K^0

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

K^0 MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
497.648±0.022 OUR FIT					
497.648±0.022 OUR AVERAGE					
497.625±0.001±0.031	655k	LAI	02	NA48	K^0_L beam
497.661±0.033	3713	BARKOV	87B	CMD	$e^+e^- \to K^0_L K^0_S$
497.742±0.085	780	BARKOV	85B	CMD	$e^+e^- \to K^0_L K^0_S$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
497.44 ±0.50		FITCH	67	OSPK	
498.9 ±0.5	4500	BALTAY	66	HBC	K^0 from $\overline{p}p$
497.44 ±0.33	2223	KIM	65B	HBC	K^0 from $\overline{p}p$
498.1 ±0.4		CHRISTENS...	64	OSPK	

$m_{K^0} - m_{K^\pm}$

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
3.972±0.027 OUR FIT Error includes scale factor of 1.2.						
• • • We do not use the following data for averages, fits, limits, etc. • • •						
3.95 ±0.21	417	HILL	68B	DBC	+	$K^+ d \to K^0 pp$
3.90 ±0.25	9	BURNSTEIN	65	HBC	−	
3.71 ±0.35	7	KIM	65B	HBC	−	$K^- p \to n\overline{K}^0$
5.4 ±1.1		CRAWFORD	59	HBC	+	
3.9 ±0.6		ROSENFELD	59	HBC	−	

K^0 MEAN SQUARE CHARGE RADIUS

VALUE (fm^2)	DOCUMENT ID		TECN	COMMENT
−0.076±0.018 OUR AVERAGE Error includes scale factor of 1.1.				
−0.090±0.021	LAI	03C	NA48	$K^0_L \to \pi^+\pi^- e^+ e^-$
−0.054±0.026	MOLZON	78		K_S regen. by electrons
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.087±0.046	BLATNIK	79		VMD + dispersion relations
−0.050±0.130	FOETH	69B		K_S regen. by electrons

T-VIOLATION PARAMETER IN K^0-$\overline{K}^0$ MIXING

The asymmetry $A_T = \frac{\Gamma(\overline{K}^0 \to K^0) - \Gamma(K^0 \to \overline{K}^0)}{\Gamma(\overline{K}^0 \to K^0) + \Gamma(K^0 \to \overline{K}^0)}$ must vanish if T invariance holds.

ASYMMETRY A_T IN K^0-$\overline{K}^0$ MIXING

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN
6.6±1.3±1.0	640k	[1] ANGELOPO...	98E	CPLR

[1] ANGELOPOULOS 98E measures the asymmetry $A_T = [\Gamma(\overline{K}^0_{t=0} \to e^+\pi^-\nu_{t=\tau}) - \Gamma(K^0_{t=0} \to e^-\pi^+\overline{\nu}_{t=\tau})]/[\Gamma(\overline{K}^0_{t=0} \to e^+\pi^-\nu_{t=\tau}) + \Gamma(K^0_{t=0} \to e^-\pi^+\overline{\nu}_{t=\tau})]$ as a function of the neutral-kaon eigentime τ. The initial strangeness of the neutral kaon is tagged by the charge of the accompanying charged kaon in the reactions $p\overline{p} \to K^-\pi^+K^0$ and $p\overline{p} \to K^+\pi^-\overline{K}^0$. The strangeness at the time of the decay is tagged by the lepton charge. The reported result is the average value of A_T over the interval $1\tau_S < \tau < 20\tau_S$. From this value of A_T ANGELOPOULOS 01B, assuming CPT invariance in the $e\pi\nu$ decay amplitude, determine the T-violating as $\Delta S{=}\Delta S$ conserving parameter (for its definition, see Review below) $4\mathrm{Re}(\epsilon) = (6.2 \pm 1.4 \pm 1.0) \times 10^{-3}$.

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CPT-VIOLATION PARAMETERS

In K^0-$\overline{K}^0$ mixing, if CP-violating interactions include a T conserving part then

$$|K_S\rangle = [|K_1\rangle + (\epsilon+\delta)|K_2\rangle]/\sqrt{1+|\epsilon+\delta|^2}$$
$$|K_L\rangle = [|K_2\rangle + (\epsilon-\delta)|K_1\rangle]/\sqrt{1+|\epsilon-\delta|^2}$$

where

$$|K_1\rangle = [|K^0\rangle + |\overline{K}^0\rangle]/\sqrt{2}$$
$$|K_2\rangle = [|K^0\rangle - |\overline{K}^0\rangle]/\sqrt{2}$$

and

$$|\overline{K}^0\rangle = CP|K^0\rangle.$$

The parameter δ specifies the CPT-violating part.

Estimates of δ are given below assuming the validity of the $\Delta S{=}\Delta Q$ rule. See also THOMSON 95 for a test of CPT-symmetry conservation in K^0 decays using the Bell-Steinberger relation.

REAL PART OF δ

A nonzero value violates CPT invariance.

VALUE (units 10^{-4})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2.9± 2.6±0.6	1.3M	[2] ANGELOPO...	98F	CPLR	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.4± 2.8		[3] APOSTOLA...	99B	RVUE	
180 ±200	6481	[4] DEMIDOV	95		$K_{\ell 3}$ reanalysis

[2] If $\Delta S{=}\Delta Q$ is not assumed, ANGELOPOULOS 98F finds $\mathrm{Re}\delta = (3.0 \pm 3.3 \pm 0.6) \times 10^{-4}$.
[3] APOSTOLAKIS 99B assumes only unitarity and combines CPLEAR and other results.
[4] DEMIDOV 95 reanalyzes data from HART 73 and NIEBERGALL 74.

IMAGINARY PART OF δ

A nonzero value violates CPT invariance.

VALUE (units 10^{-3})	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.024± 0.050		[5] APOSTOLA...	99B	RVUE	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
− 0.9 ± 2.9 ±1.0	1.3M	[6] ANGELOPO...	98F	CPLR	
21 ±37	6481	[7] DEMIDOV	95		$K_{\ell 3}$ reanalysis

[5] APOSTOLAKIS 99B assumes only unitarity and combines CPLEAR and other results.
[6] If $\Delta S{=}\Delta Q$ is not assumed, ANGELOPOULOS 98F finds Im$\delta{=}(-15 \pm 23 \pm 3) \times 10^{-3}$.
[7] DEMIDOV 95 reanalyzes data from HART 73 and NIEBERGALL 74.

$|m_{K^0} - m_{\overline{K}^0}| / m_{\text{average}}$

A test of *CPT* invariance. "Our Evaluation" is described in the "Tests of Conservation Laws" section. It assumes *CPT* invariance in the decay and neglects some contributions from decay channels other than $\pi\pi$.

VALUE	*CL%*	*DOCUMENT ID*	*TECN*
$< 10^{-18}$ (CL = 90%) OUR EVALUATION			
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$(-\ 3 \pm 4) \times 10^{-18}$		[8] ANGELOPO... 99B	RVUE

[8] ANGELOPOULOS 99B assumes only unitarity and combines CPLEAR and other results.

$(\Gamma_{K^0} - \Gamma_{\overline{K}^0})/m_{\text{average}}$

A test of *CPT* invariance.

VALUE	*DOCUMENT ID*	*TECN*
$(7.8 \pm 8.4) \times 10^{-18}$	[9] ANGELOPO... 99B	RVUE

[9] ANGELOPOULOS 99B assumes only unitarity and combines CPLEAR with other results. Correlated with $(m_{K^0} - m_{\overline{K}^0}) / m_{\text{average}}$ with a correlation coefficient of -0.95.

K^0 REFERENCES

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LAI	02	PL B533 196	A. Lai *et al.*	(CERN NA48 Collab.)
ANGELOPO...	01B	EPJ C22 55	A. Angelopoulos *et al.*	(CPLEAR Collab.)
ANGELOPO...	99B	PL B471 332	A. Angelopoulos *et al.*	(CPLEAR Collab.)
APOSTOLA...	99B	PL B456 297	A. Apostolakis *et al.*	(CPLEAR Collab.)
ANGELOPO...	98E	PL B444 43	A. Angelopoulos *et al.*	(CPLEAR Collab.)
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DEMIDOV	95	PAN 58 968	V. Demidov, K. Gusev, E. Shabalin	(ITEP)
From YAF 58 1041.				
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FITCH	67	PR 164 1711	V.L. Fitch *et al.*	(PRIN)
BALTAY	66	PR 142 932	C. Baltay *et al.*	(YALE, BNL)
BURNSTEIN	65	PR 138B 895	R.A. Burnstein, H.A. Rubin	(UMD)
KIM	65B	PR 140B 1334	J.K. Kim, L. Kirsch, D. Miller	(COLU)
CHRISTENS...	64	PRL 13 138	J.H. Christenson *et al.*	(PRIN)
CRAWFORD	59	PRL 2 112	F.S. Crawford *et al.*	(LRL)
ROSENFELD	59	PRL 2 110	A.H. Rosenfeld, F.T. Solmitz, R.D. Tripp	(LRL)