n

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

We have omitted some results that have been superseded by later experiments. See our earlier editions.

n MASS (atomic mass units u)

The mass is known much more precisely in u (atomic mass units) than in MeV. See the next data block.

VALUE (u)	*DOCUMENT ID*		*TECN*	*COMMENT*
1.00866491560±0.00000000055	MOHR	05	RVUE	2002 CODATA value
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.00866491578±0.00000000055	MOHR	99	RVUE	1998 CODATA value
1.008665904 ±0.000000014	COHEN	87	RVUE	1986 CODATA value

n MASS (MeV)

The mass is known much more precisely in u (atomic mass units) than in MeV. The conversion from u to MeV, 1 u = 931.494043±0.000080 MeV/c^2 (MOHR 05, the 2002 CODATA value), involves the relatively poorly known electronic charge.

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
939.565360±0.000081	MOHR	05	RVUE	2002 CODATA value
• • • We do not use the following data for averages, fits, limits, etc. • • •				
939.565331±0.000037	[1] KESSLER	99	SPEC	$np \to d\gamma$
939.565330±0.000038	MOHR	99	RVUE	1998 CODATA value
939.56565 ±0.00028	[2,3] DIFILIPPO	94	TRAP	Penning trap
939.56563 ±0.00028	COHEN	87	RVUE	1986 CODATA value
939.56564 ±0.00028	[3,4] GREENE	86	SPEC	$np \to d\gamma$
939.5731 ±0.0027	[3] COHEN	73	RVUE	1973 CODATA value

[1] We use the 1998 CODATA u-to-MeV conversion factor (see the heading above) to get this mass in MeV from the much more precisely measured KESSLER 99 value of 1.00866491637 ± 0.00000000082 u.

[2] The mass is known much more precisely in u: m = 1.0086649235 ± 0.0000000023 u. We use the 1986 CODATA conversion factor to get the mass in MeV.

[3] These determinations are not independent of the $m_n - m_p$ measurements below.

[4] The mass is known much more precisely in u: m = 1.008664919 ± 0.000000014 u.

$\overline{n}$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
939.485±0.051	59	[5] CRESTI	86	HBC	$\overline{p}p \to \overline{n}n$

[5] This is a corrected result (see the erratum). The error is statistical. The maximum systematic error is 0.029 MeV.

$(m_n - m_{\overline{n}})/m_n$

A test of *CPT* invariance. Calculated from the n and $\overline{n}$ masses, above.

VALUE	DOCUMENT ID
$(9\pm5)\times10^{-5}$ OUR EVALUATION	

$m_n - m_p$

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
1.2933317±0.0000005	[6] MOHR	05	RVUE	2002 CODATA value
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.2933318±0.0000005	[7] MOHR	99	RVUE	1998 CODATA value
1.293318 ±0.000009	[8] COHEN	87	RVUE	1986 CODATA value
1.2933328±0.0000072	GREENE	86	SPEC	$np \to d\gamma$
1.293429 ±0.000036	COHEN	73	RVUE	1973 CODATA value

[6] Calculated by us from the MOHR 05 ratio $m_n/m_p = 1.00137841870 \pm 0.00000000058$. In u, $m_n - m_p = (1.3884487 \pm 0.0000006) \times 10^{-3}$ u.

[7] Calculated by us from the MOHR 99 ratio $m_n/m_p = 1.00137841887 \pm 0.00000000058$. In u, $m_n - m_p = (1.3884489 \pm 0.0000006) \times 10^{-3}$ u.

[8] Calculated by us from the COHEN 87 ratio $m_n/m_p = 1.001378404 \pm 0.000000009$. In u, $m_n - m_p = 0.001388434 \pm 0.000000009$ u.

n MEAN LIFE

We now compile only direct measurements of the lifetime, not those inferred from decay correlation measurements. For the average, we only use measurements with an error less than 10 s.

The most recent result, that of SEREBROV 05, is so far from other results that it makes no sense to include it in the average. It is up to workers in this field to resolve this issue. Until this major disagreement is understood our present average of 885.7 ± 0.8 s must be suspect.

For an early review, see EROZOLIMSKII 89 and papers that follow it in an issue of NIM devoted to the "Proceedings of the International Workshop on Fundamental Physics with Slow Neutrons" (Grenoble 1989). For later reviews and/or commentary, see FREEDMAN 90, SCHRECKENBACH 92, and PENDLEBURY 93.

Limits on lifetimes for *bound* neutrons are given in the section "p PARTIAL MEAN LIVES."

VALUE (s)	DOCUMENT ID		TECN	COMMENT
885.7± 0.8 OUR AVERAGE				
886.8± 1.2± 3.2	DEWEY	03	CNTR	In-beam n, p trap
885.4± 0.9± 0.4	ARZUMANOV	00	CNTR	UCN double bottle
889.2± 3.0± 3.8	BYRNE	96	CNTR	Penning trap
882.6± 2.7	[9] MAMPE	93	CNTR	Gravitational trap
888.4± 3.1± 1.1	NESVIZHEV...	92	CNTR	Gravitational trap
887.6± 3.0	MAMPE	89	CNTR	Gravitational trap
891 ± 9	SPIVAK	88	CNTR	Beam

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

878.5± 0.7± 0.3	[10] SEREBROV	05	CNTR	Gravitational trap	
888.4± 2.9	ALFIMENKOV	90	CNTR	See NESVIZHEVSKII 92	
893.6± 3.8± 3.7	BYRNE	90	CNTR	See BYRNE 96	
878 ±27 ±14	KOSSAKOW...	89	TPC	Pulsed beam	
877 ±10	PAUL	89	CNTR	Storage ring	
876 ±10 ±19	LAST	88	SPEC	Pulsed beam	
903 ±13	KOSVINTSEV	86	CNTR	Gravitational trap	
937 ±18	[11] BYRNE	80	CNTR		
875 ±95	KOSVINTSEV	80	CNTR		
881 ± 8	BONDAREN...	78	CNTR	See SPIVAK 88	
918 ±14	CHRISTENSEN	72	CNTR		

[9] IGNATOVICH 95 calls into question some of the corrections and averaging procedures used by MAMPE 93. The response, BONDARENKO 96, denies the validity of the criticisms.

[10] This SEREBROV 05 result is 6.5 standard deviations from our average of previous results and 5.6 standard deviations from the previous most precise result (that of ARZUMANOV 00).

[11] This measurement has been withdrawn (J. Byrne, private communication, 1990).

n MAGNETIC MOMENT

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

VALUE (μ_N)	DOCUMENT ID		TECN	COMMENT
−1.91304273±0.00000045	MOHR	05	RVUE	2002 CODATA value

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

−1.91304272±0.00000045	MOHR	99	RVUE	1998 CODATA value
−1.91304275±0.00000045	COHEN	87	RVUE	1986 CODATA value
−1.91304277±0.00000048	[12] GREENE	82	MRS	

[12] GREENE 82 measures the moment to be (1.04187564 ± 0.00000026) × 10^{-3} Bohr magnetons. The value above is obtained by multiplying this by $m_p/m_e = 1836.152701 \pm 0.000037$ (the 1986 CODATA value from COHEN 87).

n ELECTRIC DIPOLE MOMENT

A nonzero value is forbidden by both T invariance and P invariance. A number of early results have been omitted. See RAMSEY 90 and GOLUB 94 for reviews.

VALUE (10^{-25} e cm)	CL%	DOCUMENT ID		TECN	COMMENT
< 0.63	90	[13] HARRIS	99	MRS	$d = (-0.1 \pm 0.36) \times 10^{-25}$

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

< 0.97	90	ALTAREV	96	MRS	$(+0.26 \pm 0.40 \pm 0.16) \times 10^{-25}$
< 1.1	95	ALTAREV	92	MRS	See ALTAREV 96
< 1.2	95	SMITH	90	MRS	See HARRIS 99
< 2.6	95	ALTAREV	86	MRS	$d = (-1.4 \pm 0.6) \times 10^{-25}$
0.3 ±4.8		PENDLEBURY	84	MRS	Ultracold neutrons
< 6	90	ALTAREV	81	MRS	$d = (2.1 \pm 2.4) \times 10^{-25}$
<16	90	ALTAREV	79	MRS	$d = (4.0 \pm 7.5) \times 10^{-25}$

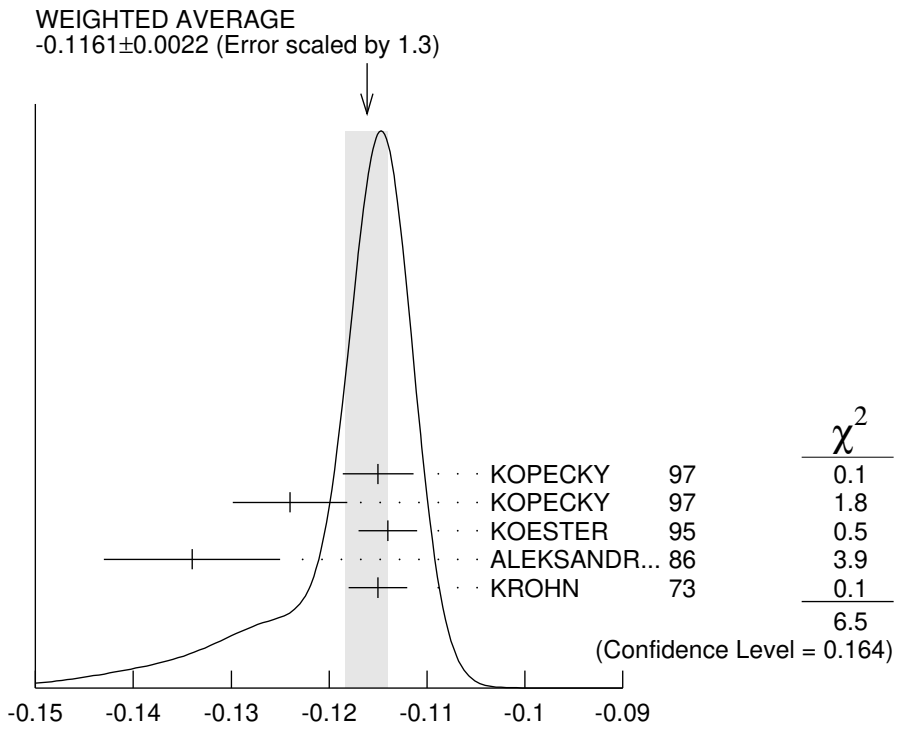
[13] This HARRIS 99 result includes the result of SMITH 90. However, the averaging of the results of these two experiments has been criticized by LAMOREAUX 00.

n MEAN-SQUARE CHARGE RADIUS

The mean-square charge radius of the neutron, $\langle r_n^2 \rangle$, is related to the neutron-electron scattering length b_{ne} by $\langle r_n^2 \rangle = 3(m_e a_0/m_n) b_{ne}$, where m_e and m_n are the masses of the electron and neutron, and a_0 is the Bohr radius. Numerically, $\langle r_n^2 \rangle = 86.34\ b_{ne}$, if we use a_0 for a nucleus with infinite mass.

VALUE (fm^2)	*DOCUMENT ID*		*COMMENT*
-0.1161 ± 0.0022 OUR AVERAGE	Error includes scale factor of 1.3. See the ideogram below.		
$-0.115 \pm 0.002 \pm 0.003$	KOPECKY	97	ne scattering (Pb)
$-0.124 \pm 0.003 \pm 0.005$	KOPECKY	97	ne scattering (Bi)
-0.114 ± 0.003	KOESTER	95	ne scattering (Pb, Bi)
-0.134 ± 0.009	ALEKSANDR...	86	ne scattering (Bi)
-0.115 ± 0.003	[14] KROHN	73	ne scattering (Ne, Ar, Kr, Xe)
• • • We do not use the following data for averages, fits, limits, etc. • • •			
$-0.113 \pm 0.003 \pm 0.004$	KOPECKY	95	ne scattering (Pb)
-0.114 ± 0.003	KOESTER	86	ne scattering (Pb, Bi)
-0.118 ± 0.002	KOESTER	76	ne scattering (Pb)
-0.120 ± 0.002	KOESTER	76	ne scattering (Bi)
-0.116 ± 0.003	KROHN	66	ne scattering (Ne, Ar, Kr, Xe)

[14] This value is as corrected by KOESTER 76.



n ELECTRIC POLARIZABILITY α_n

Following is the electric polarizability α_n defined in terms of the induced electric dipole moment by $\mathbf{D} = 4\pi\epsilon_0\alpha_n\mathbf{E}$. For a review, see SCHMIEDMAYER 89.

VALUE (10^{-4} fm^3)	DOCUMENT ID		TECN	COMMENT
11.6± 1.5 OUR AVERAGE				
$12.5 \pm 1.8^{+1.6}_{-1.3}$	[15] KOSSERT	03	CNTR	$\gamma d \to \gamma pn$
8.8± 2.4±3.0	[16] LUNDIN	03	CNTR	$\gamma d \to \gamma d$
12.0± 1.5±2.0	SCHMIEDM...	91	CNTR	n Pb transmission
$10.7^{+3.3}_{-10.7}$	ROSE	90B	CNTR	$\gamma d \to \gamma np$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
13.6	[17] KOLB	00	CNTR	$\gamma d \to \gamma np$
0.0± 5.0	[18] KOESTER	95	CNTR	n Pb, n Bi transmission
$11.7^{+4.3}_{-11.7}$	ROSE	90	CNTR	See ROSE 90B
8 ±10	KOESTER	88	CNTR	n Pb, n Bi transmission
12 ±10	SCHMIEDM...	88	CNTR	n Pb, n C transmission

[15] KOSSERT 03 gets $\alpha_n - \beta_n = (9.8 \pm 3.6^{+2.1}_{-1.1} \pm 2.2) \times 10^{-4}$ fm^3, and uses $\alpha_n + \beta_n = (15.2 \pm 0.5) \times 10^{-4}$ fm^3 from LEVCHUK 00. Thus the errors on α_n and β_n are anti-correlated.

[16] LUNDIN 03 measures $\alpha_N - \beta_N = (6.4 \pm 2.4) \times 10^{-4}$ fm^3 and uses accurate values for α_p and α_p and a precise sum-rule result for $\alpha_n + \beta_n$. The second error is a model uncertainty, and errors on α_n and β_n are anticorrelated.

[17] KOLB 00 obtains this value with a lower limit of 7.6×10^{-4} fm^3 but no upper limit from this experiment alone. Combined with results of ROSE 90, the 1-σ range is (7.6–14.0) $\times 10^{-4}$ fm^3.

[18] KOESTER 95 uses natural Pb and the isotopes 208, 207, and 206. See this paper for a discussion of methods used by various groups to extract α_n from data.

n MAGNETIC POLARIZABILITY β_n

VALUE (10^{-4} fm^3)	DOCUMENT ID		TECN	COMMENT
3.7±2.0 OUR AVERAGE				
$2.7 \pm 1.8^{+1.3}_{-1.6}$	[19] KOSSERT	03	CNTR	$\gamma d \to \gamma pn$
6.5±2.4±3.0	[20] LUNDIN	03	CNTR	$\gamma d \to \gamma d$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.6	[21] KOLB	00	CNTR	$\gamma d \to \gamma np$

[19] KOSSERT 03 gets $\alpha_n - \beta_n = (9.8 \pm 3.6^{+2.1}_{-1.1} \pm 2.2) \times 10^{-4}$ fm^3, and uses $\alpha_n + \beta_n = (15.2 \pm 0.5) \times 10^{-4}$ fm^3 from LEVCHUK 00. Thus the errors on α_n and β_n are anti-correlated.

[20] LUNDIN 03 measures $\alpha_N - \beta_N = (6.4 \pm 2.4) \times 10^{-4}$ fm^3 and uses accurate values for α_p and α_p and a precise sum-rule result for $\alpha_n + \beta_n$. The second error is a model uncertainty, and errors on α_n and β_n are anticorrelated.

[21] KOLB 00 obtains this value with an upper limit of 7.6×10^{-4} fm^3 but no lower limit from this experiment alone. Combined with results of ROSE 90, the 1-σ range is (1.2–7.6) $\times 10^{-4}$ fm^3.

n CHARGE

See also "$|q_p + q_e|/e$" in the proton Listings.

VALUE (10^{-21} e)	DOCUMENT ID		TECN	COMMENT
$=$ **0.4± 1.1**	[22] BAUMANN	88		Cold n deflection
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-15 ± 22	[23] GAEHLER	82	CNTR	Cold n deflection

[22] The BAUMANN 88 error ± 1.1 gives the 68% CL limits about the the value -0.4.
[23] The GAEHLER 82 error ± 22 gives the 90% CL limits about the the value -15.

LIMIT ON $n\overline{n}$ OSCILLATIONS

Mean Time for $n\overline{n}$ Transition in Vacuum

A test of ΔB=2 baryon number nonconservation. MOHAPATRA 80 and MOHAPATRA 89 discuss the theoretical motivations for looking for $n\overline{n}$ oscillations. DOVER 83 and DOVER 85 give phenomenological analyses. The best limits come from looking for the decay of neutrons bound in nuclei. However, these analyses require model-dependent corrections for nuclear effects. See KABIR 83, DOVER 89, ALBERICO 91, and GAL 00 for discussions. Direct searches for $n \to \overline{n}$ transitions using reactor neutrons are cleaner but give somewhat poorer limits. We include limits for both free and bound neutrons in the Summary Table.

VALUE (s)	CL%	DOCUMENT ID		TECN	COMMENT
$>1.3\times10^{8}$	90	CHUNG	02B	SOU2	n bound in iron
$>8.6\times10^{7}$	90	BALDO-...	94	CNTR	Reactor (free) neutrons
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$>1\times10^{7}$	90	BALDO-...	90	CNTR	See BALDO-CEOLIN 94
$>1.2\times10^{8}$	90	BERGER	90	FREJ	n bound in iron
$>4.9\times10^{5}$	90	BRESSI	90	CNTR	Reactor neutrons
$>4.7\times10^{5}$	90	BRESSI	89	CNTR	See BRESSI 90
$>1.2\times10^{8}$	90	TAKITA	86	CNTR	n bound in oxygen
$>1\times10^{6}$	90	FIDECARO	85	CNTR	Reactor neutrons
$>8.8\times10^{7}$	90	PARK	85B	CNTR	
$>3\times10^{7}$		BATTISTONI	84	NUSX	
$>2.7\times10^{7}$–1.1×10^{8}		JONES	84	CNTR	
$>2\times10^{7}$		CHERRY	83	CNTR	

n DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	$p e^- \overline{\nu}_e$	100 %	
Γ_2	hydrogen-atom $\overline{\nu}_e$		
Γ_3	$p e^- \overline{\nu}_e \gamma$	[a] $< 6.9\times10^{-3}$	90%
	Charge conservation (Q) violating mode		
Γ_4	$p \nu_e \overline{\nu}_e$	Q $< 8\times10^{-27}$	68%

[a] This limit is for γ energies between 35 and 100 keV.

n BRANCHING RATIOS

$\Gamma(\text{hydrogen-atom}\,\overline{\nu}_e)/\Gamma_{\text{total}}$ Γ_2/Γ

VALUE	CL%	DOCUMENT ID		TECN
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$<3\times10^{-2}$	95	[24] GREEN	90	RVUE

[24] GREEN 90 infers that $\tau(\text{hydrogen-atom}\,\overline{\nu}_e) > 3\times10^4$ s by comparing neutron lifetime measurements made in storage experiments with those made in β-decay experiments. However, the result depends sensitively on the lifetime measurements, and does not of course take into account more recent measurements of same.

$\Gamma(p e^-\overline{\nu}_e\gamma)/\Gamma_{\text{total}}$ Γ_3/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<6.9\times10^{-3}$	90	[25] BECK	02	CNTR	Cold n

[25] This BECK 02 limit is for γ energies between 35 and 100 keV.

$\Gamma(p\,\nu_e\overline{\nu}_e)/\Gamma_{\text{total}}$ Γ_4/Γ

Forbidden by charge conservation.

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
$<8\times10^{-27}$	68	[26] NORMAN	96	RVUE	^{71}Ga $\rightarrow$ ^{71}Ge neutrals
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$<9.7\times10^{-18}$	90	ROY	83	CNTR	^{113}Cd $\rightarrow$ ^{113m}In neut.
$<7.9\times10^{-21}$		VAIDYA	83	CNTR	^{87}Rb $\rightarrow$ ^{87m}Sr neut.
$<9\times10^{-24}$	90	BARABANOV	80	CNTR	^{71}Ga $\rightarrow$ ^{71}GeX
$<3\times10^{-19}$		NORMAN	79	CNTR	^{87}Rb $\rightarrow$ ^{87m}Sr neut.

[26] NORMAN 96 gets this limit by attributing SAGE and GALLEX counting rates to the charge-nonconserving transition ^{71}Ga $\rightarrow$ ^{71}Ge+neutrals rather than to solar-neutrino reactions.

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$n \rightarrow p e^-\overline{\nu}_e$ DECAY PARAMETERS

See the above "Note on Baryon Decay Parameters." For discussions of recent results, see the references cited at the beginning of the section on the neutron mean life. For discussions of the values of the weak coupling constants g_A and g_V obtained using the neutron lifetime and asymmetry parameter A, comparisons with other methods of obtaining these constants, and implications for particle physics and for astrophysics, see DUBBERS 91 and WOOLCOCK 91. For tests of the $V-A$ theory of neutron decay, see EROZOLIMSKII 91B and MOSTOVOI 96.

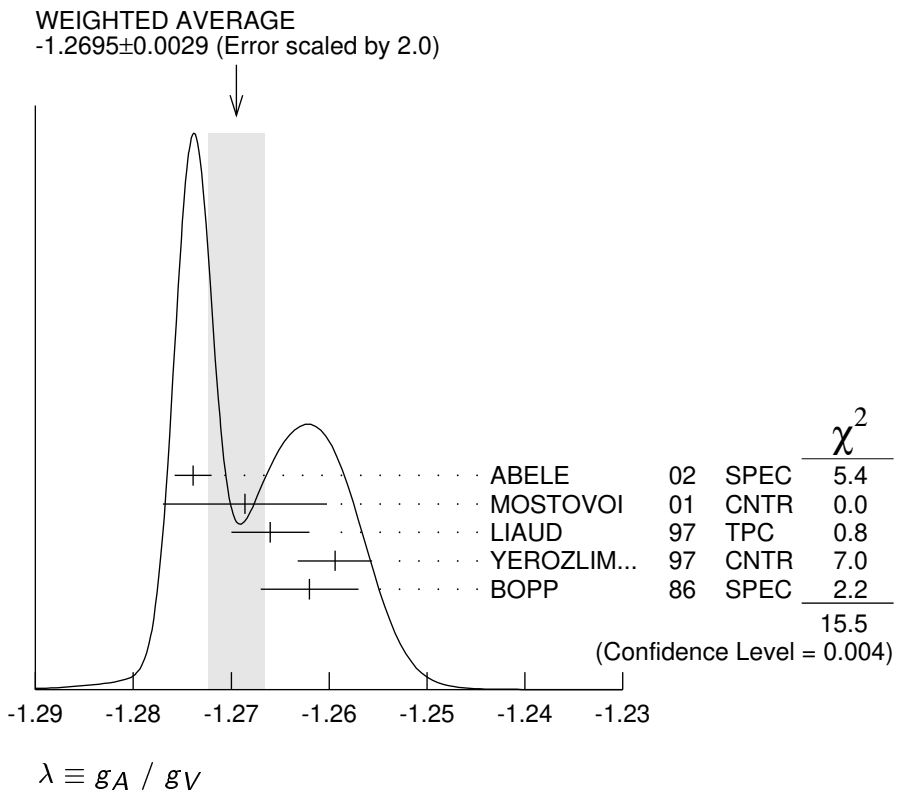
$\lambda \equiv g_A / g_V$

VALUE	DOCUMENT ID		TECN	COMMENT
-1.2695 ± 0.0029 OUR AVERAGE	Error includes scale factor of 2.0. See the ideogram below.			
-1.2739 ± 0.0019	[27] ABELE	02	SPEC	Cold n, polarized, A
$-1.2686\pm0.0046\pm0.007$	[28] MOSTOVOI	01	CNTR	A and $B\times$ polarizations
$-1.266\ \pm0.004$	LIAUD	97	TPC	Cold n, polarized, A
-1.2594 ± 0.0038	[29] YEROZLIM...	97	CNTR	Cold n, polarized, A
$-1.262\ \pm0.005$	BOPP	86	SPEC	Cold n, polarized, A

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

−1.274 ±0.003		ABELE	97D	SPEC	Cold n, polarized, A
−1.266 ±0.004		SCHRECK...	95	TPC	See LIAUD 97
−1.2544 ±0.0036		EROZOLIM...	91	CNTR	See YEROZOLIM-SKY 97
−1.226 ±0.042		MOSTOVOY	83	RVUE	
−1.261 ±0.012		EROZOLIM...	79	CNTR	Cold n, polarized, A
−1.259 ±0.017	[30]	STRATOWA	78	CNTR	p recoil spectrum, a
−1.263 ±0.015		EROZOLIM...	77	CNTR	See EROZOLIMSKII 79
−1.250 ±0.036	[30]	DOBROZE...	75	CNTR	See STRATOWA 78
−1.258 ±0.015	[31]	KROHN	75	CNTR	Cold n, polarized, A
−1.263 ±0.016	[32]	KROPF	74	RVUE	n decay alone
−1.250 ±0.009	[32]	KROPF	74	RVUE	n decay + nuclear ft

[27] This is the combined result of ABELE 02 and ABELE 97D.
[28] MOSTOVOI 01 measures the two P-odd correlations A and B, or rather SA and SB, where S is the n polarization, in free neutron decay.
[29] YEROZOLIMSKY 97 makes a correction to the EROZOLIMSKII 91 value.
[30] These experiments measure the absolute value of g_A/g_V only.
[31] KROHN 75 includes events of CHRISTENSEN 70.
[32] KROPF 74 reviews all data through 1972.

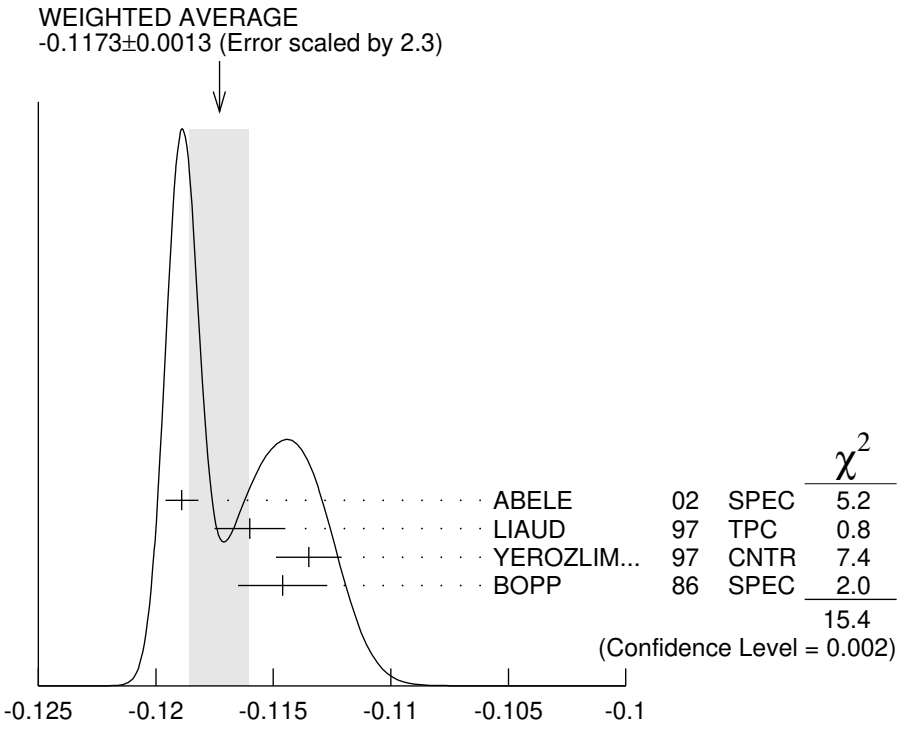


β ASYMMETRY PARAMETER *A*

This is the neutron-spin electron-momentum correlation coefficient. Unless otherwise noted, the values are corrected for radiative effects and weak magnetism.

VALUE	*DOCUMENT ID*		*TECN*	*COMMENT*
-0.1173 ± 0.0013 OUR AVERAGE	Error includes scale factor of 2.3. See the ideogram below.			
-0.1189 ± 0.0007	[33] ABELE	02	SPEC	Cold n, polarized
$-0.1160 \pm 0.0009 \pm 0.0012$	LIAUD	97	TPC	Cold n, polarized
-0.1135 ± 0.0014	[34] YEROZLIM...	97	CNTR	Cold n, polarized
-0.1146 ± 0.0019	BOPP	86	SPEC	Cold n, polarized
• • • We do not use the following data for averages, fits, limits, etc. • • •				
-0.1168 ± 0.0017	[35] MOSTOVOI	01	CNTR	Inferred
-0.1189 ± 0.0012	ABELE	97D	SPEC	Cold n, polarized
$-0.1160 \pm 0.0009 \pm 0.0011$	SCHRECK...	95	TPC	See LIAUD 97
-0.1116 ± 0.0014	EROZOLIM...	91	CNTR	See YEROZOLIM-SKY 97
-0.114 ± 0.005	[36] EROZOLIM...	79	CNTR	Cold n, polarized
-0.113 ± 0.006	[36] KROHN	75	CNTR	Cold n, polarized

[33] This is the combined result of ABELE 02 and ABELE 97D.
[34] YEROZOLIMSKY 97 makes a correction to the EROZOLIMSKII 91 value.
[35] MOSTOVOI 01 calculates this from its measurement of $\lambda = g_A/g_V$ above.
[36] These results are not corrected for radiative effects and weak magnetism, but the corrections are small compared to the errors.



$\overline{\nu}_e$ ASYMMETRY PARAMETER B

This is the neutron-spin antineutrino-momentum correlation coefficient.

VALUE	DOCUMENT ID		TECN	COMMENT
0.983 ±0.004 OUR AVERAGE				
0.9801±0.0046	SEREBROV	98	CNTR	Cold n, polarized
0.9894±0.0083	KUZNETSOV	95	CNTR	Cold n, polarized
0.995 ±0.034	CHRISTENSEN	70	CNTR	Cold n, polarized
1.00 ±0.05	EROZOLIM...	70C	CNTR	Cold n, polarized
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.9876±0.0004	[37] MOSTOVOI	01	CNTR	Inferred

[37] MOSTOVOI 01 calculates this from its measurement of $\lambda=g_A/g_V$ above.

e-$\overline{\nu}_e$ ANGULAR CORRELATION COEFFICIENT a

VALUE	DOCUMENT ID		TECN	COMMENT
−0.103 ±0.004 OUR AVERAGE				
−0.1054±0.0055	BYRNE	02	SPEC	Proton recoil spectrum
−0.1017±0.0051	STRATOWA	78	CNTR	Proton recoil spectrum
−0.091 ±0.039	GRIGOREV	68	SPEC	Proton recoil spectrum
• • • We do not use the following data for averages, fits, limits, etc. • • •				
−0.1045±0.0014	[38] MOSTOVOI	01	CNTR	Inferred

[38] MOSTOVOI 01 calculates this from its measurement of $\lambda=g_A/g_V$ above.

ϕ_{AV}, PHASE OF g_A RELATIVE TO g_V

Time reversal invariance requires this to be 0 or 180°. This is related to D given in the next data block and $\lambda \equiv g_A/g_V$ by $\sin(\phi_{AV}) = D(1+3\lambda^2)/2\lambda$.

VALUE (°)	DOCUMENT ID		TECN	COMMENT
180.06±0.07 OUR AVERAGE				
180.04±0.09	SOLDNER	04	CNTR	Cold n, polarized
180.08±0.13	LISING	00	CNTR	Polarized >93%
179.71±0.39	EROZOLIM...	78	CNTR	Cold n, polarized
180.35±0.43	EROZOLIM...	74	CNTR	Cold n, polarized
180.14±0.22	STEINBERG	74	CNTR	Cold n, polarized
• • • We do not use the following data for averages, fits, limits, etc. • • •				
181.1 ±1.3	[39] KROPF	74	RVUE	n decay

[39] KROPF 74 reviews all data through 1972.

TRIPLE CORRELATION COEFFICIENT D

These are measurements of the component of n spin perpendicular to the decay plane in β decay. Should be zero if T invariance is not violated.

VALUE (units 10^{-4})	DOCUMENT ID		TECN	COMMENT
= 4 ± 6 OUR AVERAGE				
− 2.8± 6.4±3.0	SOLDNER	04	CNTR	Cold n, polarized
− 6 ±12 ±5	LISING	00	CNTR	Polarized >93%
+22 ±30	EROZOLIM...	78	CNTR	Cold n, polarized
−27 ±50	[40] EROZOLIM...	74	CNTR	Cold n, polarized
−11 ±17	STEINBERG	74	CNTR	Cold n, polarized

[40] EROZOLIMSKII 78 says asymmetric proton losses and nonuniform beam polarization may give a systematic error up to 30×10^{-4}, thus increasing the EROZOLIMSKII 74 error to 50×10^{-4}. STEINBERG 74 and STEINBERG 76 estimate these systematic errors to be insignificant in their experiment.

n REFERENCES

We have omitted some papers that have been superseded by later experiments. See our earlier editions.

MOHR	05	RMP 77 1	P.J. Mohr, B.N. Taylor	(NIST)
SEREBROV	05	PL B605 72	A. Serebrov *et al.*	(PNPI, JINR, ILLG)
SOLDNER	04	PL B581 49	T. Soldner *et al.*	(ILLG, MUNT)
DEWEY	03	PRL 91 152302	M.S. Dewey *et al.*	(NIST, TULN, IND+)
KOSSERT	03	EPJ A16 259	K. Kossert *et al.*	(Mainz MAMI Collab.)
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LUNDIN	03	PRL 90 192501	M. Lundin *et al.*	
ABELE	02	PRL 88 211801	H. Abele *et al.*	(PERKEO-II Collab.)
BECK	02	JETPL 76 332	M. Beck *et al.*	(LEUV, SUSS, KIAE, PNPI)
		Translated from ZETFP 76 392.		
BYRNE	02	JPG 28 1325	J. Byrne *et al.*	
CHUNG	02B	PR D66 032004	J. Chung *et al.*	(SOUDAN-2 Collab.)
MOSTOVOI	01	PAN 64 1955	Yu.A. Mostovoi *et al.*	
		Translated from YAF 64 2040.		
ARZUMANOV	00	PL B483 15	S. Arzumanov *et al.*	
GAL	00	PR C61 028201	A. Gal	
KOLB	00	PRL 85 1388	N.R. Kolb *et al.*	
LAMOREAUX	00	PR D61 051301R	S.K. Lamoreaux, R. Golub	
LEVCHUK	00	NP A674 449	M.I. Levchuk, A.I. L'vov	(BELA, LEBD)
LISING	00	PR C62 055501	L.J. Lising *et al.*	(NIST emiT Collab.)
HARRIS	99	PRL 82 904	P.G. Harris *et al.*	
KESSLER	99	PL A255 221	E.G. Kessler Jr *et al.*	
MOHR	99	JPCRD 28 1713	P.J. Mohr, B.N. Taylor	(NIST)
Also	00	RMP 72 351	P.J. Mohr, B.N. Taylor	(NIST)
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		Translated from ZETF 113 1963.		
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KOPECKY	97	PR C56 2229	S. Kopecky *et al.*	
LIAUD	97	NP A612 53	P. Liaud *et al.*	(ILLG, LAPP)
YEROZLIM...	97	PL B412 240	B.G. Erozolimsky *et al.*	(HARV, PNPI, KIAE)
ALTAREV	96	PAN 59 1152	I.S. Altarev *et al.*	(PNPI)
		Translated from YAF 59 1204.		
BONDAREN...	96	JETPL 64 416	L.N. Bondarenko *et al.*	(KIAE)
		Translated from ZETFP 64 382.		
BYRNE	96	EPL 33 187	J. Byrne *et al.*	(SUSS, ILLG)
MOSTOVOI	96	PAN 59 968	Y.A. Mostovoy	(KIAE)
		Translated from YAF 59 1013.		
NORMAN	96	PR D53 4086	E.B. Norman, J.N. Bahcall, M. Goldhaber	(LBL+)
IGNATOVICH	95	JETPL 62 1	V.K. Ignatovich	(JINR)
		Translated from ZETFP 62 3.		
KOESTER	95	PR C51 3363	L. Koester *et al.*	(+)
KOPECKY	95	PRL 74 2427	S. Kopecky *et al.*	
KUZNETSOV	95	PRL 75 794	I.A. Kuznetsov *et al.*	(PNPI, KIAE, HARV+)
SCHRECK...	95	PL B349 427	K. Schreckenbach *et al.*	(MUNT, ILLG, LAPP)
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NESVIZHEV...	92	JETP 75 405	V.V. Nesvizhevsky *et al.*	(PNPI, JINR)
		Translated from ZETF 102 740.		
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DOVER	89	NIM A284 13	C.B. Dover, A. Gal, J.M. Richard	(BNL, HEBR+)
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KABIR	83	PRL 51 231	P.K. Kabir	(HARV)
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