References

1. See, for example, D.H. Perkins, Ann. Rev. Nucl. and Part. Sci. **34**, 1 (1984).
2. H. Georgi and S.L. Glashow, Phys. Rev. Lett. **32**, 438 (1974).
3. M. Goldhaber and W.J. Marciano, Comm. Nucl. Part. Phys. **16**, 23 (1986);
   W.J. Marciano, in *Proceedings of the 8th Workshop on Grand Unification*, Syracuse, 1987, ed. K.C. Wali (World Scientific, Singapore, 1988), p. 185.

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 × 10^{25}	***p, n***	[8,9] EVANS	77	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
>3 × 10^{23}	p	[9] DIX	70	CNTR
>3 × 10^{23}	p, n	[9,10] FLEROV	58	

[8] Mean lifetime of nucleons in ^{130}Te nuclei.
[9] Converted to mean life by dividing half-life by ln(2) = 0.693.
[10] 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 × 10^{7}			GOLDEN	79	SPEC	$\overline{p}/p$, cosmic rays
>3.7 × 10^{-3}			BREGMAN	78	CNTR	Storage ring

p DECAY MODES

For N decays, p and n distinguish proton and neutron partial lifetimes. See also the "Note on Proton Mean Life Limits" in these Full Listings.

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	$N \to e^+\pi$	> 130 (n), > 550 (p)	90%
τ_2	$N \to \mu^+\pi$	> 100 (n), > 270 (p)	90%
τ_3	$N \to \nu\pi$	> 100 (n), > 25 (p)	90%
τ_4	$p \to e^+\eta$	> 140	90%
τ_5	$p \to \mu^+\eta$	> 69	90%
τ_6	$n \to \nu\eta$	> 54	90%
τ_7	$N \to e^+\rho$	> 58 (n), > 75 (p)	90%
τ_8	$N \to \mu^+\rho$	> 23 (n), > 110 (p)	90%
τ_9	$N \to \nu\rho$	> 19 (n), > 27 (p)	90%
τ_{10}	$p \to e^+\omega$	> 45	90%
τ_{11}	$p \to \mu^+\omega$	> 57	90%
τ_{12}	$n \to \nu\omega$	> 43	90%
τ_{13}	$N \to e^+K$	> 1.3 (n), > 150 (p)	90%
τ_{14}	$p \to e^+K^0_S$	> 76	90%
τ_{15}	$p \to e^+K^0_L$	> 44	90%
τ_{16}	$N \to \mu^+K$	> 1.1 (n), > 120 (p)	90%
τ_{17}	$p \to \mu^+K^0_S$	> 64	90%
τ_{18}	$p \to \mu^+K^0_L$	> 44	90%
τ_{19}	$N \to \nu K$	> 86 (n), > 100 (p)	90%
τ_{20}	$p \to e^+K^*(892)^0$	> 52	90%
τ_{21}	$N \to \nu K^*(892)$	> 22 (n), > 20 (p)	90%
	Antilepton + mesons		
τ_{22}	$p \to e^+\pi^+\pi^-$	> 21	90%
τ_{23}	$p \to e^+\pi^0\pi^0$	> 38	90%
τ_{24}	$n \to e^+\pi^-\pi^0$	> 32	90%
τ_{25}	$p \to \mu^+\pi^+\pi^-$	> 17	90%
τ_{26}	$p \to \mu^+\pi^0\pi^0$	> 33	90%
τ_{27}	$n \to \mu^+\pi^-\pi^0$	> 33	90%
τ_{28}	$n \to e^+K^0\pi^-$	> 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}	$p \to e^-\pi^+K^+$	> 20	90%
τ_{40}	$p \to \mu^-\pi^+K^+$	> 5	90%
	Antilepton + photon(s)		
τ_{41}	$p \to e^+\gamma$	> 460	90%
τ_{42}	$p \to \mu^+\gamma$	> 380	90%
τ_{43}	$n \to \nu\gamma$	> 24	90%
τ_{44}	$p \to e^+\gamma\gamma$	> 100	90%
	Three leptons		
τ_{45}	$p \to e^+e^+e^-$	> 510	90%
τ_{46}	$p \to e^+\mu^+\mu^-$	> 81	90%
τ_{47}	$p \to e^+\nu\nu$	> 11	90%
τ_{48}	$n \to e^+e^-\nu$	> 74	90%
τ_{49}	$n \to \mu^+e^-\nu$	> 47	90%
τ_{50}	$n \to \mu^+\mu^-\nu$	> 42	90%
τ_{51}	$p \to \mu^+e^+e^-$	> 91	90%
τ_{52}	$p \to \mu^+\mu^+\mu^-$	> 190	90%
τ_{53}	$p \to \mu^+\nu\nu$	> 21	90%
τ_{54}	$p \to e^-\mu^+\mu^+$	> 6	90%
τ_{55}	$n \to 3\nu$	> 0.0005	90%
	Inclusive modes		
τ_{56}	$N \to e^+$anything	> 0.6 (n, p)	90%
τ_{57}	$N \to \mu^+$anything	> 12 (n, p)	90%
τ_{58}	$N \to \nu$anything		
τ_{59}	$N \to e^+\pi^0$anything	> 0.6 (n, p)	90%
τ_{60}	$N \to$ 2 bodies, ν-free		
	$\Delta B = 2$ dinucleon modes		
	The following are lifetime limits per iron nucleus.		
τ_{61}	$pp \to \pi^+\pi^+$	> 0.7	90%
τ_{62}	$pn \to \pi^+\pi^0$	> 2	90%
τ_{63}	$nn \to \pi^+\pi^-$	> 0.7	90%
τ_{64}	$nn \to \pi^0\pi^0$	> 3.4	90%
τ_{65}	$pp \to e^+e^+$	> 5.8	90%
τ_{66}	$pp \to e^+\mu^+$	> 3.6	90%
τ_{67}	$pp \to \mu^+\mu^+$	> 1.7	90%
τ_{68}	$pn \to e^+\overline{\nu}$	> 2.8	90%
τ_{69}	$pn \to \mu^+\overline{\nu}$	> 1.6	90%
τ_{70}	$nn \to \nu_e\overline{\nu}_e$	> 0.000012	90%
τ_{71}	$nn \to \nu_\mu\overline{\nu}_\mu$	> 0.000006	90%

$\overline{p}$ DECAY MODES

	Mode	Partial mean life (years)	Confidence level
τ_{72}	$\overline{p} \to e^-\gamma$	> 1848	95%
τ_{73}	$\overline{p} \to e^-\pi^0$	> 554	95%
τ_{74}	$\overline{p} \to e^-\eta$	> 171	95%
τ_{75}	$\overline{p} \to e^-K^0_S$	> 29	95%
τ_{76}	$\overline{p} \to e^-K^0_L$	> 9	95%