BANNER 69 PR 188 2033 +Cronin, Liu, Pilcher (PRIN)
BOHM 69 Thesis (AACH)
BOZOKI 69 PL 30B 498 +Fenyves, Gombosi, Nagy+ (BUDA)
DOYLE 69 UCRL 18139 Thesis (LRL)
GOBBI 69 PRL 22 682 +Green, Hakel, Moffett, Rosen+ (ROCH)
HYAMS 69B PL 29B 521 +Koch, Potter, VonLindern, Lorenz+ (CERN, MPIM)
MORFIN 69 PRL 23 660 +Sinclair (MICH)
STUTZKE 69 PR 177 2009 +Abashian, Jones, Mantsch, Orr, Smith (ILL)
DONALD 68B PL 27B 58 +Edwards, Nisar+ (LIVP, CERN, IPNP, CDEF)
HILL 68 PR 171 1418 +Robinson, Sakitt+ (BNL, CMU)
BOTT-... 67 PL 24B 194 Bott-Bodenhausen, DeBouard, Cassel+ (CERN)
ALFF-... 66B PL 21 595 Alff-Steinberger, Heuer, Kleinknecht+ (CERN)
BEHR 66 PL 22 540 +Brisson, Petiau+ (EPOL, MILA, PADO, ORSAY)
BELLOTTI 66 NC 45A 737 +Pullia, Baldo-Ceolin+ (MILA, PADO)
KIRSCH 66 PR 147 939 +Schmidt (COLU)
ANDERSON 65 PRL 14 475 +Crawford, Golden, Stern, Binford+ (LRL, WISC)
AUBERT 65 PL 17 59 +Behr, Canavan, Chounet+ (EPOL, ORSAY)
BROWN 63 PR 130 769 +Kadyk, Trilling, Roe+ (LRL, MICH)
CHRETIEN 63 PR 131 2208 + (BRAN, BROW, HARV, MIT)
ANDERSON 62B CERN Conf. 836 +Crawford+ (LRL)
BROWN 61 NC 19 1155 +Bryant, Burnstein, Glaser, Kadyk+ (MICH)
BAGLIN 60 NC 18 1043 +Bloch, Brisson, Hennessy+ (EPOL)
COLUMBIA 60B Rochester Conf. 727 Schwartz+ (COLU)
CRAWFORD 59B PRL 2 266 +Cresti, Douglass, Good, Ticho+ (LRL)
BOLDT 58B PRL 1 150 +Caldwell, Pal (MIT)

OTHER RELATED PAPERS

LITTENBERG 93 ARNPS 43 729 +Valencia (BNL, FNAL)
Rare and Radiative Kaon Decays
BATTISTON 92 PRPL 214 293 +Cocolicchio, Fogli, Paver (PGIA, CERN, TRSTT)
Status and Perspectives of K Decay Physics
TRILLING 65B UCRL 16473 (LRL)
Updated from 1965 Argonne Conference, page 115.
CRAWFORD 62 CERN Conf. 827 (LRL)
FITCH 61 NC 22 1160 +Piroue, Perkins (PRIN, LASL)
GOOD 61 PR 124 1223 +Matsen, Muller, Piccioni+ (LRL)
BIRGE 60 Rochester Conf. 601 +Ely+ (LRL, WISC)
MULLER 60 PRL 4 418 +Birge, Fowler, Good, Piccioni+ (LRL, BNL)

K^0_L

$I(J^P) = \frac{1}{2}(0^-)$

$m_{K^0_L} - m_{K^0_S}$

For earlier measurements, beginning with GOOD 61 and FITCH 61, see our our 1986 edition, Physics Letters **170B** 132 (1986).

VALUE (10^{10} $\hbar$ s^{-1})	DOCUMENT ID	TECN	COMMENT
0.5333±0.0027 OUR AVERAGE	Error includes scale factor of 1.2.		
0.5257±0.0049	[1] GIBBONS 93C	E731	20–160 GeV K beams
0.5340±0.00255±0.0015	[2] GEWENIGER 74C	SPEC	Gap method
0.5334±0.0040 ±0.0015	[2] GJESDAL 74	SPEC	Charge asymmetry
0.542 ±0.006	CULLEN 70	CNTR	
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.5286±0.0028	[3] GIBBONS 93	E731	20–160 GeV K beams
0.482 ±0.014	[4] ARONSON 82B	SPEC	E=30–110 GeV
0.534 ±0.007	[5] CARNEGIE 71	ASPK	Gap method
0.542 ±0.006	[5] ARONSON 70	ASPK	Gap method

[1] GIBBONS 93C fits $\Delta(m)$ and ϕ_{+-}. Finds above $\Delta(m)$ and $\phi_{+-} = (42.2 \pm 1.4)^\circ$.

[2] These two experiments have a common systematic error due to the uncertainty in the momentum scale, as pointed out in WAHL 89.

[3] GIBBONS 93 value assume $\phi_{+-} = \phi_{00} = \phi_{SW} = (43.7 \pm 0.2)^\circ$.

[4] ARONSON 82 find that $\Delta(m)$ may depend on the kaon energy.

[5] ARONSON 70 and CARNEGIE 71 use K^0_S mean life $= (0.862 \pm 0.006) \times 10^{-10}$ s. We have not attempted to adjust these values for the subsequent change in the K^0_S mean life or in η_{+-}.

K^0_L MEAN LIFE

VALUE (10^{-8} s)	EVTS	DOCUMENT ID	TECN
5.17 ±0.04 OUR FIT			
5.15 ±0.04 OUR AVERAGE			
5.154±0.044	0.4M	VOSBURGH 72	CNTR
5.15 ±0.14		DEVLIN 67	CNTR
• • • We do not use the following data for averages, fits, limits, etc. • • •			
5.0 ±0.5		[6] LOWYS 67	HLBC
6.1 $^{+1.5}_{-1.2}$	1700	ASTBURY 65C	CNTR
5.3 ±0.6		FUJII 64	OSPK
5.1 $^{+2.4}_{-1.3}$	15	DARMON 62	FBC
8.1 $^{+3.2}_{-2.4}$	34	BARDON 58	CNTR

[6] Sum of partial decay rates.

K^0_L DECAY MODES

	Mode		Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	$3\pi^0$		(21.6 ±0.8) %	S=1.5
Γ_2	$\pi^+\pi^-\pi^0$		(12.38±0.21) %	S=1.5
Γ_3	$\pi^\pm\mu^\mp\nu$	[a]	(27.0 ±0.4) %	S=1.3
	Called $K^0_{\mu3}$.			
Γ_4	$\pi^-\mu^+\nu_\mu$			
Γ_5	$\pi^+\mu^-\overline{\nu}_\mu$			
Γ_6	$\pi^\pm e^\mp\nu$	[a]	(38.7 ±0.5) %	S=1.4
	Called K^0_{e3}.			
Γ_7	$\pi^- e^+\nu_e$			
Γ_8	$\pi^+ e^-\overline{\nu}_e$			
Γ_9	2γ		(5.73±0.27) $\times 10^{-4}$	S=2.0
Γ_{10}	$\pi^0 2\gamma$	[b]	(1.70±0.28) $\times 10^{-6}$	
Γ_{11}	$\pi^0\pi^\pm e^\mp\nu$	[a]	(5.18±0.29) $\times 10^{-5}$	
Γ_{12}	$(\pi\mu\,\text{atom})\nu$		(1.05±0.11) $\times 10^{-7}$	
Γ_{13}	$\pi^\pm e^\mp\nu_e\gamma$	[a,b,c]	(1.3 ±0.8) %	
Γ_{14}	$\pi^+\pi^-\gamma$	[b,c]	(4.61±0.14) $\times 10^{-5}$	
Γ_{15}	$\pi^0\pi^0\gamma$		< 5.6 $\times 10^{-6}$	
	Charge conjugation × Parity (*CP*) or Lepton Family number (*LF*) violating modes, or $\Delta S = 1$ weak neutral current (*S1*) modes			
Γ_{16}	$\pi^+\pi^-$	*CPV*	(2.03±0.04) $\times 10^{-3}$	S=1.2
Γ_{17}	$\pi^0\pi^0$	*CPV*	(9.14±0.34) $\times 10^{-4}$	S=1.8
Γ_{18}	$\mu^+\mu^-$	*S1*	(7.4 ±0.4) $\times 10^{-9}$	
Γ_{19}	$\mu^+\mu^-\gamma$	*S1*	(2.8 ±2.8) $\times 10^{-7}$	
Γ_{20}	e^+e^-	*S1*	< 4.1 $\times 10^{-11}$	CL=90%
Γ_{21}	$e^+e^-\gamma$	*S1*	(9.1 ±0.5) $\times 10^{-6}$	
Γ_{22}	$e^+e^-\gamma\gamma$	*S1* [b]	(6.6 ±3.2) $\times 10^{-7}$	
Γ_{23}	$\pi^+\pi^-e^+e^-$	*S1*	< 2.5 $\times 10^{-6}$	CL=90%
Γ_{24}	$\mu^+\mu^-e^+e^-$	*S1*	< 4.9 $\times 10^{-6}$	CL=90%
Γ_{25}	$e^+e^-e^+e^-$	*S1* [d]	(3.9 ±0.7) $\times 10^{-8}$	
Γ_{26}	$\pi^0\mu^+\mu^-$	*CP,S1* [e]	< 5.1 $\times 10^{-9}$	CL=90%
Γ_{27}	$\pi^0 e^+e^-$	*CP,S1* [e]	< 4.3 $\times 10^{-9}$	CL=90%
Γ_{28}	$\pi^0\nu\overline{\nu}$	*CP,S1* [f]	< 2.2 $\times 10^{-4}$	CL=90%
Γ_{29}	$e^\pm\mu^\mp$	*LF* [a]	< 3.3 $\times 10^{-11}$	CL=90%

[a] The value is for the sum of the charge states indicated.

[b] See the Full Listings below for the energy limits used in this measurement.

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

[d] $m_{e^+e^-}$ >470 MeV

[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.

CONSTRAINED FIT INFORMATION

An overall fit to the mean life, 4 decay rate, and 12 branching ratios uses 53 measurements and one constraint to determine 8 parameters. The overall fit has a $\chi^2 = 55.3$ for 46 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\left\langle \delta p_i \delta p_j \right\rangle / (\delta p_i \cdot \delta p_j)$, in percent, from the fit to parameters p_i, including the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{\text{total}}$. The fit constrains the x_i whose labels appear in this array to sum to one.

x_2	−35						
x_3	−78	6					
x_6	−86	7	46				
x_9	−2	13	−2	−3			
x_{16}	−29	45	14	15	34		
x_{17}	−9	20	2	2	74	48	
Γ	2	−4	0	0	−1	−2	−1
	x_1	x_2	x_3	x_6	x_9	x_{16}	x_{17}