Λ_c^+

$I(J^P) = 0(\frac{1}{2}^+)$ Status: ∗∗∗∗

The parity of the Λ_c^+ is defined to be positive (as are the parities of the proton, neutron, and Λ). The spin J has not actually been measured yet. Results of an analysis of $p K^- \pi^+$ decays (JEZABEK 92) are consistent with the expected $J = 1/2$. The quark content is $u d c$.

We have omitted some results that have been superseded by later experiments. The omitted results may be found in earlier editions.

Λ_c^+ MASS

Measurements with an error greater than 5 MeV or that are otherwise obsolete have been omitted.

The fit also includes Σ_c–Λ_c^+ and Λ_c^{*+}–Λ_c^+ mass-difference measurements.

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
2284.9±0.6 OUR FIT					
2284.9±0.6 OUR AVERAGE					
2284.7±0.6±0.7	1134	AVERY	91	CLEO	Six modes
2281.7±2.7±2.6	29	ALVAREZ	90B	NA14	$p K^- \pi^+$
2285.8±0.6±1.2	101	BARLAG	89	NA32	$p K^- \pi^+$
2284.7±2.3±0.5	5	AGUILAR-...	88B	LEBC	$p K^- \pi^+$
2283.1±1.7±2.0	628	ALBRECHT	88C	ARG	$p K^- \pi^+$, $p \overline{K}^0$, $\Lambda 3\pi$
2286.2±1.7±0.7	97	ANJOS	88B	E691	$p K^- \pi^+$
2281 ±3	2	JONES	87	HBC	$p K^- \pi^+$
2283 ±3	3	BOSETTI	82	HBC	$p K^- \pi^+$
2290 ±3	1	CALICCHIO	80	HYBR	$p K^- \pi^+$

Λ_c^+ MEAN LIFE

Measurements with an error $\geq 0.1 \times 10^{-12}$ s or with fewer than 20 events have been omitted.

VALUE (10^{-12} s)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.206±0.012 OUR AVERAGE					
0.215±0.016±0.008	1340	FRABETTI	93D	E687	γBe, $\Lambda_c^+ \rightarrow p K^- \pi^+$
0.18 ±0.03 ±0.03	29	ALVAREZ	90	NA14	γ, $\Lambda_c^+ \rightarrow p K^- \pi^+$
0.20 ±0.03 ±0.03	90	FRABETTI	90	E687	γBe, $\Lambda_c^+ \rightarrow p K^- \pi^+$
$0.196^{+0.023}_{-0.020}$	101	BARLAG	89	NA32	$p K^- \pi^+$ + c.c.
0.22 ±0.03 ±0.02	97	ANJOS	88B	E691	$p K^- \pi^+$ + c.c.

Λ_c^+ DECAY MODES

Nearly all branching fractions of the Λ_c^+ are measured relative to the $pK^-\pi^+$ mode, but there are no model-independent measurements of this branching fraction. We explain how we arrive at our value of B($\Lambda_c^+ \to pK^-\pi^+$) in a Note at the beginning of the branching-ratio measurements, below. When this branching fraction is eventually well determined, all the other branching fractions will slide up or down proportionally as the true value differs from the value we use here.

	Mode		Fraction (Γ_i/Γ)	Scale factor/ Confidence level
	Hadronic modes with a p and one $\overline{K}$			
Γ_1	$p\overline{K}^0$		(2.3 ± 0.6) %	
Γ_2	$pK^-\pi^+$	[a]	(5.0 ± 1.3) %	
Γ_3	$p\overline{K}^*(892)^0$	[b]	(1.6 ± 0.5) %	
Γ_4	$\Delta(1232)^{++}K^-$		(8.6 ± 3.0) $\times 10^{-3}$	
Γ_5	$\Lambda(1520)\pi^+$	[b]	(5.9 ± 2.1) $\times 10^{-3}$	
Γ_6	$pK^-\pi^+$ nonresonant		(2.8 ± 0.8) %	
Γ_7	$p\overline{K}^0\pi^0$		(3.3 ± 1.0) %	
Γ_8	$p\overline{K}^0\eta$		(1.2 ± 0.4) %	
Γ_9	$p\overline{K}^0\pi^+\pi^-$		(2.6 ± 0.7) %	
Γ_{10}	$pK^-\pi^+\pi^0$		(3.4 ± 1.0) %	
Γ_{11}	$pK^*(892)^-\pi^+$	[b]	(1.1 ± 0.5) %	
Γ_{12}	$p(K^-\pi^+)_{\text{nonresonant}}\pi^0$		(3.6 ± 1.2) %	
Γ_{13}	$\Delta(1232)\overline{K}^*(892)$		seen	
Γ_{14}	$pK^-\pi^+\pi^+\pi^-$		(1.1 ± 0.8) $\times 10^{-3}$	
Γ_{15}	$pK^-\pi^+\pi^0\pi^0$		(8 ± 4) $\times 10^{-3}$	
Γ_{16}	$pK^-\pi^+\pi^0\pi^0\pi^0$		(5.0 ± 3.4) $\times 10^{-3}$	
	Hadronic modes with a p and zero or two K's			
Γ_{17}	$p\pi^+\pi^-$		(3.5 ± 2.0) $\times 10^{-3}$	
Γ_{18}	$pf_0(980)$	[b]	(2.8 ± 1.9) $\times 10^{-3}$	
Γ_{19}	$p\pi^+\pi^+\pi^-\pi^-$		(1.8 ± 1.2) $\times 10^{-3}$	
Γ_{20}	pK^+K^-		(2.3 ± 0.9) $\times 10^{-3}$	
Γ_{21}	$p\phi$	[b]	(1.2 ± 0.5) $\times 10^{-3}$	
	Hadronic modes with a hyperon			
Γ_{22}	$\Lambda\pi^+$		(9.0 ± 2.8) $\times 10^{-3}$	
Γ_{23}	$\Lambda\pi^+\pi^0$		(3.6 ± 1.3) %	
Γ_{24}	$\Lambda\rho^+$		$<$ 5 %	CL=95%
Γ_{25}	$\Lambda\pi^+\pi^+\pi^-$		(3.3 ± 1.0) %	
Γ_{26}	$\Lambda\pi^+\eta$		(1.8 ± 0.6) %	
Γ_{27}	$\Sigma(1385)^+\eta$	[b]	(8.5 ± 3.3) $\times 10^{-3}$	
Γ_{28}	$\Lambda K^+\overline{K}^0$		(6.0 ± 2.1) $\times 10^{-3}$	
Γ_{29}	$\Sigma^0\pi^+$		(9.9 ± 3.2) $\times 10^{-3}$	

Γ_{30}	$\Sigma^+ \pi^0$		(1.00 ± 0.34) %	
Γ_{31}	$\Sigma^+ \eta$		$(5.5 \pm 2.3) \times 10^{-3}$	
Γ_{32}	$\Sigma^+ \pi^+ \pi^-$		(3.4 ± 1.0) %	
Γ_{33}	$\Sigma^+ \rho^0$		< 1.4 %	CL=95%
Γ_{34}	$\Sigma^- \pi^+ \pi^+$		(1.8 ± 0.8) %	
Γ_{35}	$\Sigma^0 \pi^+ \pi^0$		(1.8 ± 0.8) %	
Γ_{36}	$\Sigma^0 \pi^+ \pi^+ \pi^-$		(1.1 ± 0.4) %	
Γ_{37}	$\Sigma^+ \pi^+ \pi^- \pi^0$		—	
Γ_{38}	$\Sigma^+ \omega$	[b]	(2.7 ± 1.0) %	
Γ_{39}	$\Sigma^+ \pi^+ \pi^+ \pi^- \pi^-$		$(3.0 {}^{+4.1}_{-2.1}) \times 10^{-3}$	
Γ_{40}	$\Sigma^+ K^+ K^-$		$(3.5 \pm 1.2) \times 10^{-3}$	
Γ_{41}	$\Sigma^+ \phi$	[b]	$(3.5 \pm 1.7) \times 10^{-3}$	
Γ_{42}	$\Sigma^+ K^+ \pi^-$		$(7 {}^{+6}_{-4}) \times 10^{-3}$	
Γ_{43}	$\Xi^0 K^+$		$(3.9 \pm 1.4) \times 10^{-3}$	
Γ_{44}	$\Xi^- K^+ \pi^+$		$(4.9 \pm 1.7) \times 10^{-3}$	
Γ_{45}	$\Xi(1530)^0 K^+$	[b]	$(2.6 \pm 1.0) \times 10^{-3}$	

Semileptonic modes

Γ_{46}	$\Lambda \ell^+ \nu_\ell$	[c]	(2.0 ± 0.6) %	
Γ_{47}	$\Lambda e^+ \nu_e$		(2.1 ± 0.6) %	
Γ_{48}	$\Lambda \mu^+ \nu_\mu$		(2.0 ± 0.7) %	

Inclusive modes

Γ_{49}	e^+ anything		(4.5 ± 1.7) %	
Γ_{50}	$p e^+$ anything		(1.8 ± 0.9) %	
Γ_{51}	Λe^+ anything			
Γ_{52}	p anything		(50 ± 16) %	
Γ_{53}	p anything (no Λ)		(12 ± 19) %	
Γ_{54}	p hadrons			
Γ_{55}	n anything		(50 ± 16) %	
Γ_{56}	n anything (no Λ)		(29 ± 17) %	
Γ_{57}	Λ anything		(35 ± 11) %	S=1.4
Γ_{58}	$\Sigma^\pm$ anything	[d]	(10 ± 5) %	

$\Delta C = 1$ weak neutral current ($C1$) modes, or Lepton number (L) violating modes

Γ_{59}	$p \mu^+ \mu^-$	$C1$	$< 3.4 \times 10^{-4}$	CL=90%
Γ_{60}	$\Sigma^- \mu^+ \mu^+$	L	$< 7.0 \times 10^{-4}$	CL=90%

[a] See the "Note on Λ_c^+ Branching Fractions" below.

[b] This branching fraction includes all the decay modes of the final-state resonance.

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

[*d*] The value is for the sum of the charge states or particle/antiparticle states indicated.

Λ_c^+ BRANCHING FRACTIONS

Revised 2000 by P.R. Burchat (Stanford University).

Most Λ_c^+ branching fractions are measured relative to the decay mode $\Lambda_c^+ \to pK^-\pi^+$. However, there are no model-independent measurements of the absolute branching fraction for $\Lambda_c^+ \to pK^-\pi^+$. Here we describe the measurements that have been used to extract $\mathrm{B}(\Lambda_c^+ \to pK^-\pi^+)$, the model-dependence of the results, and the method we have used to average the results.

ARGUS (ALBRECHT 88C) and CLEO (CRAWFORD 92) measure $\mathrm{B}(\overline{B} \to \Lambda_c^+ \mathrm{X}) \times \mathrm{B}(\Lambda_c^+ \to pK^-\pi^+)$ to be $(0.30 \pm 0.12 \pm 0.06)\%$ and $(0.273 \pm 0.051 \pm 0.039)\%$. Under the assumptions that decays of $\overline{B}$ mesons to baryons are dominated by $\overline{B} \to \Lambda_c^+ \mathrm{X}$ and that $\Lambda_c^+ \mathrm{X}$ final states other than $\Lambda_c^+ \overline{N} \mathrm{X}$ can be neglected, they also measure $\mathrm{B}(\overline{B} \to \Lambda_c^+ \mathrm{X})$ to be $(6.8 \pm 0.5 \pm 0.3)\%$ (ALBRECHT 92O) and $(6.4 \pm 0.8 \pm 0.8)\%$ (CRAWFORD 92). Combining these results, we get $\mathrm{B}(\Lambda_c^+ \to pK^-\pi^+) = (4.14 \pm 0.91)\%$. However, the assumption that $\overline{B}$ decay modes to baryons other than $\Lambda_c^+ \overline{N} \mathrm{X}$ are negligible is not on solid ground experimentally or theoretically [1]. Therefore, the branching fraction for $\Lambda_c^+ \to pK^-\pi^+$ given above may be low by some undetermined amount.

The second type of model-dependent determination of $\mathrm{B}(\Lambda_c^+ \to pK^-\pi^+)$ is based on measurements by ARGUS (ALBRECHT 91G) and CLEO (BERGFELD 94) of $\sigma(e^+e^- \to \Lambda_c^+ \mathrm{X}) \cdot \mathrm{B}(\Lambda_c^+ \to \Lambda \ell^+ \nu_\ell) = (4.15 \pm 1.03 \pm 1.18)$ pb and $(4.77 \pm 0.25 \pm 0.66)$ pb. ARGUS (ALBRECHT 96E) and CLEO (AVERY 91) have also measured $\sigma(e^+e^- \to \Lambda_c^+ \mathrm{X}) \cdot \mathrm{B}(\Lambda_c^+ \to pK^-\pi^+)$. The weighted average is (11.2 ± 1.3) pb.

From these measurements, we extract $R \equiv \mathrm{B}(\Lambda_c^+ \to pK^-\pi^+)/\mathrm{B}(\Lambda_c^+ \to \Lambda\ell^+\nu_\ell) = 2.40 \pm 0.43$. We estimate the $\Lambda_c^+ \to pK^-\pi^+$ branching fraction from the equation

$$\mathrm{B}(\Lambda_c^+ \to pK^-\pi^+) = R\, f\, F\ \frac{\Gamma(D \to \mathrm{X}\ell^+\nu_\ell)}{1 + |V_{cd}/V_{cs}|^2} \cdot \tau(\Lambda_c^+)\ , \quad (1)$$

where $f = \mathrm{B}(\Lambda_c^+ \to \Lambda\ell^+\nu_\ell)/\mathrm{B}(\Lambda_c^+ \to X_s\ell^+\nu_\ell)$ and $F = \Gamma(\Lambda_c^+ \to X_s\ell^+\nu_\ell)/\Gamma(D^0 \to X_s\ell^+\nu_\ell)$. When we use $1+|V_{cd}/V_{cs}|^2 = 1.05$ and the world averages $\Gamma(D \to \mathrm{X}\ell^+\nu_\ell) = (0.163 \pm 0.006) \times 10^{-12}\ \mathrm{s}^{-1}$ and $\tau(\Lambda_c^+) = (0.206 \pm 0.012) \times 10^{-12}$ s, we calculate $\mathrm{B}(\Lambda_c^+ \to pK^-\pi^+) = (7.7 \pm 1.5)\% \cdot f\, F$. Theoretical estimates for f and F are near 1.0 with significant uncertainties.

So, we have two results with significant model-dependence: $\mathrm{B}(\Lambda_c^+ \to pK^-\pi^+) = (4.14 \pm 0.91)\%$ from $\overline{B}$ decays, and $\mathrm{B}(\Lambda_c^+ \to pK^-\pi^+) = (7.7 \pm 1.5)\% \cdot f\, F$ from semileptonic Λ_c^+ decays. If we set $f\, F = 1.0$ in the second result, and assign an uncertainty of 30% to each result to account for the unknown model-dependence, we get the consistent results $\mathrm{B}(\Lambda_c^+ \to pK^-\pi^+) = (4.14 \pm 0.91 \pm 1.24)\%$ and $\mathrm{B}(\Lambda_c^+ \to pK^-\pi^+) = (7.7 \pm 1.5 \pm 2.3)\%$. The weighted average of these two results is $\mathrm{B}(\Lambda_c^+ \to pK^-\pi^+) = (5.0 \pm 1.3)\%$, where the uncertainty contains both the experimental uncertainty and the 30% estimate of model dependence in each result.

This procedure is clearly rather arbitrary, but so is any other procedure until good measurements of the absolute branching fraction are made. Therefore, we have assigned the value $(5.0 \pm 1.3)\%$ to the $\Lambda_c^+ \to pK^-\pi^+$ branching fraction (given as PDG 00 below). As was noted earlier, most of the other modes are measured relative to this mode.

New methods for measuring the Λ_c^+ absolute branching fractions have been proposed [1,2].

References

1. I. Dunietz, Phys. Rev. **D58**, 094010 (1998).
2. P. Migliozzi *et al.*, Phys. Lett. **B462**, 217 (1999).

Λ_c^+ BRANCHING RATIOS

Hadronic modes with a p and one $\overline{K}$

$\Gamma(p\overline{K}^0)/\Gamma(pK^-\pi^+)$ — Γ_1/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.47±0.04 OUR AVERAGE					
0.46±0.02±0.04	1025	ALAM	98	CLE2	$e^+e^- \approx \Upsilon(4S)$
0.44±0.07±0.05	133	AVERY	91	CLEO	e^+e^- 10.5 GeV
0.55±0.17±0.14	45	ANJOS	90	E691	γBe 70–260 GeV
0.62±0.15±0.03	73	ALBRECHT	88C	ARG	e^+e^- 10 GeV

$\Gamma(pK^-\pi^+)/\Gamma_{total}$ — Γ_2/Γ

See the "Note on Λ_c^+ Branching Fractions" above.

VALUE	DOCUMENT ID		TECN	COMMENT
0.050±0.013	PDG	00		See note at top of ratios
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.041±0.010	[1,2] ALBRECHT	92O	ARG	$e^+e^- \approx \Upsilon(4S)$
0.044±0.012	[1,3] CRAWFORD	92	CLEO	e^+e^- 10.5 GeV

[1] To extract $\Gamma(pK^-\pi^+)/\Gamma_{total}$, we use $B(\overline{B} \to \Lambda_c^+ X) \cdot B(\Lambda_c^+ \to pK^-\pi^+) = (0.28 \pm 0.06)\%$, which is the average of measurements from ARGUS (ALBRECHT 88C) and CLEO (CRAWFORD 92).

[2] ALBRECHT 92O measures $B(\overline{B} \to \Lambda_c^+ X) = (6.8 \pm 0.5 \pm 0.3)\%$.

[3] CRAWFORD 92 measures $B(\overline{B} \to \Lambda_c^+ X) = (6.4 \pm 0.8 \pm 0.8)\%$.

$\Gamma(p\overline{K}^*(892)^0)/\Gamma(pK^-\pi^+)$ — Γ_3/Γ_2

Unseen decay modes of the $\overline{K}^*(892)^0$ are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.31±0.04 OUR AVERAGE					
0.29±0.04±0.03		[4] AITALA	00	E791	$\pi^- N$, 500 GeV
$0.35^{+0.06}_{-0.07}\pm0.03$	39	BOZEK	93	NA32	π^- Cu 230 GeV
0.42±0.24	12	BASILE	81B	CNTR	$pp \to \Lambda_c^+ e^- X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.35±0.11		BARLAG	90D	NA32	See BOZEK 93

[4] AITALA 00 makes a coherent 5-dimensional amplitude analysis of 946 ± 38 $\Lambda_c^+ \to pK^-\pi^+$ decays.

$\Gamma\big(\Delta(1232)^{++}K^-\big)/\Gamma\big(pK^-\pi^+\big)$ Γ_4/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.17±0.04 OUR AVERAGE Error includes scale factor of 1.1.					
0.18±0.03±0.03		[5] AITALA	00	E791	$\pi^- N$, 500 GeV
$0.12^{+0.04}_{-0.05}\pm0.05$	14	BOZEK	93	NA32	π^- Cu 230 GeV
0.40±0.17	17	BASILE	81B	CNTR	$pp \rightarrow \Lambda_c^+ e^- X$

[5] AITALA 00 makes a coherent 5-dimensional amplitude analysis of 946 ± 38 $\Lambda_c^+ \rightarrow pK^-\pi^+$ decays.

$\Gamma\big(\Lambda(1520)\pi^+\big)/\Gamma\big(pK^-\pi^+\big)$ Γ_5/Γ_2

Unseen decay modes of the $\Lambda(1520)$ are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$0.119^{+0.032}_{-0.028}$ OUR AVERAGE					
0.15 ±0.04 ±0.02		[6] AITALA	00	E791	$\pi^- N$, 500 GeV
$0.09\ ^{+0.04}_{-0.03}\pm0.02$	12	BOZEK	93	NA32	π^- Cu 230 GeV

[6] AITALA 00 makes a coherent 5-dimensional amplitude analysis of 946 ± 38 $\Lambda_c^+ \rightarrow pK^-\pi^+$ decays.

$\Gamma\big(pK^-\pi^+\text{ nonresonant}\big)/\Gamma\big(pK^-\pi^+\big)$ Γ_6/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.55±0.06 OUR AVERAGE					
0.55±0.06±0.04		[7] AITALA	00	E791	$\pi^- N$, 500 GeV
$0.56^{+0.07}_{-0.09}\pm0.05$	71	BOZEK	93	NA32	π^- Cu 230 GeV

[7] AITALA 00 makes a coherent 5-dimensional amplitude analysis of 946 ± 38 $\Lambda_c^+ \rightarrow pK^-\pi^+$ decays.

$\Gamma\big(p\overline{K}^0\pi^0\big)/\Gamma\big(pK^-\pi^+\big)$ Γ_7/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.66±0.05±0.07	774	ALAM	98	CLE2	$e^+e^- \approx \Upsilon(4S)$

$\Gamma\big(p\overline{K}^0\eta\big)/\Gamma\big(pK^-\pi^+\big)$ Γ_8/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.25±0.04±0.04	57	AMMAR	95	CLE2	$e^+e^- \approx \Upsilon(4S)$

$\Gamma\big(p\overline{K}^0\pi^+\pi^-\big)/\Gamma\big(pK^-\pi^+\big)$ Γ_9/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.51±0.06 OUR AVERAGE					
0.52±0.04±0.05	985	ALAM	98	CLE2	$e^+e^- \approx \Upsilon(4S)$
0.43±0.12±0.04	83	AVERY	91	CLEO	e^+e^- 10.5 GeV
0.98±0.36±0.08	12	BARLAG	90D	NA32	π^- 230 GeV

$\Gamma\big(pK^-\pi^+\pi^0\big)/\Gamma\big(pK^-\pi^+\big)$ Γ_{10}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.67±0.04±0.11	2606	ALAM	98	CLE2	$e^+e^- \approx \Upsilon(4S)$

$\Gamma(pK^*(892)^-\pi^+)/\Gamma(p\overline{K}^0\pi^+\pi^-)$ — Γ_{11}/Γ_9

Unseen decay modes of the $K^*(892)^-$ are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.44±0.14	17	ALEEV	94	BIS2	nN 20–70 GeV

$\Gamma(p(K^-\pi^+)_{\text{nonresonant}}\pi^0)/\Gamma(pK^-\pi^+)$ — Γ_{12}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.73±0.12±0.05	67	BOZEK	93	NA32	π^- Cu 230 GeV

$\Gamma(\Delta(1232)\overline{K}^*(892))/\Gamma_{\text{total}}$ — Γ_{13}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	35	AMENDOLIA	87	SPEC	γ Ge-Si

$\Gamma(pK^-\pi^+\pi^+\pi^-)/\Gamma(pK^-\pi^+)$ — Γ_{14}/Γ_2

VALUE	DOCUMENT ID		TECN	COMMENT
0.022±0.015	BARLAG	90D	NA32	π^- 230 GeV

$\Gamma(pK^-\pi^+\pi^0\pi^0)/\Gamma(pK^-\pi^+)$ — Γ_{15}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.16±0.07±0.03	15	BOZEK	93	NA32	π^- Cu 230 GeV

$\Gamma(pK^-\pi^+\pi^0\pi^0\pi^0)/\Gamma(pK^-\pi^+)$ — Γ_{16}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.10±0.06±0.02	8	BOZEK	93	NA32	π^- Cu 230 GeV

Hadronic modes with a p and 0 or 2 K's

$\Gamma(p\pi^+\pi^-)/\Gamma(pK^-\pi^+)$ — Γ_{17}/Γ_2

VALUE	DOCUMENT ID		TECN	COMMENT
0.069±0.036	BARLAG	90D	NA32	π^- 230 GeV

$\Gamma(pf_0(980))/\Gamma(pK^-\pi^+)$ — Γ_{18}/Γ_2

Unseen decay modes of the $f_0(980)$ are included.

VALUE	DOCUMENT ID		TECN	COMMENT
0.055±0.036	BARLAG	90D	NA32	π^- 230 GeV

$\Gamma(p\pi^+\pi^+\pi^-\pi^-)/\Gamma(pK^-\pi^+)$ — Γ_{19}/Γ_2

VALUE	DOCUMENT ID		TECN	COMMENT
0.036±0.023	BARLAG	90D	NA32	π^- 230 GeV

$\Gamma(pK^+K^-)/\Gamma(pK^-\pi^+)$ — Γ_{20}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.046±0.012 OUR AVERAGE	Error includes scale factor of 1.2.				
0.039±0.009±0.007	214	ALEXANDER	96C	CLE2	$e^+e^- \approx \Upsilon(4S)$
0.096±0.029±0.010	30	FRABETTI	93H	E687	γ Be, $\overline{E}_\gamma$ 220 GeV
0.048±0.027		BARLAG	90D	NA32	π^- 230 GeV

$\Gamma(p\phi)/\Gamma(pK^-\pi^+)$ — Γ_{21}/Γ_2

Unseen decay modes of the ϕ are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.024±0.006±0.003	54	ALEXANDER	96C	CLE2	$e^+e^- \approx \Upsilon(4S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.040±0.027		BARLAG	90D	NA32	π^- 230 GeV

$\Gamma(p\phi)/\Gamma(pK^+K^-)$ — Γ_{21}/Γ_{20}

Unseen decay modes of the ϕ are included.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.58	90	FRABETTI	93H	E687	γ Be, $\overline{E}_\gamma$ 220 GeV

Hadronic modes with a hyperon

$\Gamma(\Lambda\pi^+)/\Gamma(pK^-\pi^+)$ — Γ_{22}/Γ_2

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
0.180±0.032 OUR AVERAGE						
0.18 ±0.03 ±0.04			ALBRECHT	92	ARG	$e^+e^- \approx$ 10.4 GeV
0.18 ±0.03 ±0.03		87	AVERY	91	CLEO	e^+e^- 10.5 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •						
<0.33	90		ANJOS	90	E691	γ Be 70–260 GeV
<0.16	90		ALBRECHT	88C	ARG	e^+e^- 10 GeV

$\Gamma(\Lambda\pi^+\pi^0)/\Gamma(pK^-\pi^+)$ — Γ_{23}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.73±0.09±0.16	464	AVERY	94	CLE2	$e^+e^- \approx \Upsilon(3S), \Upsilon(4S)$

$\Gamma(\Lambda\rho^+)/\Gamma(pK^-\pi^+)$ — Γ_{24}/Γ_2

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.95	95	AVERY	94	CLE2	$e^+e^- \approx \Upsilon(3S), \Upsilon(4S)$

$\Gamma(\Lambda\pi^+\pi^+\pi^-)/\Gamma(pK^-\pi^+)$ — Γ_{25}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.66±0.11 OUR AVERAGE					
0.65±0.11±0.12	289	AVERY	91	CLEO	e^+e^- 10.5 GeV
0.82±0.29±0.27	44	ANJOS	90	E691	γ Be 70–260 GeV
0.94±0.41±0.13	10	BARLAG	90D	NA32	π^- 230 GeV
0.61±0.16±0.04	105	ALBRECHT	88C	ARG	e^+e^- 10 GeV

$\Gamma(p\overline{K}^0\pi^+\pi^-)/\Gamma(\Lambda\pi^+\pi^+\pi^-)$ — Γ_9/Γ_{25}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.6±1.2		ALEEV	96	SPEC	n nucleus, 50 GeV/c
4.3±1.2	130	ALEEV	84	BIS2	nC 40–70 GeV

$\Gamma(\Lambda\pi^+\eta)/\Gamma(pK^-\pi^+)$ — Γ_{26}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.35±0.05±0.06	116	AMMAR	95	CLE2	$e^+e^- \approx \Upsilon(4S)$

$\Gamma(\Sigma(1385)^+\eta)/\Gamma(pK^-\pi^+)$ — Γ_{27}/Γ_2

Unseen decay modes of the $\Sigma(1385)^+$ are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.17±0.04±0.03	54	AMMAR	95	CLE2	$e^+e^- \approx \Upsilon(4S)$

$\Gamma(\Lambda K^+\overline{K}^0)/\Gamma(pK^-\pi^+)$ — Γ_{28}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.12 ±0.02 ±0.02	59	AMMAR	95	CLE2	$e^+e^- \approx \Upsilon(4S)$

$\Gamma(\Sigma^0\pi^+)/\Gamma(pK^-\pi^+)$ — Γ_{29}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.20±0.04 OUR AVERAGE					
0.21±0.02±0.04	196	AVERY	94	CLE2	$e^+e^- \approx \Upsilon(3S), \Upsilon(4S)$
0.17±0.06±0.04		ALBRECHT	92	ARG	$e^+e^- \approx$ 10.4 GeV

$\Gamma(\Sigma^+\pi^0)/\Gamma(pK^-\pi^+)$ — Γ_{30}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.20±0.03±0.03	93	KUBOTA	93	CLE2	$e^+e^- \approx \Upsilon(4S)$

$\Gamma(\Sigma^+\eta)/\Gamma(pK^-\pi^+)$ — Γ_{31}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.11±0.03±0.02	26	AMMAR	95	CLE2	$e^+e^- \approx \Upsilon(4S)$

$\Gamma(\Sigma^+\pi^+\pi^-)/\Gamma(pK^-\pi^+)$ — Γ_{32}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.68±0.09 OUR AVERAGE					
0.74±0.07±0.09	487	KUBOTA	93	CLE2	$e^+e^- \approx \Upsilon(4S)$
$0.54^{+0.18}_{-0.15}$	11	BARLAG	92	NA32	π^- Cu 230 GeV

$\Gamma(\Sigma^+\rho^0)/\Gamma(pK^-\pi^+)$ — Γ_{33}/Γ_2

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.27	95	KUBOTA	93	CLE2	$e^+e^- \approx \Upsilon(4S)$

$\Gamma(\Sigma^-\pi^+\pi^+)/\Gamma(\Sigma^+\pi^+\pi^-)$ — Γ_{34}/Γ_{32}

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.53±0.15±0.07	56	FRABETTI	94E	E687	γ Be, $\overline{E}_\gamma$ 220 GeV

$\Gamma(\Sigma^0\pi^+\pi^0)/\Gamma(pK^-\pi^+)$ — Γ_{35}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.36±0.09±0.10	117	AVERY	94	CLE2	$e^+e^- \approx \Upsilon(3S), \Upsilon(4S)$

$\Gamma(\Sigma^0\pi^+\pi^+\pi^-)/\Gamma(pK^-\pi^+)$ — Γ_{36}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.21±0.05±0.05	90	AVERY	94	CLE2	$e^+e^- \approx \Upsilon(3S), \Upsilon(4S)$

$\Gamma(\Sigma^+\omega)/\Gamma(pK^-\pi^+)$ — Γ_{38}/Γ_2

Unseen decay modes of the ω are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.54±0.13±0.06	107	KUBOTA	93	CLE2	$e^+e^- \approx \Upsilon(4S)$

$\Gamma(\Sigma^+\pi^+\pi^+\pi^-\pi^-)/\Gamma(pK^-\pi^+)$ — Γ_{39}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.06^{+0.08}_{-0.04}}$	1	BARLAG	92	NA32	π^- Cu 230 GeV

$\Gamma(\Sigma^+K^+K^-)/\Gamma(pK^-\pi^+)$ — Γ_{40}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.070±0.011±0.011	59	AVERY	93	CLE2	$e^+e^- \approx 10.5$ GeV

$\Gamma(\Sigma^+\phi)/\Gamma(pK^-\pi^+)$ — Γ_{41}/Γ_2

Unseen decay modes of the ϕ are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.069±0.023±0.016	26	AVERY	93	CLE2	$e^+e^- \approx 10.5$ GeV

$\Gamma(\Sigma^+K^+\pi^-)/\Gamma(pK^-\pi^+)$ — Γ_{42}/Γ_2

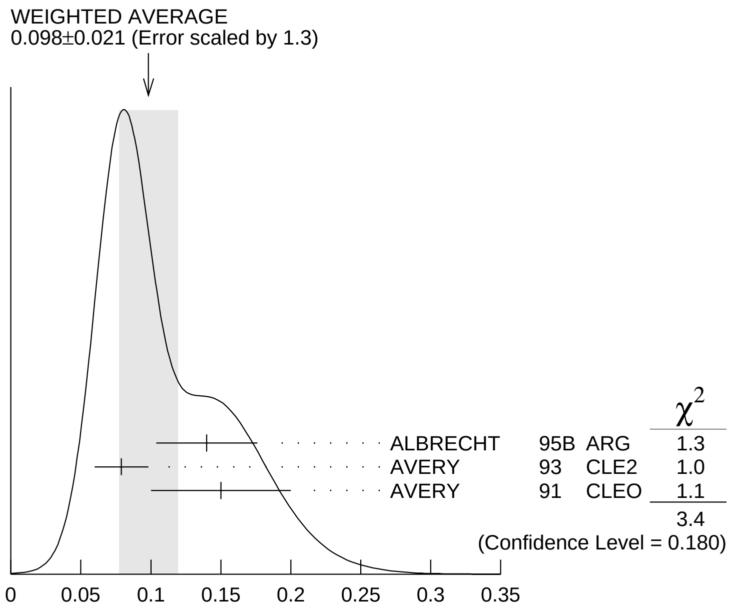
VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.13^{+0.12}_{-0.07}}$	2	BARLAG	92	NA32	π^- Cu 230 GeV

$\Gamma(\Xi^0K^+)/\Gamma(pK^-\pi^+)$ — Γ_{43}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.078±0.013±0.013	56	AVERY	93	CLE2	$e^+e^- \approx 10.5$ GeV

$\Gamma(\Xi^-K^+\pi^+)/\Gamma(pK^-\pi^+)$ — Γ_{44}/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.098±0.021 OUR AVERAGE	Error includes scale factor of 1.3. See the ideogram below.				
0.14 ±0.03 ±0.02	34	ALBRECHT	95B	ARG	$e^+e^- \approx 10.4$ GeV
0.079±0.013±0.014	60	AVERY	93	CLE2	$e^+e^- \approx 10.5$ GeV
0.15 ±0.04 ±0.03	30	AVERY	91	CLEO	e^+e^- 10.5 GeV



$\Gamma\left(\Xi^- K^+ \pi^+\right)/\Gamma\left(p K^- \pi^+\right)$

$\Gamma\left(\Xi(1530)^0 K^+\right)/\Gamma\left(p K^- \pi^+\right)$ Γ_{45}/Γ_2

Unseen decay modes of the $\Xi(1530)^0$ are included.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.052±0.014 OUR AVERAGE					
0.05 ±0.02 ±0.01	11	ALBRECHT	95B	ARG	$e^+ e^- \approx 10.4$ GeV
0.053±0.016±0.010	24	AVERY	93	CLE2	$e^+ e^- \approx 10.5$ GeV

—— Semileptonic modes ——

$\Gamma\left(\Lambda \ell^+ \nu_\ell\right)/\Gamma\left(p K^- \pi^+\right)$ Γ_{46}/Γ_2

We average here the averages of the next two data blocks.

VALUE	DOCUMENT ID		COMMENT
0.41±0.05 OUR AVERAGE			
0.42±0.07	PDG	00	Our $\Gamma(\Lambda e^+ \nu_e)/\Gamma(p K^- \pi^+)$
0.39±0.08	PDG	00	Our $\Gamma(\Lambda \mu^+ \nu_\mu)/\Gamma(p K^- \pi^+)$

$\Gamma\left(\Lambda e^+ \nu_e\right)/\Gamma\left(p K^- \pi^+\right)$ Γ_{47}/Γ_2

VALUE	DOCUMENT ID		TECN	COMMENT
0.42±0.07 OUR AVERAGE				
0.43±0.08	[8,9] BERGFELD	94	CLE2	$e^+ e^- \approx \Upsilon(4S)$
0.38±0.14	[9,10] ALBRECHT	91G	ARG	$e^+ e^- \approx 10.4$ GeV

[8] BERGFELD 94 measures $\sigma(e^+ e^- \to \Lambda_c^+ X) \cdot B(\Lambda_c^+ \to \Lambda e^+ \nu_e) = (4.87 \pm 0.28 \pm 0.69)$ pb.

[9] To extract $\Gamma(\Lambda_c^+ \to \Lambda e^+ \nu_e)/\Gamma(\Lambda_c^+ \to p K^- \pi^+)$, we use $\sigma(e^+ e^- \to \Lambda_c^+ X) \cdot B(\Lambda_c \to p K^- \pi^+) = (11.2 \pm 1.3)$ pb, which is the weighted average of measurements from ARGUS (ALBRECHT 96E) and CLEO (AVERY 91).

[10] ALBRECHT 91G measures $\sigma(e^+ e^- \to \Lambda_c^+ X) \cdot B(\Lambda_c^+ \to \Lambda e^+ \nu_e) = (4.20 \pm 1.28 \pm 0.71)$ pb.

$\Gamma(\Lambda\mu^+\nu_\mu)/\Gamma(pK^-\pi^+)$ Γ_{48}/Γ_2

VALUE		DOCUMENT ID		TECN	COMMENT
0.39±0.08 OUR AVERAGE					
0.40±0.09	[11,12]	BERGFELD	94	CLE2	$e^+e^- \approx \Upsilon(4S)$
0.35±0.20	[12,13]	ALBRECHT	91G	ARG	$e^+e^- \approx 10.4$ GeV

[11] BERGFELD 94 measures $\sigma(e^+e^- \to \Lambda_c^+ X)\cdot B(\Lambda_c^+ \to \Lambda\mu^+\nu_\mu) = (4.43 \pm 0.51 \pm 0.64)$ pb.

[12] To extract $\Gamma(\Lambda_c^+ \to \Lambda\mu^+\nu_\mu)/\Gamma(\Lambda_c^+ \to pK^-\pi^+)$, we use $\sigma(e^+e^- \to \Lambda_c^+ X)\cdot B(\Lambda_c \to pK^-\pi^+) = (11.2 \pm 1.3)$ pb, which is the weighted average of measurements from ARGUS (ALBRECHT 96E) and CLEO (AVERY 91).

[13] ALBRECHT 91G measures $\sigma(e^+e^- \to \Lambda_c^+ X)\cdot B(\Lambda_c^+ \to \Lambda\mu^+\nu_\mu) = (3.91 \pm 2.02 \pm 0.90)$ pb.

Inclusive modes

$\Gamma(e^+\text{ anything})/\Gamma_{total}$ Γ_{49}/Γ

VALUE		DOCUMENT ID		TECN	COMMENT
0.045±0.017		VELLA	82	MRK2	e^+e^- 4.5–6.8 GeV

$\Gamma(pe^+\text{ anything})/\Gamma_{total}$ Γ_{50}/Γ

VALUE		DOCUMENT ID		TECN	COMMENT
0.018±0.009	[14]	VELLA	82	MRK2	e^+e^- 4.5–6.8 GeV

[14] VELLA 82 includes protons from Λ decay.

$\Gamma(\Lambda e^+\text{ anything})/\Gamma_{total}$ Γ_{51}/Γ

VALUE		DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.011±0.008	[15]	VELLA	82	MRK2	e^+e^- 4.5–6.8 GeV

[15] VELLA 82 includes Λ's from Σ^0 decay.

$\Gamma(p\text{ anything})/\Gamma_{total}$ Γ_{52}/Γ

VALUE		DOCUMENT ID		TECN	COMMENT
0.50±0.08±0.14	[16]	CRAWFORD	92	CLEO	e^+e^- 10.5 GeV

[16] This CRAWFORD 92 value includes protons from Λ decay. The value is model dependent, but account is taken of this in the systematic error.

$\Gamma(p\text{ anything (no }\Lambda))/\Gamma_{total}$ Γ_{53}/Γ

VALUE		DOCUMENT ID		TECN	COMMENT
0.12±0.10±0.16		CRAWFORD	92	CLEO	e^+e^- 10.5 GeV

$\Gamma(n\text{ anything})/\Gamma_{total}$ Γ_{55}/Γ

VALUE		DOCUMENT ID		TECN	COMMENT
0.50±0.08±0.14	[17]	CRAWFORD	92	CLEO	e^+e^- 10.5 GeV

[17] This CRAWFORD 92 value includes neutrons from Λ decay. The value is model dependent, but account is taken of this in the systematic error.

$\Gamma(n\text{ anything (no }\Lambda))/\Gamma_{total}$ Γ_{56}/Γ

VALUE		DOCUMENT ID		TECN	COMMENT
0.29±0.09±0.15		CRAWFORD	92	CLEO	e^+e^- 10.5 GeV

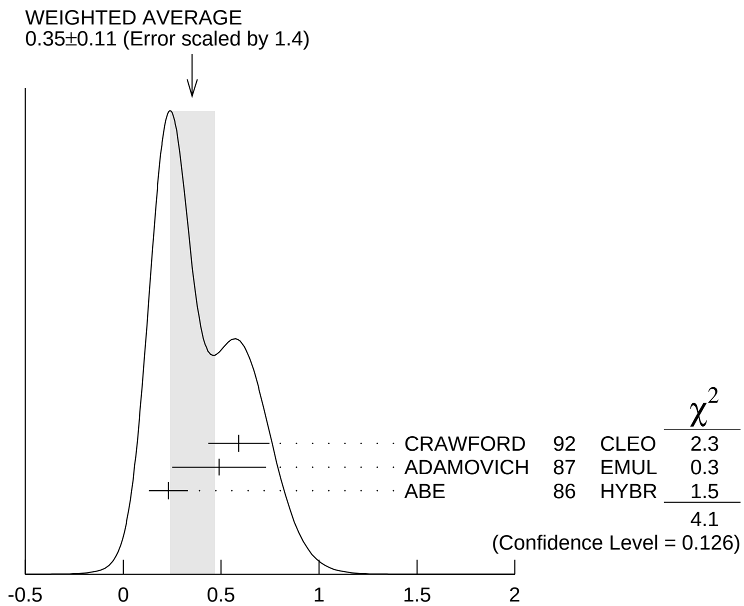
$\Gamma(p \text{ hadrons})/\Gamma_{total}$ — Γ_{54}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.41±0.24	ADAMOVICH	87	EMUL	γA 20–70 GeV/c

$\Gamma(\Lambda \text{ anything})/\Gamma_{total}$ — Γ_{57}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.35±0.11 OUR AVERAGE		Error includes scale factor of 1.4. See the ideogram below.			
0.59±0.10±0.12		CRAWFORD	92	CLEO	e^+e^- 10.5 GeV
0.49±0.24		ADAMOVICH	87	EMUL	γA 20–70 GeV/c
0.23±0.10	8	[18] ABE	86	HYBR	20 GeV γp

[18] ABE 86 includes Λ's from Σ^0 decay.



$\Gamma(\Lambda \text{ anything})/\Gamma_{total}$

$\Gamma(\Sigma^{\pm} \text{ anything})/\Gamma_{total}$ — Γ_{58}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.1 ±0.05	5	ABE	86	HYBR	20 GeV γp

Rare or forbidden modes

$\Gamma(p\mu^+\mu^-)/\Gamma_{total}$ — Γ_{59}/Γ

A test for the ΔC=1 weak neutral current. Allowed by higher-order electroweak interactions.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$<3.4\times10^{-4}$	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

$\Gamma(\Sigma^- \mu^+ \mu^+)/\Gamma_{total}$ — Γ_{60}/Γ

A test of lepton-number conservation.

VALUE	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
$<7.0 \times 10^{-4}$	90	0	KODAMA	95	E653	π^- emulsion 600 GeV

Λ_c^+ DECAY PARAMETERS

See the "Note on Baryon Decay Parameters" in the neutron Listings.

α FOR $\Lambda_c^+ \to \Lambda\pi^+$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
-0.98 ± 0.19 OUR AVERAGE					
$-0.94\pm0.21\pm0.12$	414	[19] BISHAI	95	CLE2	$e^+e^- \approx \Upsilon(4S)$
-0.96 ± 0.42		ALBRECHT	92	ARG	$e^+e^- \approx 10.4$ GeV
$-1.1\ \pm0.4$	86	AVERY	90B	CLEO	$e^+e^- \approx 10.6$ GeV

[19] BISHAI 95 actually gives $\alpha = -0.94^{+0.21}_{-0.06}{}^{+0.12}_{-0.06}$, chopping the errors at the physical limit -1.0. However, for $\alpha \approx -1.0$, some experiments should *get* unphysical values ($\alpha < -1.0$), and for averaging with other measurements such values (or errors that extend below -1.0) should *not* be chopped.

α FOR $\Lambda_c^+ \to \Sigma^+\pi^0$

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$-0.45\pm0.31\pm0.06$	89	BISHAI	95	CLE2	$e^+e^- \approx \Upsilon(4S)$

α FOR $\Lambda_c^+ \to \Lambda\ell^+\nu_\ell$

The experiments don't cover the complete (or same incomplete) $M(\Lambda\ell^+)$ range, but we average them together anyway.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$-0.82^{+0.11}_{-0.07}$ OUR AVERAGE					
$-0.82^{+0.09}_{-0.06}{}^{+0.06}_{-0.03}$	700	[20] CRAWFORD	95	CLE2	$e^+e^- \approx \Upsilon(4S)$
$-0.91\pm0.42\pm0.25$		[21] ALBRECHT	94B	ARG	$e^+e^- \approx 10$ GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$-0.89^{+0.17}_{-0.11}{}^{+0.09}_{-0.05}$	350	[22] BERGFELD	94	CLE2	See CRAWFORD 95

[20] CRAWFORD 95 measures the form-factor ratio $R \equiv f_2/f_1$ for $\Lambda_c^+ \to \Lambda e^+ \nu_e$ events to be $-0.25 \pm 0.14 \pm 0.08$ and from this calculates α, averaged over q^2, to be the above.

[21] ALBRECHT 94B uses Λe^+ and $\Lambda\mu^+$ events in the mass range $1.85 < M(\Lambda\ell^+) < 2.20$ GeV.

[22] BERGFELD 94 uses Λe^+ events.

Λ_c^+ REFERENCES

We have omitted some papers that have been superseded by later experiments. The omitted papers may be found in our 1992 edition (Physical Review **D45**, 1 June, Part II) or in earlier editions.

AITALA	00	PL B471 449	E.M. Aitala *et al.*	(FNAL E791 Collab.)
PDG	00	EPJ C15 1	D.E. Groom *et al.*	
ALAM	98	PR D57 4467	M.S. Alam *et al.*	(CLEO Collab.)
ALBRECHT	96E	PRPL 276 223	H. Albrecht *et al.*	(ARGUS Collab.)
ALEEV	96	JINRRC 3 31	A.N. Aleev *et al.*	(Serpukhov EXCHARM Collab.)
ALEXANDER	96C	PR D53 R1013	J.P. Alexander *et al.*	(CLEO Collab.)
ALBRECHT	95B	PL B342 397	H. Albrecht *et al.*	(ARGUS Collab.)
AMMAR	95	PRL 74 3534	R. Ammar *et al.*	(CLEO Collab.)
BISHAI	95	PL B350 256	M. Bishai *et al.*	(CLEO Collab.)
CRAWFORD	95	PRL 75 624	G. Crawford *et al.*	(CLEO Collab.)
KODAMA	95	PL B345 85	K. Kodama *et al.*	(FNAL E653 Collab.)
ALBRECHT	94B	PL B326 320	H. Albrecht *et al.*	(ARGUS Collab.)
ALEEV	94	PAN 57 1370	A.N. Aleev *et al.*	(Serpukhov BIS-2 Collab.)
		Translated from YF 57 1443.		
AVERY	94	PL B325 257	P. Avery *et al.*	(CLEO Collab.)
BERGFELD	94	PL B323 219	T. Bergfeld *et al.*	(CLEO Collab.)
FRABETTI	94E	PL B328 193	P.L. Frabetti *et al.*	(FNAL E687 Collab.)
AVERY	93	PRL 71 2391	P. Avery *et al.*	(CLEO Collab.)
BOZEK	93	PL B312 247	A. Bozek *et al.*	(CERN NA32 Collab.)
FRABETTI	93D	PRL 70 1755	P.L. Frabetti *et al.*	(FNAL E687 Collab.)
FRABETTI	93H	PL B314 477	P.L. Frabetti *et al.*	(FNAL E687 Collab.)
KUBOTA	93	PRL 71 3255	Y. Kubota *et al.*	(CLEO Collab.)
ALBRECHT	92	PL B274 239	H. Albrecht *et al.*	(ARGUS Collab.)
ALBRECHT	92O	ZPHY C56 1	H. Albrecht *et al.*	(ARGUS Collab.)
BARLAG	92	PL B283 465	S. Barlag *et al.*	(ACCMOR Collab.)
CRAWFORD	92	PR D45 752	G. Crawford *et al.*	(CLEO Collab.)
JEZABEK	92	PL B286 175	M. Jezabek, K. Rybicki, R. Rylko	(CRAC)
ALBRECHT	91G	PL B269 234	H. Albrecht *et al.*	(ARGUS Collab.)
AVERY	91	PR D43 3599	P. Avery *et al.*	(CLEO Collab.)
ALVAREZ	90	ZPHY C47 539	M.P. Alvarez *et al.*	(CERN NA14/2 Collab.)
ALVAREZ	90B	PL B246 256	M.P. Alvarez *et al.*	(CERN NA14/2 Collab.)
ANJOS	90	PR D41 801	J.C. Anjos *et al.*	(FNAL E691 Collab.)
AVERY	90B	PRL 65 2842	P. Avery *et al.*	(CLEO Collab.)
BARLAG	90D	ZPHY C48 29	S. Barlag *et al.*	(ACCMOR Collab.)
FRABETTI	90	PL B251 639	P.L. Frabetti *et al.*	(FNAL E687 Collab.)
BARLAG	89	PL B218 374	S. Barlag *et al.*	(ACCMOR Collab.)
AGUILAR-...	88B	ZPHY C40 321	M. Aguilar-Benitez *et al.*	(LEBC-EHS Collab.)
Also	87	PL B189 254	M. Aguilar-Benitez *et al.*	(LEBC-EHS Collab.)
Also	87B	PL B199 462	M. Aguilar-Benitez *et al.*	(LEBC-EHS Collab.)
Also	88	SJNP 48 833	M. Begalli *et al.*	(LEBC-EHS Collab.)
		Translated from YAF 48 1310.		
ALBRECHT	88C	PL B207 109	H. Albrecht *et al.*	(ARGUS Collab.)
ANJOS	88B	PRL 60 1379	J.C. Anjos *et al.*	(FNAL E691 Collab.)
ADAMOVICH	87	EPL 4 887	M.I. Adamovich *et al.*	
Also	87	SJNP 46 447	F. Viaggi *et al.*	(Photon Emulsion Collab.)
		Translated from YAF 46 799.		
AMENDOLIA	87	ZPHY C36 513	S.R. Amendolia *et al.*	(CERN NA1 Collab.)
JONES	87	ZPHY C36 593	G.T. Jones *et al.*	(CERN WA21 Collab.)
ABE	86	PR D33 1	K. Abe *et al.*	
ALEEV	84	ZPHY C23 333	A.N. Aleev *et al.*	(BIS-2 Collab.)
BOSETTI	82	PL 109B 234	P.C. Bosetti *et al.*	(AACH3, BONN, CERN+)
VELLA	82	PRL 48 1515	E. Vella *et al.*	(SLAC, LBL, UCB)
BASILE	81B	NC 62A 14	M. Basile *et al.*	(CERN, BGNA, PGIA, FRAS)
CALICCHIO	80	PL 93B 521	M. Calicchio *et al.*	(BARI, BIRM, BRUX+)

OTHER RELATED PAPERS

MIGLIOZZI	99	PL B462 217	P. Migliozzi *et al.*
DUNIETZ	98	PR D58 094010	I. Dunietz