p

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

p MASS

The mass is known much more precisely in u (atomic mass units) than in MeV; see the footnote. The conversion from u to MeV, 1 u = 931.494013±0.000037 MeV/c^2 (MOHR 99, the 1998 CODATA value), involves the relatively poorly known electronic charge.

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
938.27200 ±0.00004 OUR AVERAGE				
938.271998±0.000038	[1] MOHR	99	RVUE	1998 CODATA value
• • • We do not use the following data for averages, fits, limits, etc. • • •				
938.27231 ±0.00028	[2] COHEN	87	RVUE	1986 CODATA value
938.2796 ±0.0027	COHEN	73	RVUE	1973 CODATA value

[1] The mass is known much more precisely in u: $m = 1.00727646688 \pm 0.00000000013$ u.
[2] The mass is known much more precisely in u: $m = 1.007276470 \pm 0.000000012$ u.

$\left|m_p - m_{\overline{p}}\right|/m_p$

A test of *CPT* invariance. Note that the $\overline{p}/p$ charge-to-mass ratio, given below, is much better determined.

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
$<5 \times 10^{-7}$	[3] TORII	99	SPEC	$\overline{p}e^-$He atom

[3] TORII 99 uses the more-precisely-known constraint on the $\overline{p}$ charge-to-mass ratio of GABRIELSE 95 (see below) to get this result. This is not independent of the TORII 99 value for $\left|q_p + q_{\overline{p}}\right|/e$, below.

$\overline{p}/p$ CHARGE-TO-MASS RATIO, $\left|\frac{q_{\overline{p}}}{m_{\overline{p}}}\right|/(\frac{q_p}{m_p})$

A test of *CPT* invariance. Listed here are measurements involving the *inertial* masses. For a discussion of what may be inferred about the ratio of $\overline{p}$ and p *gravitational* masses, see ERICSON 90; they obtain an upper bound of 10^{-6}–10^{-7} for violation of the equivalence principle for $\overline{p}$'s.

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
0.99999999991±0.00000000009	GABRIELSE	99	TRAP	Penning trap
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.0000000015 ±0.0000000011	[4] GABRIELSE	95	TRAP	Penning trap
1.000000023 ±0.000000042	[5] GABRIELSE	90	TRAP	Penning trap

[4] Equation (2) of GABRIELSE 95 should read $M(\overline{p})/M(p) = 0.999\,999\,99\underline{8}5\,(11)$ (G. Gabrielse, private communication).
[5] GABRIELSE 90 also measures $m_{\overline{p}}/m_{e^-} = 1836.152660 \pm 0.000083$ and $m_p/m_{e^-} = 1836.152680 \pm 0.000088$. Both are completely consistent with the 1986 CODATA (COHEN 87) value for m_p/m_{e^-} of 1836.152701 ± 0.000037.

$(\left|\frac{q_{\overline{p}}}{m_{\overline{p}}}\right|-\frac{q_p}{m_p})/\frac{q_p}{m_p}$

A test of *CPT* invariance. Taken from the $\overline{p}/p$ charge-to-mass ratio, above.

VALUE	*DOCUMENT ID*
$(-9\pm9)\times10^{-11}$ OUR EVALUATION	

$\left|q_p + q_{\overline{p}}\right|/e$

A test of *CPT* invariance. Note that the $\overline{p}/p$ charge-to-mass ratio, given above, is much better determined. See also a similar test involving the electron.

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
$<5\times10^{-7}$				
$<5\times10^{-7}$	[6] TORII	99	SPEC	$\overline{p}e^-$He atom
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<2\times10^{-5}$	[7] HUGHES	92	RVUE	

[6] TORII 99 uses the more-precisely-known constraint on the $\overline{p}$ charge-to-mass ratio of GABRIELSE 95 (see above) to get this result. This is not independent of the TORII 99 value for $\left|m_p - m_{\overline{p}}\right|/m_p$, above.

[7] HUGHES 92 uses recent measurements of Rydberg-energy and cyclotron-frequency ratios.

$\left|q_p + q_e\right|/e$

See DYLLA 73 for a summary of experiments on the neutrality of matter. See also "*n* CHARGE" in the neutron Listings.

VALUE	*DOCUMENT ID*		*COMMENT*
$<1.0\times10^{-21}$	[8] DYLLA	73	Neutrality of SF_6
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$<0.8\times10^{-21}$	MARINELLI	84	Magnetic levitation

[8] Assumes that $q_n = q_p + q_e$.

p MAGNETIC MOMENT

See the "Note on Baryon Magnetic Moments" in the Λ Listings.

VALUE (μ_N)	*DOCUMENT ID*		*TECN*	*COMMENT*
2.792847337±0.000000029 OUR AVERAGE				
2.792847337±0.000000029	MOHR	99	RVUE	1998 CODATA value
• • • We do not use the following data for averages, fits, limits, etc. • • •				
2.792847386±0.000000063	COHEN	87	RVUE	1986 CODATA value
2.7928456 ±0.0000011	COHEN	73	RVUE	1973 CODATA value

$\overline{p}$ MAGNETIC MOMENT

A few early results have been omitted.

VALUE (μ_N)	*DOCUMENT ID*		*TECN*	*COMMENT*
−2.800 ±0.008 OUR AVERAGE				
−2.8005±0.0090	KREISSL	88	CNTR	$\overline{p}$ ^{208}Pb 11→ 10 X-ray
−2.817 ±0.048	ROBERTS	78	CNTR	
−2.791 ±0.021	HU	75	CNTR	Exotic atoms

$(\mu_p + \mu_{\overline{p}})$ / μ_p

A test of *CPT* invariance. Calculated from the p and $\overline{p}$ magnetic moments, above.

VALUE	*DOCUMENT ID*
(−2.6±2.9) × 10^{-3} OUR EVALUATION	

p ELECTRIC DIPOLE MOMENT

A nonzero value is forbidden by both T invariance and P invariance.

VALUE (10^{-23} ecm)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
− 3.7± 6.3		CHO	89	NMR	Tl F molecules
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 400		DZUBA	85	THEO	Uses ^{129}Xe moment
130 ± 200		[9] WILKENING	84		
900 ±1400		[10] WILKENING	84		
700 ± 900	1G	HARRISON	69	MBR	Molecular beam

[9] This WILKENING 84 value includes a finite-size effect and a magnetic effect.

[10] This WILKENING 84 value is more cautious than the other and excludes the finite-size effect, which relies on uncertain nuclear integrals.

p ELECTRIC POLARIZABILITY $\overline{\alpha}_p$

VALUE (10^{-4} fm^3)	*DOCUMENT ID*		*TECN*	*COMMENT*
12.1 ±0.8 ±0.5	[11] MACGIBBON	95	RVUE	global average
• • • We do not use the following data for averages, fits, limits, etc. • • •				
12.5 ±0.6 ±0.9	MACGIBBON	95	CNTR	γp Compton scattering
9.8 ±0.4 ±1.1	HALLIN	93	CNTR	γp Compton scattering
$10.62^{+1.25}_{-1.19}{}^{+1.07}_{-1.03}$	ZIEGER	92	CNTR	γp Compton scattering
10.9 ±2.2 ±1.3	[12] FEDERSPIEL	91	CNTR	γp Compton scattering

[11] MACGIBBON 95 combine the results of ZIEGER 92, FEDERSPIEL 91, and their own experiment to get a "global average" in which model errors and systematic errors are treated in a consistent way. See MACGIBBON 95 for a discussion.

[12] FEDERSPIEL 91 obtains for the (static) electric polarizablity α_p, defined in terms of the induced electric dipole moment by $\mathbf{D} = 4\pi\epsilon_0 \alpha_p \mathbf{E}$, the value $(7.0 \pm 2.2 \pm 1.3) \times 10^{-4}$ fm^3.

p MAGNETIC POLARIZABILITY $\overline{\beta}_p$

The electric and magnetic polarizabilities are subject to a dispersion sum-rule constraint $\overline{\alpha} + \overline{\beta} = (14.2 \pm 0.5) \times 10^{-4}$ fm^3. Errors here are anticorrelated with those on $\overline{\alpha}_p$ due to this constraint.

VALUE (10^{-4} fm^3)	*DOCUMENT ID*		*TECN*	*COMMENT*
2.1 ±0.8 ±0.5	[13] MACGIBBON	95	RVUE	global average
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.7 ±0.6 ±0.9	MACGIBBON	95	CNTR	γp Compton scattering
4.4 ±0.4 ±1.1	HALLIN	93	CNTR	γp Compton scattering
$3.58^{+1.19}_{-1.25}{}^{+1.03}_{-1.07}$	ZIEGER	92	CNTR	γp Compton scattering
3.3 ±2.2 ±1.3	FEDERSPIEL	91	CNTR	γp Compton scattering

[13] MACGIBBON 95 combine the results of ZIEGER 92, FEDERSPIEL 91, and their own experiment to get a "global average" in which model errors and systematic errors are treated in a consistent way. See MACGIBBON 95 for a discussion.

p MEAN LIFE

A test of baryon conservation. See the "p Partial Mean Lives" section below for limits that depend on decay modes. p = proton, n = bound neutron.

LIMIT (years)	*PARTICLE*	*DOCUMENT ID*		*TECN*
$>1.6 \times 10^{25}$	**p, n**	[14,15] EVANS	77	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$>3 \times 10^{23}$	p	[15] DIX	70	CNTR
$>3 \times 10^{23}$	p, n	[15,16] FLEROV	58	

[14] Mean lifetime of nucleons in ^{130}Te nuclei.
[15] Converted to mean life by dividing half-life by ln(2) = 0.693.
[16] Mean lifetime of nucleons in ^{232}Th nuclei.

$\overline{p}$ MEAN LIFE

The best limit by far, that of GOLDEN 79, relies, however, on a number of astrophysical assumptions. The other limits come from direct observations of stored antiprotons. See also "$\overline{p}$ Partial Mean Lives" after "p Partial Mean Lives," below.

LIMIT (years)	*CL%*	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
• • • We do not use the following data for averages, fits, limits, etc. • • •						
>0.28			GABRIELSE	90	TRAP	Penning trap
>0.08	90	1	BELL	79	CNTR	Storage ring
$>1 \times 10^{7}$			GOLDEN	79	SPEC	$\overline{p}/p$, cosmic rays
$>3.7 \times 10^{-3}$			BREGMAN	78	CNTR	Storage ring

p DECAY MODES

Below, for N decays, p and n distinguish proton and neutron partial lifetimes. See also the "Note on Nucleon Decay" in our 1994 edition (Phys. Rev. **D50**, 1673) for a short review.

The "partial mean life" limits tabulated here are the limits on τ/B_i, where τ is the total mean life and B_i is the branching fraction for the mode in question.

	Mode	Partial mean life (10^{30} years)	Confidence level
	Antilepton + meson		
τ_1	$N \rightarrow e^+ \pi$	> 158 (n), > 1600 (p)	90%
τ_2	$N \rightarrow \mu^+ \pi$	> 100 (n), > 473 (p)	90%
τ_3	$N \rightarrow \nu \pi$	> 112 (n), > 25 (p)	90%
τ_4	$p \rightarrow e^+ \eta$	> 313	90%
τ_5	$p \rightarrow \mu^+ \eta$	> 126	90%
τ_6	$n \rightarrow \nu \eta$	> 158	90%
τ_7	$N \rightarrow e^+ \rho$	> 217 (n), > 75 (p)	90%
τ_8	$N \rightarrow \mu^+ \rho$	> 228 (n), > 110 (p)	90%
τ_9	$N \rightarrow \nu \rho$	> 19 (n), > 162 (p)	90%
τ_{10}	$p \rightarrow e^+ \omega$	> 107	90%
τ_{11}	$p \rightarrow \mu^+ \omega$	> 117	90%
τ_{12}	$n \rightarrow \nu \omega$	> 108	90%
τ_{13}	$N \rightarrow e^+ K$	> 17 (n), > 150 (p)	90%
τ_{14}	$p \rightarrow e^+ K^0_S$	> 76	90%
τ_{15}	$p \rightarrow e^+ K^0_L$	> 44	90%
τ_{16}	$N \rightarrow \mu^+ K$	> 26 (n), > 120 (p)	90%
τ_{17}	$p \rightarrow \mu^+ K^0_S$	> 64	90%
τ_{18}	$p \rightarrow \mu^+ K^0_L$	> 44	90%
τ_{19}	$N \rightarrow \nu K$	> 86 (n), > 670 (p)	90%
τ_{20}	$p \rightarrow e^+ K^*(892)^0$	> 84	90%
τ_{21}	$N \rightarrow \nu K^*(892)$	> 78 (n), > 51 (p)	90%
	Antilepton + mesons		
τ_{22}	$p \rightarrow e^+ \pi^+ \pi^-$	> 82	90%
τ_{23}	$p \rightarrow e^+ \pi^0 \pi^0$	> 147	90%
τ_{24}	$n \rightarrow e^+ \pi^- \pi^0$	> 52	90%
τ_{25}	$p \rightarrow \mu^+ \pi^+ \pi^-$	> 133	90%
τ_{26}	$p \rightarrow \mu^+ \pi^0 \pi^0$	> 101	90%
τ_{27}	$n \rightarrow \mu^+ \pi^- \pi^0$	> 74	90%
τ_{28}	$n \rightarrow e^+ K^0 \pi^-$	> 18	90%

	Lepton + meson		
τ_{29}	$n \to e^- \pi^+$	> 65	90%
τ_{30}	$n \to \mu^- \pi^+$	> 49	90%
τ_{31}	$n \to e^- \rho^+$	> 62	90%
τ_{32}	$n \to \mu^- \rho^+$	> 7	90%
τ_{33}	$n \to e^- K^+$	> 32	90%
τ_{34}	$n \to \mu^- K^+$	> 57	90%
	Lepton + mesons		
τ_{35}	$p \to e^- \pi^+ \pi^+$	> 30	90%
τ_{36}	$n \to e^- \pi^+ \pi^0$	> 29	90%
τ_{37}	$p \to \mu^- \pi^+ \pi^+$	> 17	90%
τ_{38}	$n \to \mu^- \pi^+ \pi^0$	> 34	90%
τ_{39}	$p \to e^- \pi^+ K^+$	> 75	90%
τ_{40}	$p \to \mu^- \pi^+ K^+$	> 245	90%
	Antilepton + photon(s)		
τ_{41}	$p \to e^+ \gamma$	> 670	90%
τ_{42}	$p \to \mu^+ \gamma$	> 478	90%
τ_{43}	$n \to \nu \gamma$	> 28	90%
τ_{44}	$p \to e^+ \gamma \gamma$	> 100	90%
τ_{45}	$n \to \nu \gamma \gamma$	> 219	90%
	Three (or more) leptons		
τ_{46}	$p \to e^+ e^+ e^-$	> 793	90%
τ_{47}	$p \to e^+ \mu^+ \mu^-$	> 359	90%
τ_{48}	$p \to e^+ \nu \nu$	> 17	90%
τ_{49}	$n \to e^+ e^- \nu$	> 257	90%
τ_{50}	$n \to \mu^+ e^- \nu$	> 83	90%
τ_{51}	$n \to \mu^+ \mu^- \nu$	> 79	90%
τ_{52}	$p \to \mu^+ e^+ e^-$	> 529	90%
τ_{53}	$p \to \mu^+ \mu^+ \mu^-$	> 675	90%
τ_{54}	$p \to \mu^+ \nu \nu$	> 21	90%
τ_{55}	$p \to e^- \mu^+ \mu^+$	> 6	90%
τ_{56}	$n \to 3\nu$	> 0.0005	90%
τ_{57}	$n \to 5\nu$		
	Inclusive modes		
τ_{58}	$N \to e^+$ anything	> 0.6 (n, p)	90%
τ_{59}	$N \to \mu^+$ anything	> 12 (n, p)	90%
τ_{60}	$N \to \nu$ anything		
τ_{61}	$N \to e^+ \pi^0$ anything	> 0.6 (n, p)	90%
τ_{62}	$N \to$ 2 bodies, ν-free		

$\Delta B = 2$ dinucleon modes

The following are lifetime limits per iron nucleus.

τ_{63}	$p\,p \to \pi^+\pi^+$	> 0.7	90%
τ_{64}	$p\,n \to \pi^+\pi^0$	> 2	90%
τ_{65}	$n\,n \to \pi^+\pi^-$	> 0.7	90%
τ_{66}	$n\,n \to \pi^0\pi^0$	> 3.4	90%
τ_{67}	$p\,p \to e^+e^+$	> 5.8	90%
τ_{68}	$p\,p \to e^+\mu^+$	> 3.6	90%
τ_{69}	$p\,p \to \mu^+\mu^+$	> 1.7	90%
τ_{70}	$p\,n \to e^+\overline{\nu}$	> 2.8	90%
τ_{71}	$p\,n \to \mu^+\overline{\nu}$	> 1.6	90%
τ_{72}	$n\,n \to \nu_e\overline{\nu}_e$	> 0.000012	90%
τ_{73}	$n\,n \to \nu_\mu\overline{\nu}_\mu$	> 0.000006	90%

$\overline{p}$ DECAY MODES

	Mode	Partial mean life (years)	Confidence level
τ_{74}	$\overline{p} \to e^-\gamma$	$> 7 \times 10^5$	90%
τ_{75}	$\overline{p} \to \mu^-\gamma$	$> 5 \times 10^4$	90%
τ_{76}	$\overline{p} \to e^-\pi^0$	$> 4 \times 10^5$	90%
τ_{77}	$\overline{p} \to \mu^-\pi^0$	$> 5 \times 10^4$	90%
τ_{78}	$\overline{p} \to e^-\eta$	$> 2 \times 10^4$	90%
τ_{79}	$\overline{p} \to \mu^-\eta$	$> 8 \times 10^3$	90%
τ_{80}	$\overline{p} \to e^-K^0_S$	> 900	90%
τ_{81}	$\overline{p} \to \mu^-K^0_S$	$> 4 \times 10^3$	90%
τ_{82}	$\overline{p} \to e^-K^0_L$	$> 9 \times 10^3$	90%
τ_{83}	$\overline{p} \to \mu^-K^0_L$	$> 7 \times 10^3$	90%
τ_{84}	$\overline{p} \to e^-\gamma\gamma$	$> 2 \times 10^4$	90%
τ_{85}	$\overline{p} \to \mu^-\gamma\gamma$	$> 2 \times 10^4$	90%
τ_{86}	$\overline{p} \to e^-\rho$	> 200	90%
τ_{87}	$\overline{p} \to e^-\omega$	> 200	90%
τ_{88}	$\overline{p} \to e^-K^*(892)^0$	$> 1 \times 10^3$	90%

p PARTIAL MEAN LIVES

The "partial mean life" limits tabulated here are the limits on τ/B_i, where τ is the total mean life for the proton and B_i is the branching fraction for the mode in question.

Decaying particle: p = proton, n = bound neutron. The same event may appear under more than one partial decay mode. Background estimates may be accurate to a factor of two.

Antilepton + meson

$\tau(N \rightarrow e^+\pi)$ — τ_1

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
> 158							
> 158	***n***	**90**	**3**	**5**	MCGREW	99	IMB3
>1600	***p***	**90**	**0**	**0.1**	SHIOZAWA	98	SKAM
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 540	*p*	90	0	0.2	MCGREW	99	IMB3
> 70	*p*	90	0	0.5	BERGER	91	FREJ
> 70	*n*	90	0	$\leq$ 0.1	BERGER	91	FREJ
> 550	*p*	90	0	0.7	[17] BECKER-SZ...	90	IMB3
> 260	*p*	90	0	<0.04	HIRATA	89C	KAMI
> 130	*n*	90	0	<0.2	HIRATA	89C	KAMI
> 310	*p*	90	0	0.6	SEIDEL	88	IMB
> 100	*n*	90	0	1.6	SEIDEL	88	IMB
> 1.3	*n*	90	0		BARTELT	87	SOUD
> 1.3	*p*	90	0		BARTELT	87	SOUD
> 250	*p*	90	0	0.3	HAINES	86	IMB
> 31	*n*	90	8	9	HAINES	86	IMB
> 64	*p*	90	0	<0.4	ARISAKA	85	KAMI
> 26	*n*	90	0	<0.7	ARISAKA	85	KAMI
> 82	*p* (free)	90	0	0.2	BLEWITT	85	IMB
> 250	*p*	90	0	0.2	BLEWITT	85	IMB
> 25	*n*	90	4	4	PARK	85	IMB
> 15	*p*, *n*	90	0		BATTISTONI	84	NUSX
> 0.5	*p*	90	1	0.3	[18] BARTELT	83	SOUD
> 0.5	*n*	90	1	0.3	[18] BARTELT	83	SOUD
> 5.8	*p*	90	2		[19] KRISHNA...	82	KOLR
> 5.8	*n*	90	2		[19] KRISHNA...	82	KOLR
> 0.1	*n*	90			[20] GURR	67	CNTR

[17] This BECKER-SZENDY 90 result includes data from SEIDEL 88.
[18] Limit based on zero events.
[19] We have calculated 90% CL limit from 1 confined event.
[20] We have converted half-life to 90% CL mean life.

$\tau(N \to \mu^+ \pi)$ τ_2

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>473							
>473	***p***	**90**	**0**	**0.6**	MCGREW	99	IMB3
>100	***n***	**90**	**0**	**<0.2**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 90	*n*	90	1	1.9	MCGREW	99	IMB3
> 81	*p*	90	0	0.2	BERGER	91	FREJ
> 35	*n*	90	1	1.0	BERGER	91	FREJ
>230	*p*	90	0	<0.07	HIRATA	89C	KAMI
>270	*p*	90	0	0.5	SEIDEL	88	IMB
> 63	*n*	90	0	0.5	SEIDEL	88	IMB
> 76	*p*	90	2	1	HAINES	86	IMB
> 23	*n*	90	8	7	HAINES	86	IMB
> 46	*p*	90	0	<0.7	ARISAKA	85	KAMI
> 20	*n*	90	0	<0.4	ARISAKA	85	KAMI
> 59	*p* (free)	90	0	0.2	BLEWITT	85	IMB
>100	*p*	90	1	0.4	BLEWITT	85	IMB
> 38	*n*	90	1	4	PARK	85	IMB
> 10	*p*, *n*	90	0		BATTISTONI	84	NUSX
> 1.3	*p*, *n*	90	0		ALEKSEEV	81	BAKS

$\tau(N \to \nu \pi)$ τ_3

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>112							
>112	***n***	**90**	**6**	**6.6**	MCGREW	99	IMB3
> 25	***p***	**90**	**32**	**32.8**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 10	*p*	90	15	20.3	MCGREW	99	IMB3
> 13	*n*	90	1	1.2	BERGER	89	FREJ
> 10	*p*	90	11	14	BERGER	89	FREJ
>100	*n*	90	1	3	HIRATA	89C	KAMI
> 6	*n*	90	73	60	HAINES	86	IMB
> 2	*p*	90	16	13	KAJITA	86	KAMI
> 40	*n*	90	0	1	KAJITA	86	KAMI
> 7	*n*	90	28	19	PARK	85	IMB
> 7	*n*	90	0		BATTISTONI	84	NUSX
> 2	*p*	90	≤ 3		BATTISTONI	84	NUSX
> 5.8	*p*	90	1		[21] KRISHNA...	82	KOLR
> 0.3	*p*	90	2		[22] CHERRY	81	HOME
> 0.1	*p*	90			[23] GURR	67	CNTR

[21] We have calculated 90% CL limit from 1 confined event.
[22] We have converted 2 possible events to 90% CL limit.
[23] We have converted half-life to 90% CL mean life.

$\tau(p \to e^+ \eta)$ τ_4

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>313							
>313	***p***	**90**	**0**	**0.2**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 44	*p*	90	0	0.1	BERGER	91	FREJ
>140	*p*	90	0	<0.04	HIRATA	89C	KAMI
>100	*p*	90	0	0.6	SEIDEL	88	IMB
>200	*p*	90	5	3.3	HAINES	86	IMB
> 64	*p*	90	0	<0.8	ARISAKA	85	KAMI
> 64	*p* (free)	90	5	6.5	BLEWITT	85	IMB
>200	*p*	90	5	4.7	BLEWITT	85	IMB
> 1.2	*p*	90	2		[24] CHERRY	81	HOME

[24] We have converted 2 possible events to 90% CL limit.

$\tau(p \to \mu^+ \eta)$ τ_5

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>126							
>126	***p***	**90**	**3**	**2.8**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 26	*p*	90	1	0.8	BERGER	91	FREJ
> 69	*p*	90	1	<0.08	HIRATA	89C	KAMI
> 1.3	*p*	90	0	0.7	PHILLIPS	89	HPW
> 34	*p*	90	1	1.5	SEIDEL	88	IMB
> 46	*p*	90	7	6	HAINES	86	IMB
> 26	*p*	90	1	<0.8	ARISAKA	85	KAMI
> 17	*p* (free)	90	6	6	BLEWITT	85	IMB
> 46	*p*	90	7	8	BLEWITT	85	IMB

$\tau(n \to \nu \eta)$ τ_6

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>158							
>158	***n***	**90**	**0**	**1.2**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 29	*n*	90	0	0.9	BERGER	89	FREJ
> 54	*n*	90	2	0.9	HIRATA	89C	KAMI
> 16	*n*	90	3	2.1	SEIDEL	88	IMB
> 25	*n*	90	7	6	HAINES	86	IMB
> 30	*n*	90	0	0.4	KAJITA	86	KAMI
> 18	*n*	90	4	3	PARK	85	IMB
> 0.6	*n*	90	2		[25] CHERRY	81	HOME

[25] We have converted 2 possible events to 90% CL limit.

$\tau(N \rightarrow e^+ \rho)$ τ_7

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>217							
>217	***n***	**90**	**4**	**4.8**	MCGREW	99	IMB3
> 75	***p***	**90**	**2**	**2.7**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 29	*p*	90	0	2.2	BERGER	91	FREJ
> 41	*n*	90	0	1.4	BERGER	91	FREJ
> 58	*n*	90	0	1.9	HIRATA	89C	KAMI
> 38	*n*	90	2	4.1	SEIDEL	88	IMB
> 1.2	*p*	90	0		BARTELT	87	SOUD
> 1.5	*n*	90	0		BARTELT	87	SOUD
> 17	*p*	90	7	7	HAINES	86	IMB
> 14	*n*	90	9	4	HAINES	86	IMB
> 12	*p*	90	0	<1.2	ARISAKA	85	KAMI
> 6	*n*	90	2	<1	ARISAKA	85	KAMI
> 6.7	*p* (free)	90	6	6	BLEWITT	85	IMB
> 17	*p*	90	7	7	BLEWITT	85	IMB
> 12	*n*	90	4	2	PARK	85	IMB
> 0.6	*n*	90	1	0.3	[26] BARTELT	83	SOUD
> 0.5	*p*	90	1	0.3	[26] BARTELT	83	SOUD
> 9.8	*p*	90	1		[27] KRISHNA...	82	KOLR
> 0.8	*p*	90	2		[28] CHERRY	81	HOME

[26] Limit based on zero events.
[27] We have calculated 90% CL limit from 0 confined events.
[28] We have converted 2 possible events to 90% CL limit.

$\tau(N \rightarrow \mu^+ \rho)$ τ_8

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>228							
>228	***n***	**90**	**3**	**9.5**	MCGREW	99	IMB3
>110	***p***	**90**	**0**	**1.7**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 12	*p*	90	0	0.5	BERGER	91	FREJ
> 22	*n*	90	0	1.1	BERGER	91	FREJ
> 23	*n*	90	1	1.8	HIRATA	89C	KAMI
> 4.3	*p*	90	0	0.7	PHILLIPS	89	HPW
> 30	*p*	90	0	0.5	SEIDEL	88	IMB
> 11	*n*	90	1	1.1	SEIDEL	88	IMB
> 16	*p*	90	4	4.5	HAINES	86	IMB
> 7	*n*	90	6	5	HAINES	86	IMB
> 12	*p*	90	0	<0.7	ARISAKA	85	KAMI
> 5	*n*	90	1	<1.2	ARISAKA	85	KAMI
> 5.5	*p* (free)	90	4	5	BLEWITT	85	IMB
> 16	*p*	90	4	5	BLEWITT	85	IMB
> 9	*n*	90	1	2	PARK	85	IMB

$\tau(N \to \nu\rho)$ τ_9

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>162							
>162	***p***	**90**	**18**	**21.7**	MCGREW	99	IMB3
> 19	***n***	**90**	**0**	**0.5**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 9	*n*	90	4	2.4	BERGER	89	FREJ
> 24	*p*	90	0	0.9	BERGER	89	FREJ
> 27	*p*	90	5	1.5	HIRATA	89C	KAMI
> 13	*n*	90	4	3.6	HIRATA	89C	KAMI
> 13	*p*	90	1	1.1	SEIDEL	88	IMB
> 8	*p*	90	6	5	HAINES	86	IMB
> 2	*n*	90	15	10	HAINES	86	IMB
> 11	*p*	90	2	1	KAJITA	86	KAMI
> 4	*n*	90	2	2	KAJITA	86	KAMI
> 4.1	*p* (free)	90	6	7	BLEWITT	85	IMB
> 8.4	*p*	90	6	5	BLEWITT	85	IMB
> 2	*n*	90	7	3	PARK	85	IMB
> 0.9	*p*	90	2		[29] CHERRY	81	HOME
> 0.6	*n*	90	2		[29] CHERRY	81	HOME

[29] We have converted 2 possible events to 90% CL limit.

$\tau(p \to e^+\omega)$ τ_{10}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>107							
>107	***p***	**90**	**7**	**10.8**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 17	*p*	90	0	1.1	BERGER	91	FREJ
> 45	*p*	90	2	1.45	HIRATA	89C	KAMI
> 26	*p*	90	1	1.0	SEIDEL	88	IMB
> 1.5	*p*	90	0		BARTELT	87	SOUD
> 37	*p*	90	6	5.3	HAINES	86	IMB
> 25	*p*	90	1	<1.4	ARISAKA	85	KAMI
> 12	*p* (free)	90	6	7.5	BLEWITT	85	IMB
> 37	*p*	90	6	5.7	BLEWITT	85	IMB
> 0.6	*p*	90	1	0.3	[30] BARTELT	83	SOUD
> 9.8	*p*	90	1		[31] KRISHNA...	82	KOLR
> 2.8	*p*	90	2		[32] CHERRY	81	HOME

[30] Limit based on zero events.
[31] We have calculated 90% CL limit from 0 confined events.
[32] We have converted 2 possible events to 90% CL limit.

$\tau(p \to \mu^+\omega)$ τ_{11}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>117							
>117	***p***	**90**	**11**	**12.1**	MCGREW	99	IMB3

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

> 11	p	90	0	1.0	BERGER	91	FREJ
> 57	p	90	2	1.9	HIRATA	89C	KAMI
> 4.4	p	90	0	0.7	PHILLIPS	89	HPW
> 10	p	90	2	1.3	SEIDEL	88	IMB
> 23	p	90	2	1	HAINES	86	IMB
> 6.5	p (free)	90	9	8.7	BLEWITT	85	IMB
> 23	p	90	8	7	BLEWITT	85	IMB

$\tau(n \to \nu\omega)$ τ_{12}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>108							
>108	**n**	**90**	**12**	**22.5**	MCGREW	99	IMB3

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

> 17	n	90	1	0.7	BERGER	89	FREJ
> 43	n	90	3	2.7	HIRATA	89C	KAMI
> 6	n	90	2	1.3	SEIDEL	88	IMB
> 12	n	90	6	6	HAINES	86	IMB
> 18	n	90	2	2	KAJITA	86	KAMI
> 16	n	90	1	2	PARK	85	IMB
> 2.0	n	90	2		[33] CHERRY	81	HOME

[33] We have converted 2 possible events to 90% CL limit.

$\tau(N \to e^+ K)$ τ_{13}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
> 17							
> 17	**n**	**90**	**35**	**29.4**	MCGREW	99	IMB3
>150	**p**	**90**	**0**	**<0.27**	HIRATA	89C	KAMI

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

> 31	p	90	23	25.2	MCGREW	99	IMB3
> 60	p	90	0		BERGER	91	FREJ
> 70	p	90	0	1.8	SEIDEL	88	IMB
> 77	p	90	5	4.5	HAINES	86	IMB
> 38	p	90	0	<0.8	ARISAKA	85	KAMI
> 24	p (free)	90	7	8.5	BLEWITT	85	IMB
> 77	p	90	5	4	BLEWITT	85	IMB
> 1.3	p	90	0		ALEKSEEV	81	BAKS
> 1.3	n	90	0		ALEKSEEV	81	BAKS

$\tau(p \to e^+ K^0_S)$ τ_{14}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>76	**p**	**90**	**0**	**0.5**	BERGER	91	FREJ

$\tau(p \to e^+ K^0_L)$ τ_{15}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>44	**p**	**90**	**0**	**$\leq$ 0.1**	BERGER	91	FREJ

$\tau(N \to \mu^+ K)$ τ_{16}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>120	**p**	**90**	**4**	**7.2**	MCGREW	99	IMB3
> 26	**n**	**90**	**20**	**28.4**	MCGREW	99	IMB3
>120	**p**	**90**	**1**	**0.4**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 54	p	90	0		BERGER	91	FREJ
> 3.0	p	90	0	0.7	PHILLIPS	89	HPW
> 19	p	90	3	2.5	SEIDEL	88	IMB
> 1.5	p	90	0		[34] BARTELT	87	SOUD
> 1.1	n	90	0		BARTELT	87	SOUD
> 40	p	90	7	6	HAINES	86	IMB
> 19	p	90	1	<1.1	ARISAKA	85	KAMI
> 6.7	p (free)	90	11	13	BLEWITT	85	IMB
> 40	p	90	7	8	BLEWITT	85	IMB
> 6	p	90	1		BATTISTONI	84	NUSX
> 0.6	p	90	0		[35] BARTELT	83	SOUD
> 0.4	n	90	0		[35] BARTELT	83	SOUD
> 5.8	p	90	2		[36] KRISHNA...	82	KOLR
> 2.0	p	90	0		CHERRY	81	HOME
> 0.2	n	90			[37] GURR	67	CNTR

[34] BARTELT 87 limit applies to $p \to \mu^+ K^0_S$.
[35] Limit based on zero events.
[36] We have calculated 90% CL limit from 1 confined event.
[37] We have converted half-life to 90% CL mean life.

$\tau(p \to \mu^+ K^0_S)$ τ_{17}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>64	**p**	**90**	**0**	**1.2**	BERGER	91	FREJ

$\tau(p \to \mu^+ K^0_L)$ τ_{18}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>44	**p**	**90**	**0**	**≤ 0.1**	BERGER	91	FREJ

$\tau(N \to \nu K)$ τ_{19}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>670							
>670	**p**	**90**			HAYATO	99	SKAM
> 86	**n**	**90**	**0**	**2.4**	HIRATA	89C	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>151	p	90	15	21.4	MCGREW	99	IMB3
> 30	n	90	34	34.1	MCGREW	99	IMB3

$>$ 43	p	90	1	1.54	[38] ALLISON	98	SOU2
$>$ 15	n	90	1	1.8	BERGER	89	FREJ
$>$ 15	p	90	1	1.8	BERGER	89	FREJ
$>$100	p	90	9	7.3	HIRATA	89C	KAMI
$>$ 0.28	p	90	0	0.7	PHILLIPS	89	HPW
$>$ 0.3	p	90	0		BARTELT	87	SOUD
$>$ 0.75	n	90	0		[39] BARTELT	87	SOUD
$>$ 10	p	90	6	5	HAINES	86	IMB
$>$ 15	n	90	3	5	HAINES	86	IMB
$>$ 28	p	90	3	3	KAJITA	86	KAMI
$>$ 32	n	90	0	1.4	KAJITA	86	KAMI
$>$ 1.8	p (free)	90	6	11	BLEWITT	85	IMB
$>$ 9.6	p	90	6	5	BLEWITT	85	IMB
$>$ 10	n	90	2	2	PARK	85	IMB
$>$ 5	n	90	0		BATTISTONI	84	NUSX
$>$ 2	p	90	0		BATTISTONI	84	NUSX
$>$ 0.3	n	90	0		[40] BARTELT	83	SOUD
$>$ 0.1	p	90	0		[40] BARTELT	83	SOUD
$>$ 5.8	p	90	1		[41] KRISHNA...	82	KOLR
$>$ 0.3	n	90	2		[42] CHERRY	81	HOME

[38] This ALLISON 98 limit is with no background subtraction; with subtraction the limit becomes $> 46 \times 10^{30}$ years.
[39] BARTELT 87 limit applies to $n \to \nu K^0_S$.
[40] Limit based on zero events.
[41] We have calculated 90% CL limit from 1 confined event.
[42] We have converted 2 possible events to 90% CL limit.

$\tau(p \to e^+ K^*(892)^0)$ τ_{20}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>84							
>84	***p***	**90**	**38**	**52.0**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>10	p	90	0	0.8	BERGER	91	FREJ
>52	p	90	2	1.55	HIRATA	89C	KAMI
>10	p	90	1	<1	ARISAKA	85	KAMI

$\tau(N \to \nu K^*(892))$ τ_{21}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>51							
>51	***p***	**90**	**7**	**9.1**	MCGREW	99	IMB3
>78	***n***	**90**	**40**	**50**	MCGREW	99	IMB3

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

>22	n	90	0	2.1	BERGER	89	FREJ
>17	p	90	0	2.4	BERGER	89	FREJ
>20	p	90	5	2.1	HIRATA	89C	KAMI
>21	n	90	4	2.4	HIRATA	89C	KAMI
>10	p	90	7	6	HAINES	86	IMB
> 5	n	90	8	7	HAINES	86	IMB
> 8	p	90	3	2	KAJITA	86	KAMI
> 6	n	90	2	1.6	KAJITA	86	KAMI
> 5.8	p (free)	90	10	16	BLEWITT	85	IMB
> 9.6	p	90	7	6	BLEWITT	85	IMB
> 7	n	90	1	4	PARK	85	IMB
> 2.1	p	90	1		[43] BATTISTONI	82	NUSX

[43] We have converted 1 possible event to 90% CL limit.

Antilepton + mesons

$\tau(p \to e^+ \pi^+ \pi^-)$ — τ_{22}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>82							
>82	**p**	**90**	**16**	**23.1**	MCGREW	99	IMB3

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

>21	p	90	0	2.2	BERGER	91	FREJ

$\tau(p \to e^+ \pi^0 \pi^0)$ — τ_{23}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>147							
>147	**p**	**90**	**2**	**0.8**	MCGREW	99	IMB3

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

> 38	p	90	1	0.5	BERGER	91	FREJ

$\tau(n \to e^+ \pi^- \pi^0)$ — τ_{24}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>52							
>52	**n**	**90**	**38**	**34.2**	MCGREW	99	IMB3

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

>32	n	90	1	0.8	BERGER	91	FREJ

$\tau(p \to \mu^+ \pi^+ \pi^-)$ — τ_{25}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>133							
>133	**p**	**90**	**25**	**38.0**	MCGREW	99	IMB3

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

> 17	p	90	1	2.6	BERGER	91	FREJ
> 3.3	p	90	0	0.7	PHILLIPS	89	HPW

$\tau(p \to \mu^+ \pi^0 \pi^0)$ τ_{26}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>101							
>101	***p***	**90**	**3**	**1.6**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 33	*p*	90	1	0.9	BERGER	91	FREJ

$\tau(n \to \mu^+ \pi^- \pi^0)$ τ_{27}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>74							
>74	***n***	**90**	**17**	**20.8**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>33	*n*	90	0	1.1	BERGER	91	FREJ

$\tau(n \to e^+ K^0 \pi^-)$ τ_{28}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>18	***n***	**90**	**1**	**0.2**	BERGER	91	FREJ

Lepton + meson

$\tau(n \to e^- \pi^+)$ τ_{29}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>65	***n***	**90**	**0**	**1.6**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>55	*n*	90	0	1.09	BERGER	91B	FREJ
>16	*n*	90	9	7	HAINES	86	IMB
>25	*n*	90	2	4	PARK	85	IMB

$\tau(n \to \mu^- \pi^+)$ τ_{30}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>49	***n***	**90**	**0**	**0.5**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>33	*n*	90	0	1.40	BERGER	91B	FREJ
> 2.7	*n*	90	0	0.7	PHILLIPS	89	HPW
>25	*n*	90	7	6	HAINES	86	IMB
>27	*n*	90	2	3	PARK	85	IMB

$\tau(n \to e^- \rho^+)$ τ_{31}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>62	***n***	**90**	**2**	**4.1**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>12	*n*	90	13	6	HAINES	86	IMB
>12	*n*	90	5	3	PARK	85	IMB

$\tau(n \rightarrow \mu^- \rho^+)$ — τ_{32}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>7	***n***	**90**	**1**	**1.1**	SEIDEL	88	IMB
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>2.6	*n*	90	0	0.7	PHILLIPS	89	HPW
>9	*n*	90	7	5	HAINES	86	IMB
>9	*n*	90	2	2	PARK	85	IMB

$\tau(n \rightarrow e^- K^+)$ — τ_{33}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>32	***n***	**90**	**3**	**2.96**	BERGER	91B	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 0.23	*n*	90	0	0.7	PHILLIPS	89	HPW

$\tau(n \rightarrow \mu^- K^+)$ — τ_{34}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>57	***n***	**90**	**0**	**2.18**	BERGER	91B	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 4.7	*n*	90	0	0.7	PHILLIPS	89	HPW

Lepton + mesons

$\tau(p \rightarrow e^- \pi^+ \pi^+)$ — τ_{35}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>30	***p***	**90**	**1**	**2.50**	BERGER	91B	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 2.0	*p*	90	0	0.7	PHILLIPS	89	HPW

$\tau(n \rightarrow e^- \pi^+ \pi^0)$ — τ_{36}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>29	***n***	**90**	**1**	**0.78**	BERGER	91B	FREJ

$\tau(p \rightarrow \mu^- \pi^+ \pi^+)$ — τ_{37}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>17	***p***	**90**	**1**	**1.72**	BERGER	91B	FREJ
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 7.8	*p*	90	0	0.7	PHILLIPS	89	HPW

$\tau(n \rightarrow \mu^- \pi^+ \pi^0)$ — τ_{38}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>34	***n***	**90**	**0**	**0.78**	BERGER	91B	FREJ

$\tau(p \to e^- \pi^+ K^+)$ τ_{39}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>75							
>75	***p***	**90**	**81**	**127.2**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>20	*p*	90	3	2.50	BERGER	91B	FREJ

$\tau(p \to \mu^- \pi^+ K^+)$ τ_{40}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>245							
>245	***p***	**90**	**3**	**4.0**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 5	*p*	90	2	0.78	BERGER	91B	FREJ

Antilepton + photon(s)

$\tau(p \to e^+ \gamma)$ τ_{41}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>670							
>670	***p***	**90**	**0**	**0.1**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>133	*p*	90	0	0.3	BERGER	91	FREJ
>460	*p*	90	0	0.6	SEIDEL	88	IMB
>360	*p*	90	0	0.3	HAINES	86	IMB
> 87	*p* (free)	90	0	0.2	BLEWITT	85	IMB
>360	*p*	90	0	0.2	BLEWITT	85	IMB
> 0.1	*p*	90			[44] GURR	67	CNTR

[44] We have converted half-life to 90% CL mean life.

$\tau(p \to \mu^+ \gamma)$ τ_{42}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>478							
>478	***p***	**90**	**0**	**0.1**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>155	*p*	90	0	0.1	BERGER	91	FREJ
>380	*p*	90	0	0.5	SEIDEL	88	IMB
> 97	*p*	90	3	2	HAINES	86	IMB
> 61	*p* (free)	90	0	0.2	BLEWITT	85	IMB
>280	*p*	90	0	0.6	BLEWITT	85	IMB
> 0.3	*p*	90			[45] GURR	67	CNTR

[45] We have converted half-life to 90% CL mean life.

$\tau(n \rightarrow \nu\gamma)$ — τ_{43}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>28							
>28	***n***	**90**	**163**	**144.7**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>24	*n*	90	10	6.86	BERGER	91B	FREJ
> 9	*n*	90	73	60	HAINES	86	IMB
>11	*n*	90	28	19	PARK	85	IMB

$\tau(p \rightarrow e^+\gamma\gamma)$ — τ_{44}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>100	***p***	**90**	**1**	**0.8**	BERGER	91	FREJ

$\tau(n \rightarrow \nu\gamma\gamma)$ — τ_{45}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>219	***n***	**90**	**5**	**7.5**	MCGREW	99	IMB3

Three (or more) leptons

$\tau(p \rightarrow e^+e^+e^-)$ — τ_{46}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>793							
>793	***p***	**90**	**0**	**0.5**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>147	*p*	90	0	0.1	BERGER	91	FREJ
>510	*p*	90	0	0.3	HAINES	86	IMB
> 89	*p* (free)	90	0	0.5	BLEWITT	85	IMB
>510	*p*	90	0	0.7	BLEWITT	85	IMB

$\tau(p \rightarrow e^+\mu^+\mu^-)$ — τ_{47}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>359							
>359	***p***	**90**	**1**	**0.9**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 81	*p*	90	0	0.16	BERGER	91	FREJ
> 5.0	*p*	90	0	0.7	PHILLIPS	89	HPW

$\tau(p \rightarrow e^+\nu\nu)$ — τ_{48}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>17							
>17	***p***	**90**	**152**	**153.7**	MCGREW	99	IMB3
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>11	*p*	90	11	6.08	BERGER	91B	FREJ

$\tau(n \rightarrow e^+ e^- \nu)$ τ_{49}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>257							
>257	***n***	**90**	**5**	**7.5**	MCGREW	99	IMB3

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

> 74	*n*	90	0	< 0.1	BERGER	91B	FREJ
> 45	*n*	90	5	5	HAINES	86	IMB
> 26	*n*	90	4	3	PARK	85	IMB

$\tau(n \rightarrow \mu^+ e^- \nu)$ τ_{50}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>83							
>83	***n***	**90**	**25**	**29.4**	MCGREW	99	IMB3

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

>47	*n*	90	0	< 0.1	BERGER	91B	FREJ

$\tau(n \rightarrow \mu^+ \mu^- \nu)$ τ_{51}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>79							
>79	***n***	**90**	**100**	**145**	MCGREW	99	IMB3

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

>42	*n*	90	0	1.4	BERGER	91B	FREJ
> 5.1	*n*	90	0	0.7	PHILLIPS	89	HPW
>16	*n*	90	14	7	HAINES	86	IMB
>19	*n*	90	4	7	PARK	85	IMB

$\tau(p \rightarrow \mu^+ e^+ e^-)$ τ_{52}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>529							
>529	***p***	**90**	**0**	**1.0**	MCGREW	99	IMB3

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

> 91	*p*	90	0	≤ 0.1	BERGER	91	FREJ

$\tau(p \rightarrow \mu^+ \mu^+ \mu^-)$ τ_{53}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>675							
>675	***p***	**90**	**0**	**0.3**	MCGREW	99	IMB3

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

>119	*p*	90	0	0.2	BERGER	91	FREJ
> 10.5	*p*	90	0	0.7	PHILLIPS	89	HPW
>190	*p*	90	1	0.1	HAINES	86	IMB
> 44	*p* (free)	90	1	0.7	BLEWITT	85	IMB
>190	*p*	90	1	0.9	BLEWITT	85	IMB
> 2.1	*p*	90	1		[46] BATTISTONI	82	NUSX

[46] We have converted 1 possible event to 90% CL limit.

$\tau(p \to \mu^+ \nu\nu)$ τ_{54}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>21	***p***	**90**	**7**	**11.23**	BERGER	91B	FREJ

$\tau(p \to e^- \mu^+ \mu^+)$ τ_{55}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>6.0	***p***	**90**	**0**	**0.7**	PHILLIPS	89	HPW

$\tau(n \to 3\nu)$ τ_{56}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>0.00049	***n***	**90**	**2**	**2**	[47] SUZUKI	93B	KAMI
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>0.0023	*n*	90			[48] GLICENSTEIN	97	KAMI
>0.00003	*n*	90	11	6.1	[49] BERGER	91B	FREJ
>0.00012	*n*	90	7	11.2	[49] BERGER	91B	FREJ
>0.0005	*n*	90	0		LEARNED	79	RVUE

[47] The SUZUKI 93B limit applies to any of $\nu_e \nu_e \overline{\nu}_e$, $\nu_\mu \nu_\mu \overline{\nu}_\mu$, or $\nu_\tau \nu_\tau \overline{\nu}_\tau$.

[48] GLICENSTEIN 97 uses Kamioka data and the idea that the disappearance of the neutron's magnetic moment should produce radiation.

[49] The first BERGER 91B limit is for $n \to \nu_e \nu_e \overline{\nu}_e$, the second is for $n \to \nu_\mu \nu_\mu \overline{\nu}_\mu$.

$\tau(n \to 5\nu)$ τ_{57}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>0.0017	*n*	90			[50] GLICENSTEIN	97	KAMI

[50] GLICENSTEIN 97 uses Kamioka data and the idea that the disappearance of the neutron's magnetic moment should produce radiation.

Inclusive modes

$\tau(N \to e^+ \text{anything})$ τ_{58}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>0.6	***p, n***	**90**			[51] LEARNED	79	RVUE

[51] The electron may be primary or secondary.

$\tau(N \to \mu^+ \text{anything})$ τ_{59}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>12	***p, n***	**90**	**2**		[52,53] CHERRY	81	HOME
• • • We do not use the following data for averages, fits, limits, etc. • • •							
> 1.8	*p, n*	90			[53] COWSIK	80	CNTR
> 6	*p, n*	90			[53] LEARNED	79	RVUE

[52] We have converted 2 possible events to 90% CL limit.

[53] The muon may be primary or secondary.

$\tau(N \rightarrow \nu\,\text{anything})$ — τ_{60}

Anything = π, ρ, K, etc.

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>0.0002	p, n	90	0		LEARNED	79	RVUE

$\tau(N \rightarrow e^+\pi^0\,\text{anything})$ — τ_{61}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
>0.6	**p, n**	**90**	**0**		LEARNED	79	RVUE

$\tau(N \rightarrow 2\,\text{bodies}, \nu\text{-free})$ — τ_{62}

LIMIT (10^{30} years)	PARTICLE	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •							
>1.3	p, n	90	0		ALEKSEEV	81	BAKS

$\Delta B = 2$ dinucleon modes

$\tau(pp \rightarrow \pi^+\pi^+)$ — τ_{63}

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>0.7	**90**	**4**	**2.34**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pn \rightarrow \pi^+\pi^0)$ — τ_{64}

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>2.0	**90**	**0**	**0.31**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(nn \rightarrow \pi^+\pi^-)$ — τ_{65}

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>0.7	**90**	**4**	**2.18**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(nn \rightarrow \pi^0\pi^0)$ — τ_{66}

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>3.4	**90**	**0**	**0.78**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pp \rightarrow e^+e^+)$ — τ_{67}

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>5.8	**90**	**0**	**<0.1**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pp \rightarrow e^+\mu^+)$ — τ_{68}

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>3.6	**90**	**0**	**<0.1**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pp \to \mu^+ \mu^+)$ — τ_{69}

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>1.7	**90**	**0**	**0.62**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pn \to e^+ \overline{\nu})$ — τ_{70}

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>2.8	**90**	**5**	**9.67**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(pn \to \mu^+ \overline{\nu})$ — τ_{71}

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>1.6	**90**	**4**	**4.37**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(nn \to \nu_e \overline{\nu}_e)$ — τ_{72}

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>0.000012	**90**	**5**	**9.7**	BERGER	91B	FREJ	τ per iron nucleus

$\tau(nn \to \nu_\mu \overline{\nu}_\mu)$ — τ_{73}

LIMIT (10^{30} years)	CL%	EVTS	BKGD EST	DOCUMENT ID		TECN	COMMENT
>0.000006	**90**	**4**	**4.4**	BERGER	91B	FREJ	τ per iron nucleus

$\overline{p}$ PARTIAL MEAN LIVES

The "partial mean life" limits tabulated here are the limits on $\overline{\tau}/B_i$, where $\overline{\tau}$ is the total mean life for the antiproton and B_i is the branching fraction for the mode in question.

$\tau(\overline{p} \to e^- \gamma)$ — τ_{74}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
> 7×10^5 (CL = 90%)					
> 7×10^5	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
>1848	95	GEER	94	CALO	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to \mu^- \gamma)$ — τ_{75}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>5 $\times 10^4$	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$>5.0 \times 10^4$	90	HU	98B	APEX	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to e^- \pi^0)$ — τ_{76}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
> 4×10^5 (CL = 90%)					
> 4×10^5	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
>554	95	GEER	94	CALO	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to \mu^- \pi^0)$ — τ_{77}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>5 × 10⁴	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$>4.8 \times 10^4$	90	HU	98B	APEX	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to e^- \eta)$ — τ_{78}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
> 2 × 10⁴ (CL = 90%)					
> 2 × 10⁴	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
>171	95	GEER	94	CALO	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to \mu^- \eta)$ — τ_{79}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>8 × 10³	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$>7.9 \times 10^3$	90	HU	98B	APEX	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to e^- K^0_S)$ — τ_{80}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>900 (CL = 90%)					
>900	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
> 29	95	GEER	94	CALO	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to \mu^- K^0_S)$ — τ_{81}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>4 × 10³	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$>4.3 \times 10^3$	90	HU	98B	APEX	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to e^- K^0_L)$ — τ_{82}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>9 × 10³ (CL = 90%)					
>9 × 10³	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
>9	95	GEER	94	CALO	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to \mu^- K^0_L)$ — τ_{83}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>7 × 10³	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$>6.5 \times 10^3$	90	HU	98B	APEX	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to e^- \gamma\gamma)$ τ_{84}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
$>2 \times 10^4$	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to \mu^- \gamma\gamma)$ τ_{85}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
$>2 \times 10^4$	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$>2.3 \times 10^4$	90	HU	98B	APEX	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to e^- \rho)$ τ_{86}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
>200	90	[54] GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam

[54] This GEER 00 measurement has been withdrawn (APEX Collaboration, private communication).

$\tau(\overline{p} \to e^- \omega)$ τ_{87}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
>200	90	GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam

$\tau(\overline{p} \to e^- K^*(892)^0)$ τ_{88}

VALUE (years)	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$>1 \times 10^3$	90	[55] GEER	00	APEX	8.9 GeV/c $\overline{p}$ beam

[55] This GEER 00 measurement has been withdrawn (APEX Collaboration, private communication).

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BERGER	91B	PL B269 227	C. Berger *et al.*	(FREJUS Collab.)
FEDERSPIEL	91	PRL 67 1511	F.J. Federspiel *et al.*	(ILL)
BECKER-SZ...	90	PR D42 2974	R.A. Becker-Szendy *et al.*	(IMB-3 Collab.)
ERICSON	90	EPL 11 295	T.E.O. Ericson, A. Richter	(CERN, DARM)
GABRIELSE	90	PRL 65 1317	G. Gabrielse *et al.*	(HARV, MANZ, WASH+)
BERGER	89	NP B313 509	C. Berger *et al.*	(FREJUS Collab.)
CHO	89	PRL 63 2559	D. Cho, K. Sangster, E.A. Hinds	(YALE)

HIRATA	89C	PL B220 308	K.S. Hirata *et al.*	(Kamiokande Collab.)
PHILLIPS	89	PL B224 348	T.J. Phillips *et al.*	(HPW Collab.)
KREISSL	88	ZPHY C37 557	A. Kreissl *et al.*	(CERN PS176 Collab.)
SEIDEL	88	PRL 61 2522	S. Seidel *et al.*	(IMB Collab.)
BARTELT	87	PR D36 1990	J.E. Bartelt *et al.*	(Soudan Collab.)
Also	89	PR D40 1701 erratum	J.E. Bartelt *et al.*	(Soudan Collab.)
COHEN	87	RMP 59 1121	E.R. Cohen, B.N. Taylor	(RISC, NBS)
HAINES	86	PRL 57 1986	T.J. Haines *et al.*	(IMB Collab.)
KAJITA	86	JPSJ 55 711	T. Kajita *et al.*	(Kamiokande Collab.)
ARISAKA	85	JPSJ 54 3213	K. Arisaka *et al.*	(Kamiokande Collab.)
BLEWITT	85	PRL 55 2114	G.B. Blewitt *et al.*	(IMB Collab.)
DZUBA	85	PL 154B 93	V.A. Dzuba, V.V. Flambaum, P.G. Silvestrov	(NOVO)
PARK	85	PRL 54 22	H.S. Park *et al.*	(IMB Collab.)
BATTISTONI	84	PL 133B 454	G. Battistoni *et al.*	(NUSEX Collab.)
MARINELLI	84	PL 137B 439	M. Marinelli, G. Morpurgo	(GENO)
WILKENING	84	PR A29 425	Wilkening, Ramsey, Larson	(HARV, VIRG)
BARTELT	83	PRL 50 651	J.E. Bartelt *et al.*	(MINN, ANL)
BATTISTONI	82	PL 118B 461	G. Battistoni *et al.*	(NUSEX Collab.)
KRISHNA...	82	PL 115B 349	M.R. Krishnaswamy *et al.*	(TATA, OSKC+)
ALEKSEEV	81	JETPL 33 651	E.N. Alekseev *et al.*	(PNPI)
		Translated from ZETFP 33 664.		
CHERRY	81	PRL 47 1507	M.L. Cherry *et al.*	(PENN, BNL)
COWSIK	80	PR D22 2204	R. Cowsik, V.S. Narasimham	(TATA)
BELL	79	PL 86B 215	M. Bell *et al.*	(CERN)
GOLDEN	79	PRL 43 1196	R.L. Golden *et al.*	(NASA, PSLL)
LEARNED	79	PRL 43 907	J.G. Learned, F. Reines, A. Soni	(UCI)
BREGMAN	78	PL 78B 174	M. Bregman *et al.*	(CERN)
ROBERTS	78	PR D17 358	B.L. Roberts	(WILL, RHEL)
EVANS	77	Science 197 989	J.C. Evans Jr., R.I. Steinberg	(BNL, PENN)
HU	75	NP A254 403	E. Hu *et al.*	(COLU, YALE)
COHEN	73	JPCRD 2 663	E.R. Cohen, B.N. Taylor	(RISC, NBS)
DYLLA	73	PR A7 1224	H.F. Dylla, J.G. King	(MIT)
DIX	70	Thesis Case	F.W. Dix	(CASE)
HARRISON	69	PRL 22 1263	G.E. Harrison, P.G.H. Sandars, S.J. Wright	(OXF)
GURR	67	PR 158 1321	H.S. Gurr *et al.*	(CASE, WITW)
FLEROV	58	DOKL 3 79	Flerov *et al.*	(ASCI)