (YALE, BNL)
LUM 81 PR D23 2522 +Wiegand, Kessler, Deslattes, Seki+ (LBL, NBS+)
LYONS 81 ZPHY C10 215 +Albajar, Myatt (OXF)
MORSE 80 PR D21 1750 +Leipuner, Larsen, Schmidt, Blatt+ (BNL, YALE)
WHITMAN 80 PR D21 652 +Abrams, Carroll, Kycia, Li+ (ILLC, BNL, ILL)
BARKOV 79 NP B148 53 +Vasserman, Zolotorev, Krupin+ (NOVO, KIAE)
HEINTZE 79 NP B149 365 +Heinzelmann, Igo-Kemenes+ (HEIDP, CERN)
ABRAMS 77 PR D15 22 +Carroll, Kycia, Li, Michael, Mockett+ (BNL)
DEVAUX 77 NP B126 11 +Bloch, Diamant-Berger, Maillard+ (SACL, GEVA)
HEINTZE 77 PL 70B 482 +Heinzelmann, Igo-Kemenes+ (HEIDP, CERN)
ROSSELET 77 PR D15 574 +Extermann, Fischer, Guisan+ (GEVA, SACL)
BERTRAND 76 NP B114 387 +Sacton+ (BRUX, KIDR, DUUC, LOUC, WARS)
BLOCH 76 PL 60B 393 +Bunce, Devaux, Diamant-Berger+ (GEVA, SACL)
BRAUN 76B LNC 17 521 +Martyn, Erriquez+ (AACH3, BARI, BELG, CERN)
DIAMANT-... 76 PL 62B 485 Diamant-Berger, Bloch, Devaux+ (SACL, GEVA)
HEINTZE 76 PL 60B 302 +Heinzelmann, Igo-Kemenes, Mundhenke+ (HEIDP)
SMITH 76 NP B109 173 +Booth, Renshall, Jones+ (GLAS, LIVP, OXF, RHEL)
WEISSENBE... 76 NP B115 55 Weissenberg, Egorov, Minervina+ (ITEP, LEBD)
BLOCH 75 PL 56B 201 +Brehin, Bunce, Devaux+ (SACL, GEVA)
BRAUN 75 NP B89 210 +Cornelssen+ (AACH3, BARI, BRUX, CERN)
CHENG 75 NP A254 381 +Asano, Chen, Dugan, Hu, Wu+ (COLU, YALE)
HEARD 75 PL 55B 324 +Heintze, Heinzelmann+ (CERN, HEIDH)
HEARD 75B PL 55B 327 +Heintze, Heinzelmann+ (CERN, HEIDH)
SHEAFF 75 PR D12 2570 (WISC)
SMITH 75 NP B91 45 +Booth, Renshall, Jones+ (GLAS, LIVP, OXF, RHEL)
ARNOLD 74 PR D9 1221 +Roe, Sinclair (MICH)
BRAUN 74 PL 51B 393 +Cornelssen, Martyn+ (AACH3, BARI, BRUX, CERN)
CENCE 74 PR D10 776 +Harris, Jones, Morgado+ (HAWA, LBL, WISC)
Also 73 Thesis unpub. Clarke (WISC)
KUNSELMAN 74 PR C9 2469 (WYOM)
MERLAN 74 PR D9 107 +Kasha, Wanderer, Adair+ (YALE, BNL, LASL)
WEISSENBE... 74 PL 48B 474 Weissenberg, Egorov, Minervina+ (ITEP, LEBD)
ABRAMS 73B PRL 30 500 +Carroll, Kycia, Li, Menes, Michael+ (BNL)
BACKENSTO... 73 PL 43B 431 Backenstoss+ (CERN, KARLK, KARLE, HEID, STOH)
BEIER 73 PRL 30 399 +Buchholz, Mann, Parker, Roberts (PENN)
BRAUN 73B PL 47B 185 +Cornelssen (AACH3, BARI, BRUX, CERN)
Also 75 NP B89 210 Braun, Cornelssen+ (AACH3, BARI, BRUX, CERN)
BRAUN 73C PL 47B 182 +Cornelssen (AACH3, BARI, BRUX, CERN)
Also 75 NP B89 210 Braun, Cornelssen+ (AACH3, BARI, BRUX, CERN)
CABLE 73 PR D8 3807 +Hildebrand, Pang, Stiening (EFI, LBL)
LJUNG 73 PR D8 1307 +Cline (WISC)
Also 72 PRL 28 523 Ljung (WISC)
Also 72 PRL 28 1287 Cline, Ljung (WISC)
Also 69 PRL 23 326 Camerini, Ljung, Sheaff, Cline (WISC)
LUCAS 73 PR D8 719 +Taft, Willis (YALE)
LUCAS 73B PR D8 727 +Taft, Willis (YALE)
PANG 73 PR D8 1989 +Hildebrand, Cable, Stiening (EFI, ARIZ, LBL)
Also 72 PL 40B 699 Cable, Hildebrand, Pang, Stiening (EFI, LBL)
SMITH 73 NP B60 411 +Booth, Renshall, Jones+ (GLAS, LIVP, OXF, RHEL)
ABRAMS 72 PRL 29 1118 +Carroll, Kycia, Li, Menes, Michael+ (BNL)

ANKENBRA... 72 PRL 28 1472 Ankenbrandt, Larsen+ (BNL, LASL, FNAL, YALE)
AUBERT 72 NC 12A 509 +Heusse, Pascaud, Vialle+ (ORSAY, BRUX, EPOL)
BEIER 72 PRL 29 678 +Buchholz, Mann, Parker (PENN)
CHIANG 72 PR D6 1254 +Rosen, Shapiro, Handler, Olsen+ (ROCH, WISC)
CLARK 72 PRL 29 1274 +Cork, Elioff, Kerth, McReynolds, Newton+ (LBL)
EDWARDS 72 PR D5 2720 +Beier, Bertram, Herzo, Koester+ (ILL)
FORD 72 PL 38B 335 +Piroue, Remmel, Smith, Souder (PRIN)
HOFFMASTER 72 NP B36 1 +Koller, Taylor+ (STEV, SETO, LEHI)
BASILE 71C PL 36B 619 +Brehin, Diamant-Berger, Kunz+ (SACL, GEVA)
BOURQUIN 71 PL 36B 615 +Boymond, Extermann, Marasco+ (GEVA, SACL)
GINSBERG 71 PR D4 2893 (MIT)
HAIDT 71 PR D3 10 (AACH, BARI, CERN, EPOL, NIJM+)
Also 69 PL 29B 691 Haidt+ (AACH, BARI, CERN, EPOL, NIJM, ORSAY+)
KLEMS 71 PR D4 66 +Hildebrand, Stiening (CHIC, LRL)
Also 70 PRL 24 1086 Klems, Hildebrand, Stiening (LRL, CHIC)
Also 70B PRL 25 473 Klems, Hildebrand, Stiening (LRL, CHIC)
OTT 71 PR D3 52 +Pritchard (LOQM)
ROMANO 71 PL 36B 525 +Renton, Aubert, Burban-Lutz (BARI, CERN, ORSAY)
SCHWEINB... 71 PL 36B 246 Schweinberger (AACH, BELG, CERN, NIJM+)
STEINER 71 PL 36B 521 (AACH, BARI, CERN, EPOL, ORSAY, NIJM, PADO+)
BARDIN 70 PL 32B 121 +Bilenky, Pontecorvo (JINR)
BECHERRAWY 70 PR D1 1452 (ROCH)
BOTTERILL 70 PL 31B 325 +Brown, Clegg, Corbett, Culligan+ (OXF)
FORD 70 PRL 25 1370 +Piroue, Remmel, Smith, Souder (PRIN)
GAILLARD 70 CERN 70-14 +Chounet (CERN, ORSAY)
GINSBERG 70 PR D1 229 (HAIF)
GRAUMAN 70 PR D1 1277 +Koller, Taylor, Pandoulas+ (STEV, SETO, LEHI)
Also 69 PRL 23 737 Grauman, Koller, Taylor+ (STEV, SETO, LEHI)
MALTSEV 70 SJNP 10 678 +Pestova, Solodovnikova, Fadeev+ (JINR)
Translated from YAF 10 1195.
PANDOULAS 70 PR D2 1205 +Taylor, Koller, Grauman+ (STEV, SETO)
CUTTS 69 PR 184 1380 +Stiening, Wiegand, Deutsch (LRL, MIT)
Also 68 PRL 20 955 Cutts, Stiening, Wiegand, Deutsch (LRL, MIT)
DAVISON 69 PR 180 1333 +Bacastow, Barkas, Evans, Fung, Porter+ (UCR)
ELY 69 PR 180 1319 +Gidal, Hagopian, Kalmus+ (LOUC, WISC, LRL)
EMMERSON 69 PRL 23 393 +Quirk (OXF)
HERZO 69 PR 186 1403 +Banner, Beier, Bertram, Edwards+ (ILL)
KIJEWSKI 69 Thesis UCRL 18433 (LBL)
LOBKOWICZ 69 PR 185 1676 +Melissinos, Nagashima, Tewksbury+ (ROCH, BNL)
Also 66 PRL 17 548 Lobkowicz, Melissinos, Nagashima+ (ROCH, BNL)
MACEK 69 PRL 22 32 +Mann, McFarlane, Roberts+ (PENN, TEMP)
MAST 69 PR 183 1200 +Gershwin, Alston-Garnjost, Bangerter+ (LRL)
SELLERI 69 NC 60A 291
ZELLER 69 PR 182 1420 +Haddock, Helland, Pahl+ (UCLA, LRL)
BETTELS 68 NC 56A 1106 (AACH, BARI, BERG, CERN, EPOL, NIJM, ORSAY+)
Also 71 PR D3 10 Haidt (AACH, BARI, CERN, EPOL, NIJM+)
BOTTERILL 68B PRL 21 766 +Brown, Clegg, Corbett+ (OXF)
BOTTERILL 68C PR 174 1661 +Brown, Clegg, Corbett+ (OXF)
BUTLER 68 UCRL 18420 +Bland, Goldhaber, Goldhaber, Hirata+ (LRL)
CHANG 68 PRL 20 510 +Yodh, Ehrlich, Plano+ (UMD, RUTG)
CHEN 68 PRL 20 73 +Cutts, Kijewski, Stiening+ (LRL, MIT)
EICHTEN 68 PL 27B 586 (AACH, BARI, CERN, EPOL, ORSAY, PADO, VALE)
EISLER 68 PR 169 1090 +Fung, Marateck, Meyer, Plano (RUTG)
ESCHSTRUTH 68 PR 165 1487 +Franklin, Hughes+ (PRIN, PENN)
GARLAND 68 PR 167 1225 +Tsipis, Devons, Rosen+ (COLU, RUTG, WISC)
MOSCOSO 68 Thesis (ORSAY)
AUERBACH 67 PR 155 1505 +Dobbs, Mann+ (PENN, PRIN)
Also 74 PR D9 3216 Auerbach
Erratum.
BELLOTTI 67 Heidelberg Conf. +Pullia (MILA)
BELLOTTI 67B NC 52A 1287 +Fiorini, Pullia (MILA)
Also 66B PL 20 690 Bellotti, Fiorini, Pullia+ (MILA)
BISI 67 PL 25B 572 +Cester, Chiesa, Vigone (TORI)
BOTTERILL 67 PRL 19 982 +Brown, Corbett, Culligan+ (OXF)
Also 68 PR 171 1402 Botterill, Brown, Clegg, Corbett+ (OXF)
BOWEN 67B PR 154 1314 +Mann, McFarlane, Hughes+ (PPA)
CLINE 67B Herceg Novi Tbl. 4
Proc. International School on Elementary Particle Physics.
FLETCHER 67 PRL 19 98 +Beier, Edwards+ (ILL)

FORD	67	PRL 18 1214	+Lemonick, Nauenberg, Piroue	(PRIN)
GINSBERG	67	PR 162 1570		(MASB)
IMLAY	67	PR 160 1203	+Eschstruth, Franklin+	(PRIN)
KALMUS	67	PR 159 1187	+Kernan	(LRL)
ZINCHENKO	67	Thesis Rutgers		(RUTG)
CALLAHAN	66	NC 44A 90		(WISC)
CALLAHAN	66B	PR 150 1153	+Camerini+	(WISC, LRL, UCR, BARI)
CESTER	66	PL 21 343	+Eschstruth, Oneill+	(PPA)
See footnote 1 in AUERBACH 67.				
Also	67	PR 155 1505	Auerbach, Dobbs, Mann+	(PENN, PRIN)
BIRGE	65	PR 139B 1600	+Ely, Gidal, Camerini, Cline+	(LRL, WISC)
BISI	65	NC 35 768	+Borreani, Cester, Ferraro+	(TORI)
BISI	65B	PR 139B 1068	+Borreani, Marzari-Chiesa, Rinaudo+	(TORI)
BORREANI	65	PR 140B 1686	+Gidal, Rinaudo, Caforio+	(BARI, TORI)
CALLAHAN	65	PRL 15 129	+Cline	(WISC)
CAMERINI	65	NC 37 1795	+Cline, Gidal, Kalmus, Kernan	(WISC, LRL)
CLINE	65	PL 15 293	+Fry	(WISC)
CUTTS	65	PR 138B 969	+Elioff, Stiening	(LRL)
DEMARCO	65	PR 140B 1430	+Grosso, Rinaudo	(TORI, CERN)
FITCH	65B	PR 140B 1088	+Quarles, Wilkins	(PRIN, MTHO)
GREINER	65	ARNS 15 67		(LRL)
STAMER	65	PR 138B 440	+Huetter, Koller, Taylor, Grauman	(STEV)
TRILLING	65B	UCRL 16473		(LRL)
Updated from 1965 Argonne Conference, page 5.				
YOUNG	65	Thesis UCRL 16362		(LRL)
Also	67	PR 156 1464	Young, Osborne, Barkas	(LRL)
BORREANI	64	PL 12 123	+Rinaudo, Werbrouck	(TORI)
CALLAHAN	64	PR 136B 1463	+March, Stark	(WISC)
CAMERINI	64	PRL 13 318	+Cline, Fry, Powell	(WISC, LRL)
CLINE	64	PRL 13 101	+Fry	(WISC)
GIACOMELLI	64	NC 34 1134	+Monti, Quareni+	(BGNA, MUNI)
GREINER	64	PRL 13 284	+Osborne, Barkas	(LRL)
JENSEN	64	PR 136B 1431	+Shaklee, Roe, Sinclair	(MICH)
KALMUS	64	PRL 13 99	+Kernan, Pu, Powell, Dowd	(LRL, WISC)
SHAKLEE	64	PR 136B 1423	+Jensen, Roe, Sinclair	(MICH)
BARKAS	63	PRL 11 26	+Dyer, Heckman	(LRL)
BOYARSKI	62	PR 128 2398	+Loh, Niemela, Ritson	(MIT)
BROWN	62B	PRL 8 450	+Kadyk, Trilling, Roe+	(LRL, MICH)
BARKAS	61	PR 124 1209	+Dyer, Mason, Norris, Nickols, Smit	(LRL)
BHOWMIK	61	NC 20 857	+Jain, Mathur	(DELH)
FERRO-LUZZI	61	NC 22 1087	+Miller, Murray, Rosenfeld+	(LRL)
NORDIN	61	PR 123 2166		(LRL)
ROE	61	PRL 7 346	+Sinclair, Brown, Glaser+	(MICH, LRL)
FREDEN	60B	PR 118 564	+Gilbert, White	(LRL)
BURROWES	59	PRL 2 117	+Caldwell, Frisch, Hill+	(MIT)
TAYLOR	59	PR 114 359	+Harris, Orear, Lee, Baumel	(COLU)
EISENBERG	58	NC 8 663	+Koch, Lohrmann, Nikolic+	(BERN)
ALEXANDER	57	NC 6 478	+Johnston, Oceallaigh	(DUUC)
COHEN	57	Fund. Cons. Phys.	+Crowe, Dumond	(NAAS, LRL, CIT)
COOMBES	57	PR 108 1348	+Cork, Galbraith, Lambertson, Wenzel	(LBL)
BIRGE	56	NC 4 834	+Perkins, Peterson, Stork, Whitehead	(LRL)
ILOFF	56	PR 102 927	+Goldhaber, Lannutti, Gilbert+	(LRL)

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BATTISTON	92	PRPL 214 293	+Cocolicchio, Fogli, Paver	(PGIA, CERN, TRSTT)
Status and Perspectives of *K* Decay Physics				
BRYMAN	89	IJMP A4 79		(TRIU)
"Rare Kaon Decays"				
CHOUNET	72	PRPL 4C 199	+Gaillard, Gaillard	(ORSAY, CERN)
FEARING	70	PR D2 542	+Fischbach, Smith	(STON, BOHR)
HAIDT	69B	PL 29B 696	+	(AACH, BARI, CERN, EPOL, NIJM, ORSAY+)
CRONIN	68B	Vienna Conf. 241		(PRIN)
Rapporteur talk.				

WILLIS	67	Heidelberg Conf. 273		(YALE)
Rapporteur	talk.			
CABIBBO	66	Berkeley Conf. 33		(CERN)
ADAIR	64	PL 12 67	+Leipuner	(YALE, BNL)
CABIBBO	64	PL 9 352	+Maksymowicz	(CERN)
Also	64B	PL 11 360	Cabibbo, Maksymowicz	(CERN)
Also	65	PL 14 72	Cabibbo, Maksymowicz	(CERN)
BIRGE	63	PRL 11 35	+Ely, Gidal, Camerini+	(LRL, WISC, BARI)
BLOCK	62B	CERN Conf. 371	+Lendinara, Monari	(NWES, BGNA)
BRENE	61	NP 22 553	+Egardt, Qvist	(NORD)