N BARYONS
$(S = 0,\ I = 1/2)$

p, $N^+ = uud$; n, $N^0 = udd$

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 = 931.49432±0.00028 MeV, involves the relatively poorly known electronic charge.

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

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

$\overline{p}$ MASS

See, however, the next entry in the Listings, which establishes the $\overline{p}$ mass much more precisely.

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
938.22 ±0.04 OUR AVERAGE				
938.30 ±0.13	ROBERTS	78	CNTR	
938.229±0.049	ROBERSON	77	CNTR	
938.179±0.058	HU	75	CNTR	Exotic atoms
938.3 ±0.5	BAMBERGER	70	CNTR	

$\overline{p}/p$ MASS RATIO, $m_{\overline{p}}/m_p$

A test of *CPT* invariance. GABRIELSE 90 below measures the ratio of *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*
0.999999977±0.000000042	[2] GABRIELSE	90	TRAP	Penning trap

[2] 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. We use the CODATA values of the proton and electron masses (they come from an overall fit to a variety of data on the fundamental constants) and don't try to take into account more recent measurements involving the masses.

$(m_p - m_{\overline{p}})\ /\ m_{\text{average}}$

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

VALUE	*DOCUMENT ID*
$(2\pm4) \times 10^{-8}$ OUR EVALUATION	

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

A test of *CPT* invariance. See also a similar test involving the electron.

VALUE	*DOCUMENT ID*		*TECN*
$<2 \times 10^{-5}$	[3] HUGHES	92	RVUE

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

$|q_p + q_e|/e$

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

VALUE (units 10^{-21})	*DOCUMENT ID*		*COMMENT*
<1.0	[4] DYLLA	73	Neutrality of SF_6
• • • We do not use the following data for averages, fits, limits, etc. • • •			
<0.8	MARINELLI	84	Magnetic levitation

[4] 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*
2.792847386±0.000000063	COHEN	87	RVUE	1986 CODATA value
• • • We do not use the following data for averages, fits, limits, etc. • • •				
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

$(\mu_p - |\mu_{\overline{p}}|)\ /\ |\mu_{\text{average}}|$

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

VALUE	*DOCUMENT ID*
$(-2.6\pm2.9) \times 10^{-3}$ 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		[5] WILKENING	84		
900 ±1400		[6] WILKENING	84		
700 ± 900	1G	HARRISON	69	MBR	Molecular beam

[5] This WILKENING 84 value includes a finite-size effect and a magnetic effect.
[6] 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*
10.2 ±0.9 OUR AVERAGE				
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	[7] FEDERSPIEL	91	CNTR	γp Compton scattering

[7] 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 $(7.0\pm2.2\pm1.3)\times10^{-4}$ 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.

VALUE (10^{-4} fm^3)	*DOCUMENT ID*		*TECN*	*COMMENT*
4.0 ±0.9 OUR AVERAGE				
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

NOTE ON NUCLEON DECAY

(by K. Nakamura, Institute for Cosmic Ray Research, University of Tokyo)

Although there was a rather long pre-GUT history in the search for nucleon decay [1], modern nucleon-decay experiments have been motivated by the SU(5) Grand Unified Theory of Georgi and Glashow [2]. GUTs provide a simple and elegant framework for the unification of strong, weak, and electromagnetic forces, a natural understanding of the Weinberg angle, an explanation of electric-charge quantization, and, above all, a prediction that the nucleon lifetime is finite.