Adopted Levels, Gammas 2017Ke05

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	J. H. Kelley, J. E. Purcell and C. G. Sheu	NP A968,71 (2017)	1-Jan-2017

Q(β^-)=−17338.1 *10*; S(n)=18720.71 *6*; S(p)=15956.68 *1*; Q(α)=−7366.59 *4* 2017Wa10

^{12}C Levels

Cross Reference (XREF) Flags

A	^{12}B β^- decay:20.20 ms	V	^{11}B(^{3}He,^{12}C)	AP	^{12}C(^{14}N,^{14}N)
B	^{12}N β^+ decay:11.000 ms	W	^{11}B(α,t)	AQ	^{12}C(^{16}O,^{12}C)
C	^{6}Li(^{6}Li,γ),(^{6}Li,p),(^{6}Li,n):res	X	^{11}B(^{7}Li,^{6}He)	AR	^{12}C(^{40}Ca,^{12}C)
D	^{6}Li(^{9}Be,t)	Y	^{12}C(γ,γ)	AS	^{13}B β^-n decay:17.30 ms
E	^{9}Be(^{3}He,γ):res	Z	^{12}C(γ,α),(γ,n),(γ,p)	AT	^{13}C(γ,n),^{13}C(e,e′n)
F	^{9}Be(^{3}He,n),(^{3}He,α):res	Others:		AU	^{13}C(π^+,p)
G	^{9}Be(α,n),(α,^{12}C)	AA	^{12}C(e,e′)	AV	^{13}C(p,d)
H	^{9}Be(^{6}Li,t)	AB	^{12}C(e,e′p)	AW	^{13}C(d,t)
I	^{9}Be(^{9}Be,^{6}He)	AC	^{12}C(π,π),(π^-,π^-)	AX	^{13}C(^{3}He,α)
J	^{9}Be(^{10}C,^{12}C)	AD	^{12}C(n,n′)	AY	^{13}C(^{6}Li,^{7}Li),^{13}C(^{7}Li,^{8}Li)
K	^{10}Be(^{3}He,n)	AE	^{12}C(p,p′)	AZ	^{13}O εp decay:8.58 ms
L	^{10}B(d,p),(d,d),(d,α):res	AF	^{12}C(p,p′),(α,α′)	BA	^{14}C(p,t)
M	^{10}B(^{3}He,p)	AG	^{12}C(P,P′α)	BB	^{14}N(p,^{3}He)
N	^{10}B(^{3}He,p3α),^{11}B(^{3}He,D3A)	AH	^{12}C(P,P′P),^{12}C(P,P′α)	BC	^{14}N(d,α)
O	^{10}B(^{6}Li,α)	AI	^{12}C(d,d)	BD	^{15}N(p,α)
P	^{11}B(p,γ):res	AJ	^{12}C(^{3}He,^{3}He)	BE	^{16}N $\beta^-\alpha$ decay
Q	^{11}B(p,n):res	AK	^{12}C(α,α′)	BF	^{16}O(P,P′α)
R	^{11}B(p,p):res	AL	^{12}C(^{6}Li,^{6}Li)	BG	^{16}O(d,^{6}Li)
S	^{11}B(p,α)	AM	^{12}C(^{11}B,^{12}C),(^{11}B,^{11}B)	BH	^{16}O(^{3}He,^{7}Be)
T	^{11}B(d,n)	AN	^{12}C(^{12}C,3α)	BI	^{16}O(α,^{8}Be)
U	^{11}B(^{3}He,d)	AO	^{12}C(^{12}C,^{12}C),(^{12}C,X)		

E(level)	J$^\pi$	T$_{1/2}$	XREF	Comments
0	0$^+$	stable	AB DE GHI K MNOP TU WX Z	XREF: Others: AA, AC, AD, AE, AF, AI, AJ, AK, AL, AM, AO, AP, AQ, AS, AT, AU, AV, AW, AX, AY, AZ, BA, BB, BC, BD, BE, BF, BG, BH, BI T=0; g=2.0010415963 *45* (2002Be82)
4439.82 *21*	2$^+$	10.8×10^{-3} eV *6*	AB DE GHI K MNOP TU WXY	XREF: Others: AA, AC, AD, AE, AF, AI, AJ, AK, AL, AM, AO, AP, AQ, AS, AT, AU, AV, AW, AX, AY, AZ, BA, BB, BC, BD, BF, BG, BH, BI %IT=100 T=0; Q=6 *3* (1983Ve01) E(level): From average of values given in (1967Ch19, 1967Ko14, 1971St22, 1974Jo14, 1974No07, 2016Mu06). The value is dominated by Eγ=4438.91 keV *31* in (1967Ch19). Γ: From average of (1958Ra14,1967Cr01,1968Ri16,1970Co09,1970St10).
7654.07 *19*	0$^+$	9.3 eV *9*	AB DE GHIJK MNOP TUVWX	XREF: Others: AA, AC, AD, AE, AF, AI, AJ, AK, AL, AN, AO, AP, AQ, AR, AU, AV, AW, AX, AY, AZ, BA, BB, BC, BD, BG, BH, BI %IT=4.16×10^{-2}; %α≈100 T=0 E(level): See discussion in (1976No02). Note: E$_x$=7657.8 keV *10* is obtained from analysis of γ rays measured in (2016Mu06).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)

E(level)	J^π	$T_{1/2}$	XREF	Comments
				Γ: Using $\Gamma_\pi/\Gamma=(6.7\ 6)\times10^{-6}$ (average of 1972Ob01,1977Ro05,1977Al31) and $\Gamma_{E0}=\Gamma_\pi=(62.3\ \mu eV\ 20)$ (see discussion in 2010Ch17,2011Vo16). $\Gamma_{rad}/\Gamma=(\Gamma_\gamma+\Gamma_\pi)/\Gamma=(4.16\ 11)\times10^{-4}$. From $10^4\times\Gamma_{rad}/\Gamma$=3.3 *9* (1961Al23), 3.5 *12* (1964Ha23), 4.20 *22* (1974Ch03), 4.4 *2* (1975Da08), 4.15 *34* (1975Ma34), 4.09 *27* (1976Ob03), 3.87 *25* (1976Ma46). The value from (1961Al23) has sometimes been miscopied as 3.4, but it has no impact on the average. The value of (1975Da08) has been corrected, as indicated in (1976Ob03). The value $(2.82\ 29)\times10^{-4}$ (1963Se23) is a statistical outlier; including this value yields the average $(3.99\ 18)\times10^{-4}$ that is the weighted average using the external uncertainty. The value in (1990Aj01) did not use the corrected (1975Da08) value. In (2014Fr09), the value $(4.19\ 10)\times10^{-4}$ is deduced by rounding the above values to the nearest tenth. Γ_{rad}=3.87 meV *39* and $\Gamma_{E2}=\Gamma_\gamma$=3.81 meV *39*. Decay mechanisms were analyzed in (2017Sm03); the decay is >99.92% via sequential α-decay to $^8Be_{g.s.}$ and <0.047% via direct decay into 3α-particles. This is relevant for the astrophysical 3α rate, via detailed balance. Also see (2011Ra43, 2012Ma10, 2012Ki07, 2013Ra20, 2014It01, 2016Mo05, 2017De25).
9641 *5*	3^-	46 keV *3*	DE GHIJ MNOP TUVWXY	XREF: Others: AA, AC, AD, AE, AF, AI, AJ, AK, AL, AM, AN, AO, AP, AQ, AR, AV, AX, AY, BA, BB, BC, BG, BH, BI %IT<4.1×10^{-5}; %α≈100 T=0 E(level): From average of (1956Do41,1962Br10, 1960Fo01,1965Ha17,1969Su03). $\Gamma_{rad}/\Gamma<4.1\times10^{-7}$ (1974Ch32). This implies Γ_{rad}<19 meV. Γ: Weighted average of (1956Do41,1962Br10,2012Al22,2013Ko14) with external errors.
9870 *60*	2^+	850 keV *85*		XREF: Others: AE, AF, AK %IT≈7.1×10^{-6}; %α≈100 T=0 E(level),Γ: From average of (2011It08,2011Zi01,2013Zi03). $\Gamma_{\gamma0}$=60 meV *10* (2013Zi03); deduced from photobreakup.
9930?# *30*	0^+	2710 keV *80*	Z	XREF: Others: AF, AK E(level),Γ: Support for a group at E_x=9.93 MeV is found separately in the $^{12}C(\alpha,\alpha')$ works of (2003Jo07) and (2011It08). In (2011It08) the group is suggested as a $J^\pi=0^+_3$ and 0^+_4 doublet with E_x=9.04 MeV *9* and Γ=1.45 MeV *18* and E_x=10.56 MeV *6* and Γ=1.42 MeV *8*, respectively. Additional support for strength in this region is found in the R-matrix analysis of ^{12}B and ^{12}N β-decay data, (2010Hy01) report evidence for J^π= 2^+ and 0^+ states at E_x=11.1 MeV *3* and 11.2 MeV *3*,

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)

E(level)	J^{π}	$T_{1/2}$	XREF	Comments
				respectively. Differences in assumptions and analysis techniques may suggest the J^{π}= 0^{+} state seen in (2010Hy01) could be the same as the one in (2011It08). In the present evaluation, the higher precision E_x=9.93 MeV *3* is accepted for a tentative state.
10.3×10^{3}? *3*	(0^{+})	3.0 MeV *7*	AB N Z	XREF: Others: AD, AI, AN, AV %$\alpha\approx$100 T=0 E(level),Γ: From (1966Sc23). The R-matrix analysis of (2010Hy01) indicates the origin of the 10.3 MeV group is related to interference between the J^{π}=0^{+} state at E_x=7.65 MeV and higher-lying strength near 11 MeV that, "gives the very broad component from 8.5 to 11 MeV, which has been mistaken for a 10.3 MeV resonance with a 3 MeV width". We continue to list this state because of the value of the historic record of reports and studies of the E_x=10.3 MeV group, and because of still unresolved questions on the J^{π}=0^{+} (and 2^{+}) strength in the E_x=9-13 MeV region. However, future studies may provide different and more complete interpretation of this region.
10847 *4*	1^{-}	273 keV *5*	D GH MN TUV X	XREF: Others: AA, AD, AE, AF, AI, AJ, AK, AL, AM, AN, AP, AQ, AX, BC %$\alpha\approx$100 T=0 E(level): From (2012Al22). Γ: From average of Γ_{lab} values from (1961Hi08,1971Re03) and $\Gamma_{c.m.}$ values from (1962Br10,2012Al22).
11836 *4*	2^{-}	230 keV *8*	D GH MNO TUV XY	XREF: Others: AA, AD, AE, AF, AI, AJ, AK, AL, AN, AP, AX, BC %IT>0; %$\alpha\approx$100 E(level): From (1962Br10,1965Ol01,2012Al22). Γ: From average of (1961Hi08, 1962Br10, 1965Ol01, 1971Re03, 2012Al22).
12400?	$(5^{+},4^{-},6^{-},7^{+})$		N	%$\alpha\approx$100 $T_{1/2}$: Broad. E(level),$T_{1/2}$: From (2012Al22).
12710[†] *6*	1^{+}	18.1 eV *28*	AB GH MNOP TUVWXY	XREF: Others: AA, AC, AD, AE, AG, AI, AJ, AL, AN, AP, AT, AV, AW, AX, AY, BA, BB, BC %IT=2.2; %α=97.8 T=0; $\Gamma\alpha$=17.7 eV *28*; $\Gamma_{\gamma0}/\Gamma$=1.93×10^{-2} *12* E(level): From (1961Hi08,1962Br10,1965Ha17, 1965Pe17,1969Su03). Γ: From $\Gamma_{\gamma0}/\Gamma$=1.93×10^{-2} *12* (1977Ad02) and $\Gamma_{\gamma0}$=0.35 eV *5* (1974Ce01). Γ_{α}/Γ=0.978 *1* (1977Ad02), which implies Γ_{α}=17.7 eV *28*.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)

E(level)	J^{π}	$T_{1/2}$	XREF	Comments
13.3×10^{3}?[#] *2*	4^{+}	1.7 MeV *2*	G	T=0 E(level),$T_{1/2}$: From (2011Fr02).
13316 *20*	4^{-}	360 keV *43*	I MN T V Y	XREF: Others: AD, AE, AK, AL, AN, AP, AX, BC %IT>0; %$\alpha\approx$100 T=0 E(level): From average of (1961Hi08,1962Br10,2012Al22). Γ: From (1962Br10,1966Wa16,1971Re03).
14079 *5*	4^{+}	272 keV *6*	GHI MN T	XREF: Others: AA, AD, AE, AG, AJ, AK, AL, AN, AO, AP, AQ, AV, AX, BA, BB, BC, BD, BF, BG, BI %$\alpha\approx$100 T=0 E(level): From average of (1962Br10,2012Al22). Γ: From (1962Br10,1966Wa16,2012Al22).
15110[†] *3*	1^{+}	43.6 eV *10*	B E MNOP TU XY	XREF: Others: AA, AC, AD, AE, AI, AJ, AT, AV, AW, AX, BA, BB, BC %IT=95.9; %α=4.1 T=1; Γα=1.8 eV *4*; Γ_{γ}=41.8 eV *12* E(level): From average of (1955Ma76,1958Ka31,1962Br10,1965Ha17, 1969Su03,1974Pa01). Γ: Using Γγ0=38.5 eV *8* (1983De53), the value Γγ=41.8 eV *9* is deduced from the measured γ branching ratios of (1972Al03). Then, using Γα/Γ=0.041 *9* (1974Ba42) one obtains Γα=1.79 eV *39* and Γ=43.6 eV *10*. Also see Γα/Γ=0.012 *7* (1970Re09) and 0.060 *25* (1970Ar30).
15440[#] *40*	(2^{+})	1.77 MeV *20*		XREF: Others: AA, AE, AH, AI, AJ, AK, AV %$\alpha\approx$100 T=(0) E(level): From (1983De53, 1976Na17, 1977Bu19, 1979Go16, 1977Bu03). Γ: From (1983De53, 1977Bu19, 1979Go16, 1997Te14, 1977Bu03).
16106.0 *8*	2^{+}	5.3 keV *2*	K MN P STU XY	XREF: Others: AA, AD, AE, AH, AJ, AT, AV, AW, AX, BA, BB, BD %IT=0.27; %p=0.41; %α=99.3 T=1 Γ_{γ}=14.4 eV *17*; Γ_{p}=21.5 eV *33*; Γα=5.26 keV *2* E(level): From 16106.9 keV *6* (2016He05), 16105.2 keV *4* (1987Be17) and 16106.7 keV *4* (1979Da03). Γ: From Γ=5.3 keV *2* (1987Be17), 5.2 keV *+5−2* (1979Da03) 5.0 keV *8* (2016He05). Γ_{γ}: Using Γ=5.3 keV *2*, $\Gamma_{\gamma1}/\Gamma=2.42\times10^{-3}$ *29* (1977Ad02), the γ-ray branching ratios to ^{12}C*(0,4.4,9.64,12.72) (1977Ad02), and Γ_{γ}(16.11→10.8)=0.48 eV *12* (2016La27). Γ_{p}: From Γ, $\Gamma_{p}\Gamma_{\gamma(0+1)}/\Gamma^{2}$ and $\Gamma_{\gamma(0+1)}/\Gamma$; see (1977Ad02). Γα: From $\Gamma_{\alpha0}/\Gamma_{\alpha1}$=0.051 *5* (2016La27), Γ=5.3 keV *2* and Γ_{γ} and Γ_{p} from above.
16620 *50*	2^{-}	280 keV *28*	MNOP S	XREF: Others: AA, AE, AH, AJ, AV %IT=2.9×10^{-3}; %p≈50; %α≈50 T=1

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)

E(level)	J^π	$T_{1/2}$	XREF	Comments
				Γ_p=140 keV; $\Gamma\alpha$=140 keV; Γ_γ=8 eV E(level),Γ: From (1997Te14). Γ_{p0}/Γ=0.5, Γ_α/Γ=0.5 (1965Se06). $\Gamma_\alpha \approx \Gamma_{\alpha 1}$, $\Gamma_{\alpha 0}$<0.27 keV (1965Se06). $\Gamma_\gamma \approx \Gamma_{\gamma 1}$=8 eV. $\Gamma_{\gamma 0}=4.8\times10^{-2}$ eV *8* (1965Se06,1983De53).
17230	1^-	1.15 MeV	P RSTU YZ	%IT=4.3×10^{-3}; %p=87; %α=13 T=1 Γ_p=1.0 MeV; $\Gamma\alpha$=150 keV; $\Gamma_\gamma \approx$50 eV E(level),Γ: From (1965Se05). Γ_{p0}=1 MeV, $\Gamma_{\alpha 0}$=10 keV, $\Gamma_{\alpha 1}$=140 keV, $\Gamma_{\gamma 0}$=44 eV $\Gamma_{\gamma 1}$= 5 eV, (2J+1)$\Gamma_{\gamma 0}\geq$115 eV (1965Se06).
17760 *20*	0^+	96 keV *5*	K P RS	XREF: Others: AA, AV, BA, BD %IT=4.0×10^{-3}; %p=82; %α=17.4 T=1 E(level): From (1974Pa01). Γ: From (1982Ha12). $\Gamma_{p0}\approx$76 keV, $\Gamma_{\alpha 0}\approx$4.6 keV, $\Gamma_{\alpha 1}\approx$11.4 keV (1965Se06). Γ_γ(→12.71 MeV)=3.7 eV *15* (1982Ha12).
18160 *70*	(1^+)	240 keV *50*	P	XREF: Others: AA, AV %IT>0; %p<100 T=(0) E(level),Γ: From ^{13}C(p,d): (1987Le24,1984Sm04), respectively. (2J+1)Γ_γ(→15.1)≥2.8 eV *6* (1972Su08).
18350‡ *50*	3^-	220 keV *50*	P RSTU XY	XREF: Others: AJ, AK %IT>0; %p=22; %α=78 T=1 Γ_{p0}/Γ=0.22, $\Gamma_{\alpha 0}/\Gamma$=0.21, $\Gamma_{\alpha 1}/\Gamma$=0.57 , $\Gamma_{\gamma 0}$<1.5 eV, $\Gamma_{\gamma 1}$=3.2 eV (1965Se06). Γ_γ(→^{12}C*(9640))=5.7 eV *23* (1982Ha12). E(level),$T_{1/2}$: At least two levels are present at E_x=18.35 MeV. In (1983Ne11), the discussion describes an interpretation with two similar width states having J^π= 2^- and 3^-. At present, Γ for the 3^- state is taken from (1971Re03) while Γ of the 2^- state is taken from (1983Ne11). However, J^π=(2^+) has also been reported in (1977Bu19,1987Ki16).
18350‡ *50*	2^-	350 keV *50*	R T XY	XREF: Others: AE, AH, AI, AJ, AK %p≈100 T=0+1 E(level),$T_{1/2}$: See comments above for E_x=18350 J^π=3^-.
18390?	0^-	43 keV	PQRS	%p≈100 T=(1) E(level),Γ: From (1965Se06). Γ_{p0}/Γ=0.79, Γ_{p1}/Γ=0.21 (1965Se05).
18.6×10^3?# *1*	(3^-)	300 keV		XREF: Others: AA $T_{1/2}$: Calculated. E(level),$T_{1/2}$: From (1970To13, 1971Ya03,1972An03).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)

E(level)	J^{π}	$T_{1/2}$	XREF	Comments
18710		100 keV	P S	%p<10; %α≥90 T=(1) E(level),Γ: From (1965Se06). $\Gamma_{p0}/\Gamma \leq 0.1$.
18800 *40*	2^+	100 keV *15*	PQRS	XREF: Others: AJ, AV, BA %IT=2.5×10^{-3}; %n=1; %p=99 E(level): From (1974Pa01). Γ: Mainly from (1974Pa01,1987Le24) and $^{11}\beta^{+}$p references in (1980Aj01). Γ_{p0}=97 keV, Γ_{p1}=2 keV, Γ_{n}=1.1 keV, $\Gamma_{\gamma0}\approx$0.4 eV, $\Gamma_{\gamma1}$=2 eV (1965Se06).
19.2×10^{3} *6*	(1^-)	≈1.1 MeV	PQRS U	XREF: Others: AJ %IT=3.2×10^{-3}; %n=14; %p=63; %α=23 T=(1) E(level): From (1979Ko05). Γ: From (1965Se06). Γ_{p0}=300 keV, Γ_{p1}=400 keV, Γ_{n}=150 keV, $\Gamma_{\alpha0}$=50 keV, $\Gamma_{\alpha1}$=200 keV $\Gamma_{\gamma0}$=25 eV, $\Gamma_{\gamma1}$=10 eV (1965Se06).
19400‡ *25*	2^-	490 keV *30*	PQRS	XREF: Others: AA, AE, AH, BC %IT=6×10^{-4}; %p=46; %α=43; %n=9 T=1 E(level): From average of (1977Bu19,1983Jo08,1997Te14). Γ: From average of (1977Bu19,1983Jo08,1984Hi06,1997Te14). Partial decay widths are given in (1965Se06) for a $J^{\pi}=2^+$ Γ=1.1 MeV state at E_x=19.4 MeV. See discussion in (1983Ne11).
19555‡ *25*	4^-	485 keV *40*	TU	XREF: Others: AA, AE, AH, AJ %IT>0; %p=42; %α=58 T=1 E(level): (1983Ba62) suggests an isospin mixed doublet with $J^{\pi}=4^-$. E(level): From (1964Go14, 1969Ba06, 1977Bu19, 1983Ne11, 1984Hi06). Γ: From (1964Go14, 1983Ne11, 1984Hi06). See discussion on $J^{\pi}=2^-$ and 4^- doublet and partial widths in (1983Ne11).
19690	1^+	230 keV *35*	QR	XREF: Others: AG %n<100; %p<100 E(level),Γ: See (1957De11, 1977Ma37, 1977Ri01).
20.0×10^{3} *1*	2^+	375 keV *100*	QR	XREF: Others: AA, AV %IT>0; %n<100; %p<100 E(level): See (1975Aj02). Γ: From (1987Le24).
20270 *50*	(1^+)	215 keV *45*	QR	XREF: Others: AE, AV %n<100; %p<100 T=(1) E(level): From ^{12}C(p,p′)(1977Bu19). Γ: From average of values reported in ^{11}B(p,n), ^{11}B(p,p′), ^{12}C(p,p′) and ^{13}C(p,d).
20553 *5*	(3^+)	300 keV *50*	MN P S Y	XREF: Others: AA, AH, BA, BC %IT>0; %p<100; %α<100

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)

E(level)	J$^{\pi}$	$T_{1/2}$	XREF	Comments
				T=(1) E(level): From (2012Al22). Γ: From (1984Hi06).
20600 *30*	(3^{-})	280 keV *75*	PQRSTU	XREF: Others: AA, AE, AV %IT>0; %n>0; %p=68; %α=32 T=(1) E(level): From average of (1975As06, 1977Bu19, 1983Ne11, 1984Sm04). Γ: From ^{11}B(p,g) references in (1975Aj02,1980Aj01), ^{11}B(p,n) references in (1968Aj02), (1975As06, 1977Bu19,1983Bo19,1987Le24).
20990		≈370 keV	Q	XREF: Others: AG %n<100; %p<100 E(level),Γ: From (1981Ho13).
21.60×10^{3} *10*	(2^{+},3^{-})	1.20 MeV *15*	PQRS	XREF: Others: AB, AE, AG, AH, AJ, AK, AQ %IT>0; %n<100; %p<100; %α<100 T=0 E(level),Γ: Possibly unresolved states with Γ=1.4 MeV *2* and Γ=0.43 MeV *8*; see discussion in (1977Bu19) and see (1961Le11,1964Ba16,1972Fa07,1976Kn05, 1983Bo19,1997Te14).
21990 *50*	1^{-}	0.61 MeV *11*	QRS	XREF: Others: AA, AE, AH, AI %IT>0; %n<100; %p<100 T=1 E(level): From (1997Te14). Γ: From average of (1977Bu19,1997Te14).
22370 *50*	(1^{-})	290 keV *40*	QR U	XREF: Others: AE, BC %n<100; %p<100 T=(1) E(level): From average of ^{11}B(^{3}He,d) values given in (1975Aj02) and (1977Bu19,1976Va07). Γ: From average of ^{11}B(^{3}He,d) values from references in (1975Aj02) and (1977Bu19).
22.40×10^{3}? *20*	(5^{-})			XREF: Others: AJ, AK %α≈100 T=1 E(level),J$^{\pi}$: From (2014Ma37).
22.65×10^{3} *10*	1^{-}	3.2 MeV	PQ S Z	XREF: Others: AA, AC, AE, AH %IT=0.08; %n<100; %p<100; %α<100 T=1 E(level): From average of values given in (1974Pa01,1977Bu19,1984Bl12,1997Te14) and values from ^{12}C(e,e′) given in (1975Aj02). Γ: From (1964Al20). See other values reported in (1965Ov01, 1974Pa01, 1977Bu19, 1984Bl12, 1997Te14) and ^{12}C(e,e′) given in (1975Aj02).
23040	(2^{-})	60 keV	QRS	%n<100; %p<100 T=(1) E(level): From average of (1965Ov01, 1975Va04).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)

E(level)	J^{π}	$T_{1/2}$	XREF	Comments
				Γ: From (1965Ov01).
23530 *30*	1^-	238 keV *24*	K PQ S	XREF: Others: AA, AE, AH, AJ %IT>0; %n<100; %p<100; %α<100 T=1 E(level): From average of (1974Go23, 1977Bu03, 1977Bu19, 1997Te14). Γ: From (1977Bu19, 1997Te14).
23990 *50*	1^-	0.57 MeV *12*	Q	XREF: Others: AA, AE, AH, AK, BC %IT>0; %n<100; %p<100 T=1 E(level): From average of (1976Va07, 1977Bu19, 1997Te14). Γ: From (1976Va07, 1997Te14).
24380 *50*	2^+	671 keV *67*	Q	XREF: Others: AG, AH %n<100; %p<100 T=0 E(level),Γ: From (1997Te14).
24.41×10^3 *15*		1.3 MeV *3*	PQ	%IT>0; %n<100; %p<100 E(level),Γ: From (2008Ch13). $(2J+1)\Gamma_{p0}\Gamma_{\gamma}/\Gamma$=20.8 *28*.
24.90×10^3 *20*		920 keV	Q	XREF: Others: AA %n<100; %p<100 E(level): From (1969Gu05). Γ: From (1965Ov01).
25.30×10^3 *15*	(1^-)	0.51 MeV *10*	Q	XREF: Others: AE, AJ %n<100; %p<100 T=(1) E(level),Γ: From (1977Bu19).
25.40×10^3 *10*	(1^-)	2 MeV	L P S Z	XREF: Others: AA, AI, AJ, AK, AQ, AV %IT>0; %n<100; %p<100 E(level): From (1984Sm04). Γ: From ^{12}C(γ,n) (1975Ah06). Γ: See resonances in $^{11}\beta$(p,γ) and $^{11}\beta$(p,α) reactions in Table 12.11 (1990Aj01).
25960	2^+	710 keV	L PQ	%n<100; %p<100; %d<100; %α<100 E(level): From (1965Ov01). Γ: From (2005Ga59).
26800		275 keV	L PQ S	%IT>0; %n<100; %p<100; %d<100; %α<100 E(level): From average of values in $^{10}\beta^{+}$d and $^{11}\beta^{+}$p. Γ: From ^{11}B(p,n) references in (1975Aj02).
27.0×10^3 *3*	(1^-)	1.4 MeV *2*	L P Z	XREF: Others: AE, AI, AK %IT>0; %p<100 T=(1) E(level),Γ: From (1977Bu19).
27595.0 *24*	0^+	≤30 keV	E K	XREF: Others: BA %IT>0; %α=19.6; %p=27.4; %d=2.8 T=2 E(level),Γ: From (1978Ro08). Γ_{p0}/Γ=0.030 *22*. Γ_{p1}/Γ=0.080 *23*. Γ_{p2}/Γ=0.0 *33*. Γ_{p3}/Γ=0.084 *32*. Γ_{p4+5}/Γ=0.08 *5*. Γ_{d}/Γ=0.028 *20*.

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)

E(level)	J^π	$T_{1/2}$	XREF	Comments
				and $\Gamma_{\alpha0}/\Gamma$ =0.105 *30*. Partial widths from (1979Fr04).
27.8×10^3 *2*		≈350 keV	F P S	XREF: Others: AA %IT>0; %n<100; %p<100; %^{3}He<100; %α<100 E(level): From (1969Gu05). Γ: From (1963Du12,1965Di06).
28200	1$^-$	1.6 MeV	E	%IT>1.7×10^{-3}; %^{3}He≈100 T=1 E(level),Γ: From (1972Bl17).
28830 *40*		1.54 MeV *9*	E L P	XREF: Others: AI, AJ, AK %IT>0; %p<100; %d<100; %^{3}He<100; %α<100 E(level): From (1972Li29,1974Sh01).
29.4×10^3 *3*	(2$^+$)	≈800 keV	F P YZ	XREF: Others: AE %IT>0; %n<100; %p<100; %^{3}H<100; %^{3}He<100 T=(1) E(level): From (1977Bu19). Γ: From (2008Af04).
29630 *50*		≤200 keV		XREF: Others: BA %α≈20; %p=80 T=2 E(level),Γ: From (1976As01) Γ_p/Γ=0.8 *2*, Γ_{p0}/Γ=0.4, Γ_α/Γ≈0.2.
30290 *30*	(2$^+$,2$^-$)	1.54 MeV *9*	C E	XREF: Others: AA %IT>0; %^{3}He<100; %α<100 T=(0,1) E(level),Γ: From (1972Li29, 1974Sh01).
31160 *30*		2.10 MeV *15*	E	%IT>0; %^{3}He<100 E(level),Γ: From (1972Li29, 1974Sh01).
32290 *40*		1.32 MeV *23*	C E	XREF: Others: AA %IT>0; %n<100; %p<100; %^{3}He<100 Also decays via ^{6}Li emission. E(level),Γ: From (1972Li29, 1974Sh01).
33.47×10^3 *21*		1.93 MeV *5*	E	%IT>0; %^{3}He<100 E(level),Γ: From (1972Li29, 1974Sh01).

† See discussion on the charge-dependent matrix element between ^{12}C*(12710,15110) in Table 12.18 (2017Ke05).
‡ See discussion in (1983Ne11).
# Decay mode not specified.

$\gamma(^{12}C)$

E_i(level)	J^π_i	E_γ†	I_γ	E_f	J^π_f	Mult.	Comments
4439.82	2$^+$	4438.94	100	0	0$^+$	E2	Γ_γ=10.8×10^{-3} eV *6*; B(E2)(W.u.)=4.65 *26*
7654.07	0$^+$	3213.79	100	4439.82	2$^+$	E2	Γ_γ=3.81×10^{-3} eV *39*; B(E2)(W.u.)=8.26 *85*
9641	3$^-$	9637	100	0	0$^+$	E3	Γ_γ=3.1×10^{-4} eV *4* (1967Cr01); B(E3)(W.u.)=12 *2*
12710	1$^+$	8267	15 *3*	4439.82	2$^+$	M1	Γ_γ=5.3×10^{-2} eV *10*; B(M1)(W.u.)=4.5×10^{-3} *8*
		12703	100 *14*	0	0$^+$	M1	Γ_γ=0.35 eV *5*; B(M1)(W.u.)=8.1×10^{-3} *12* $\Gamma_{\gamma1}$ from $\Gamma_{\gamma1}/\Gamma_{\gamma0}$=0.150 *18* (1977Ad02). See also (1972Al03) who found I_γ(12.1 MeV→0)=(15 *4*)% and I_γ(12.1 MeV→4.44 MeV)=(85 *4*)%, which implies $\Gamma_{\gamma1}/\Gamma_{\gamma0}$=0.17 *5*.
15110	1$^+$	2400‡	1.5 *4*	12710	1$^+$	M1	Γ_γ=0.59 eV *17*; B(M1)(W.u.)=2.0 *6*

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas 2017Ke05 (continued)

$\gamma(^{12}C)$ (continued)

E_i(level)	J_i^π	E_γ†	I_γ	E_f	J_f^π	Mult.	Comments
15110	1+	4809	4.2 *15*	10.3×10³?	(0+)		Γ_γ=1.6 eV *6*
		7453‡	2.83 *36*	7654.07	0+	M1	Γ_γ=1.09 eV *14*; B(M1)(W.u.)=0.13 *2*
		10665‡	2.49 *34*	4439.82	2+	M1	Γ_γ=0.96 eV *13*; B(M1)(W.u.)=3.8×10⁻² *5*
		15100	100 *2*	0	0+	M1	Γ_γ=38.5 eV *8*; B(M1)(W.u.)=0.531 *11*
16106.0	2+	3396	1.5 *3*	12710	1+	M1	Γ_γ=0.19 eV *4*; B(M1)(W.u.)=0.23 *5*
		5257	3.8 *9*	10847	1−	E1	Γ_γ=0.48 eV *12*
		6463	2.4 *5*	9641	3−	E1	Γ_γ=0.31 eV *6*; B(E1)(W.u.)=3.2×10⁻³ *6*
		11660.1	100 *12*	4439.82	2+	M1	Γ_γ=12.8 eV *15*; B(M1)(W.u.)=0.38 *5*
		16094.4	4.6 *9*	0	0+	E2	Γ_γ=0.59 eV *11*; B(E2)(W.u.)=0.40 *8*
16620	2−	12180	100	4439.82	2+		Γ_γ=8 eV; B(E1)(W.u.)=1.2×10⁻²
		16608	0.60 *1*	0	0+	M2	Γ_γ=4.80×10⁻² eV *8*; B(M2)(W.u.)=0.48 *8*
17230	1−	12783	11	4439.82	2+		Γ_γ=5 eV; B(E1)(W.u.)=6.7×10⁻³
		17217	100	0	0+		Γ_γ=44 eV; B(E1)(W.u.)=2.4×10⁻² I_γ: From (1965Se06).
17760	0+	5049	100	12710	1+		Γ_γ=3.7 eV *15*; B(M1)(W.u.)=1.4 *6*
18160	(1+)	3049	100	15110	1+		
18350	3−	8706	100	9641	3−		Γ_γ=5.7 eV *23*; B(M1)(W.u.)=0.41 *2* I_γ: From (1965Se06).
		13902	56	4439.82	2+		Γ_γ=3.2 eV; B(E1)(W.u.)=3.3×10⁻³
		18335	3.5×10⁻⁴	0	0+		Γ_γ<1.5 eV; B(E3)(W.u.)<6.5×10²
18800	2+	14351	100	4439.82	2+		Γ_γ=2 eV; B(M1)(W.u.)=3.2×10⁻² I_γ: From (1965Se06).
		18784	<20	0	0+		Γ_γ≈0.4 eV; B(E2)(W.u.)≈0.13
19.2×10³	(1−)	14.75×10³	40	4439.82	2+		Γ_γ=10 eV
		19.2×10³	100	0	0+		Γ_γ=25 eV I_γ: From (1965Se06).
19400	2−	14950	100	4439.82	2+		I_γ: From (1965Se06).
20553	(3+)	20534		0	0+		
20600	(3−)	20581		0	0+		
21.60×10³	(2+,3−)	21.58×10³		0	0+		
21990	1−	21968		0	0+		
22.65×10³	1−	22.63×10³		0	0+		
23530	1−	19074		4439.82	2+		
		23505		0	0+		
24.41×10³		9.29×10³		15110	1+		
25.40×10³	(1−)	20.94×10³		4439.82	2+		
		25.37×10³		0	0+		
26800		19130		7654.07	0+		
		22338		4439.82	2+		
27595.0	0+	12478		15110	1+		
27.8×10³		23.3×10³		4439.82	2+		
		27.8×10³		0	0+		
28200	1−	20.52×10³		7654.07	0+		
		28.16×10³		0	0+		
28830		21156		7654.07	0+		
		28793		0	0+		
29.4×10³	(2+)	29.4×10³		0	0+		
30290	(2+,2−)	25.82×10³		4439.82	2+		
31160		31.12×10³		0	0+		
32290		24.61×10³		7654.07	0+		
		27.82×10³		4439.82	2+		

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas 2017Ke05 (continued)

$\gamma(^{12}C)$ (continued)

E_i(level)	J_i^{π}	E_{γ}[†]	E_f	J_f^{π}
33.47×10^3		25.79×10^3	7654.07	0^+
		28.99×10^3	4439.82	2^+

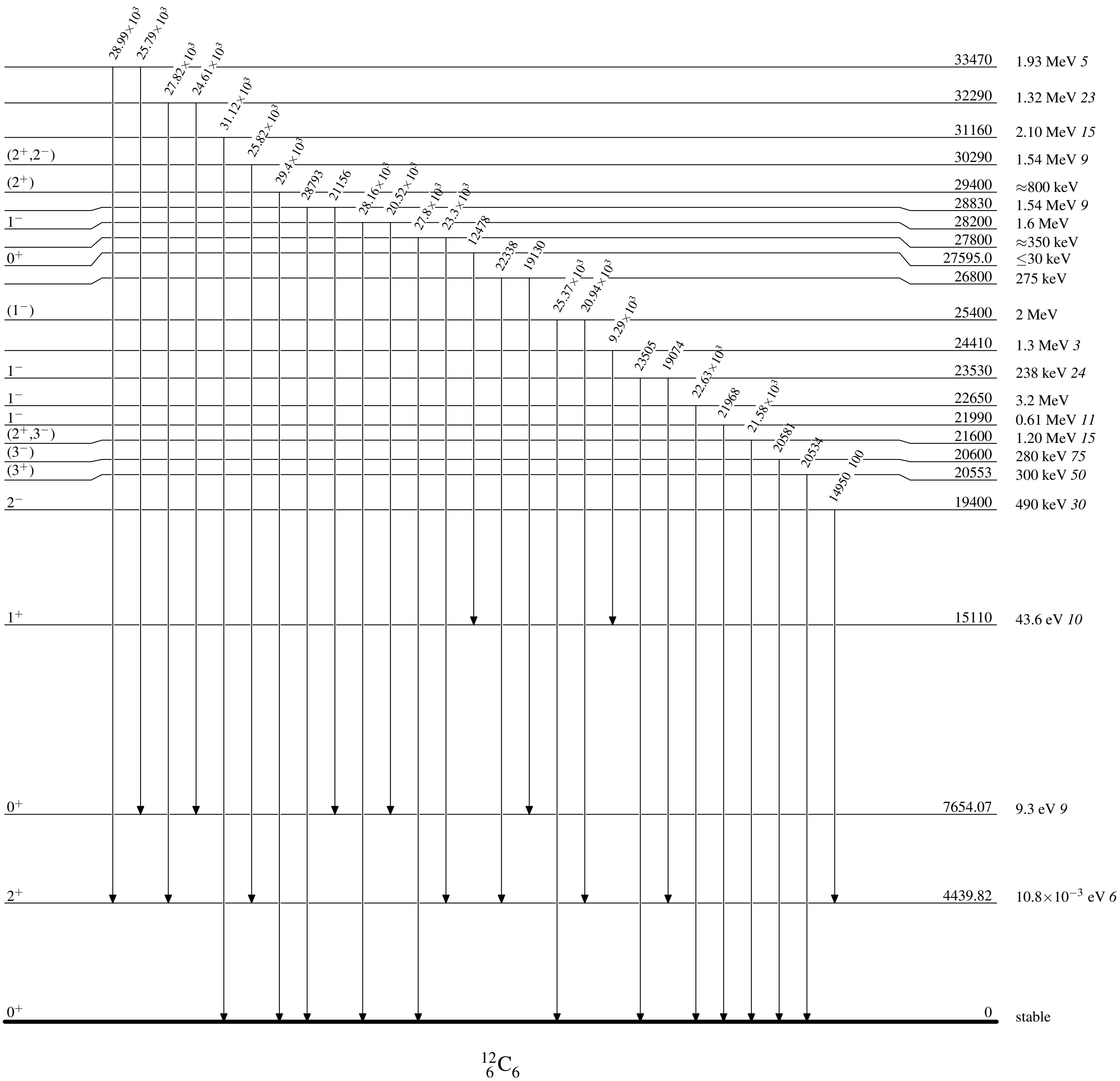
† From level energy difference; recoil correction applied.

‡ Γ data based on $\Gamma_{\gamma0}$ of (1983De53) and on branching ratios of (1972Al03): ^{12}c*(15110) to ^{12}c*(0,4439,7654,12710) are (92 *2*)%, (2.3 *3*)%, (2.6 *7*)%, (1.4 *4*)%, respectively. In addition, an undetected branching of 1.6% to ^{12}c*(10300) is indicated in the β^- decay work of (1972Al03). See also (1980Aj01).

Adopted Levels, Gammas 2017Ke05

Level Scheme

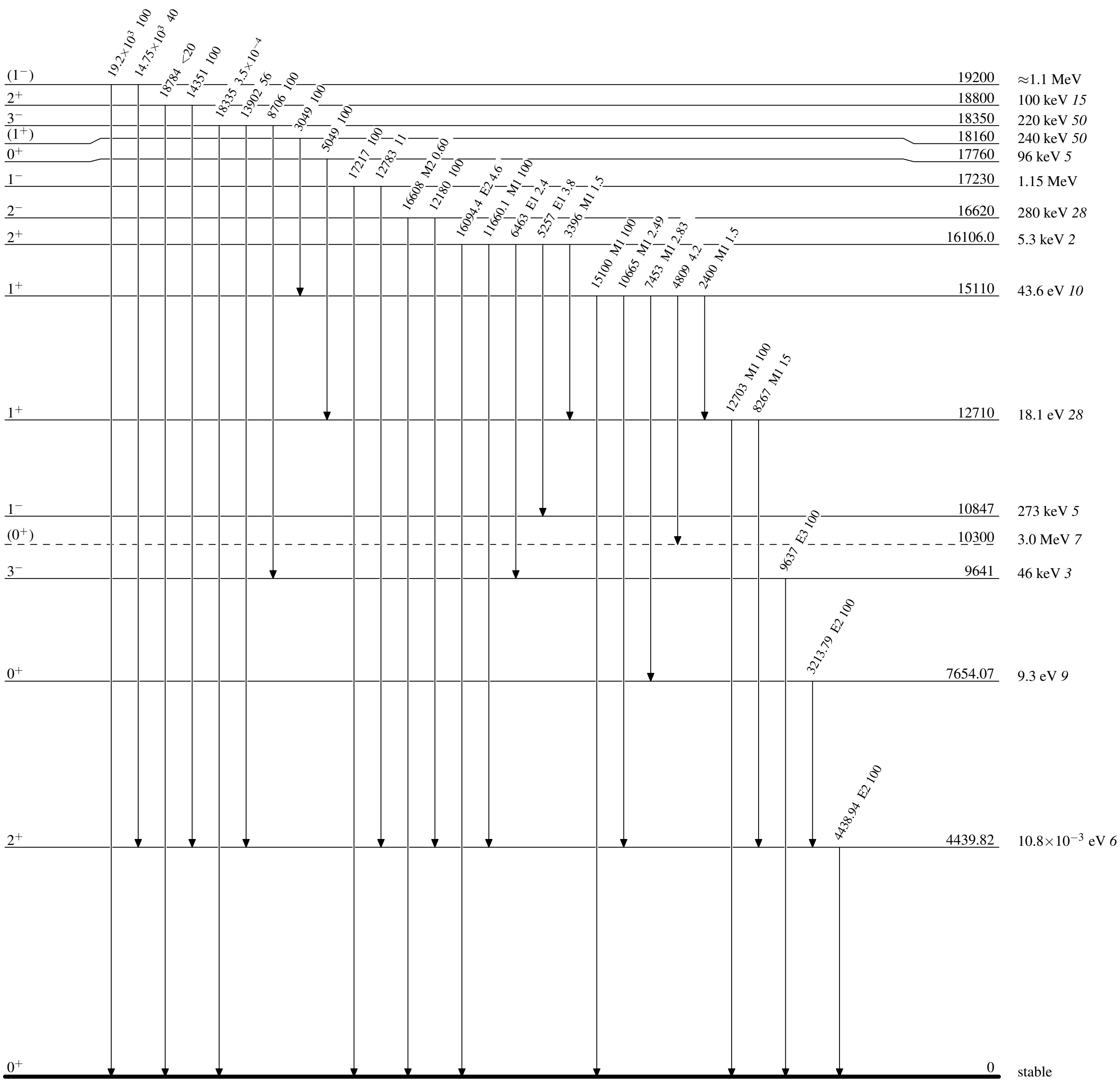
Intensities: Relative photon branching from each level



Adopted Levels, Gammas 2017Ke05

Level Scheme (continued)

Intensities: Relative photon branching from each level



$^{12}_{6}C_{6}$

Adopted Levels, Gammas 1991Aj01

History

Type	Author	Citation	Literature Cutoff Date
Update	F. Ajzenberg-selove, J. H. Kelley and C. D. Nesaraja	NP A523,1 (1991)	1-Jul-1990

Q(β^-)=156.476 *4*; S(n)=8176; S(p)=20831.2 *11*; Q(α)=−12012.5 *1* 2012Wa38
Note: Current evaluation has used the following Q record 156.475 4 *8176*.4425 *20831*.3 *11*−12011.6 *4* 1997Au04.
Additional information 1.

^{14}C Levels

Cross Reference (XREF) Flags

A	^{14}B β^- decay	K	^{13}C(p,π^+)	U	^{14}C(^{14}C,^{14}C′)
B	^{13}C(n,γ) E=thermal	L	^{13}C(d,p)	V	^{14}N(γ,π^+)
C	^{13}C(n,γ) res	M	^{13}C(t,d)	W	^{14}N(π^-,γ)
D	^{9}Be(^{6}Li,p)	N	^{13}C(^{7}Li,^{6}Li)	X	^{14}N(n,p)
E	^{9}Be(^{7}Li,d)	O	^{14}C(γ,n) res	Y	^{14}N(d,2p)
F	^{11}B(α,p)	P	^{14}C(e,e′)	Z	^{14}N(t,^{3}He)
G	^{11}B(^{6}Li,^{3}He),^{11}B(^{7}Li,α)	Q	^{14}C(π,π′)	Others:	
H	^{12}C(t,p)	R	^{14}C(p,p′)	AA	^{15}N(γ,p)
I	^{12}C(α,2p)	S	^{14}C(d,d′)	AB	^{15}N(d,^{3}He)
J	^{13}C(n,n′) res	T	^{14}C(α,α′)	AC	^{16}O(^{6}Li,^{8}B)

E(level)	J$^\pi$	T$_{1/2}$	XREF	Comments
0.0	0$^+$	5700 y *30*	AB DEFGHIJKLMNOPQRSTUVWXYZ	XREF: Others: AA, AB, AC %β^-=100 T=1 T$_{1/2}$: From the weighted average of the values 5780 y *65* [Watt et al. Intern. J. Appl. Radiat. Isot. 11 (1961) 68], 5680 y *40* (1962Ol04), 5745 y *50* (1964Hu09), 5660 y *30* (1968Be47), and 5736 y *56* (1968ReZZ and 1972Em01). The reduced-χ^2 for this average is 1.06. These values were obtained from specific activity measurements. Values that have not been included in the average, all earlier, are 4700 y *400* (1946Re10), 5100 y *200* (1948No02), 7200 y *500* (1948Ya02), 6360 y *200* (1949Ha52), 5589 y *75* (1949Jo07), 5580 y 90 [Engelkemeir & Libby, Rev. Sci. Instr. 21 (1950) 550], 6360 y 190 and 5513 y *165* [Miller et al., Phys. Rev. 77 (1950) 714], 5370 y *200* [Manov & Curtiss, J. Research Nat. Bur. Std. 46 (1951) 328], 6100 y *85* (1952Je11), 5900 y *250* [Caswell et al., J. Research Nat. Bur. Std. 53 (1954) 27]. These values were omitted because of their large uncertainties and the later improvements in the measurement methods. From a similar evaluation, 1990Ho28 gives a result of 5715 y *30* from an unweighted average of eight values. Evaluated by V. Chechev in 1998 in conjunction with the Decay Data Evaluation Project (1999BeZS,1999BeZQ).
6093.8 *2*	1$^-$	<7 fs	AB DEFGH KLMN PQ T Z	XREF: Others: AB
6589.4 *2*	0$^+$	3.0 ps *4*	AB DEF H LM	
6728.2 *13*	3$^-$	66 ps *8*	A DEFGHI KLMN PQRSTU Z	XREF: Others: AB μ=0.816 *21* (1989Ra17)
6902.6 *2*	0$^-$	25 fs *3*	B DE GH LMN P	
7012 *4*	2$^+$	9.0 fs *14*	DEFGH KLMN PQRS	XREF: Others: AB, AC
7341 *3*	2$^-$	111 fs *42*	A DE GH KLMN P T Z	XREF: Others: AB

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas 1991Aj01 (continued)

^{14}C Levels (continued)

E(level)	J^{π}	$T_{1/2}$	XREF	Comments
8317.9 *8*	2^+	3.4 keV *7*	B DEFGHIJKLM PQ T W YZ	XREF: Others: AC %IT=?; %n=?
9746[†] *7*	0^+			XREF: Others: AB
9801 *6*	3^-	45 keV *12*	D FGH JKLM P T	XREF: Others: AB %IT=?; %n=?
10425 *5*	2^+		D F H JKLM P T	XREF: Others: AB %n=100
10449 *7*	≥1		D FGH JK	XREF: Others: AB %n=100
10498 *4*	(3^-)	26 keV *8*	D GH JKLM	XREF: Others: AB %n=100
10736[†] *5*	4^+	20 keV *7*	D FGHI KLM T W	
11306 *15*	1^+	46 keV *12*	D F J OP	XREF: Others: AB %IT=0.015 *5*; %n=99.985 *5*
11395 *8*	1^-	22 keV *7*	D FGH LM T	%n=100
11500?	$1^-,2^-$		J	%n=100 $T_{1/2}$: Γ=broad.
11666 *10*	4^-	20 keV *7*	D FGHI KLM PQRST	XREF: Others: AB
11730[†] *9*	(5^-)		D FGHI K	
119×10^2 *3*	(1^-)	950 keV *300*	J LM	%n=100
12583 *10*	$(2^-,3^-)$	95 keV *15*	D GH J LM Q T	XREF: Others: AB %n=100
12863 *8*		30 keV *10*	D GH J LM P	%n=100
12963 *9*	(3^-)	30 keV *10*	D GH J LM T	%n=100
135×10^2?[†] *1*		<200 keV	K	
13700	2^-	≈1800 keV	J	%n=100
140.5×10^2?[†] *10*		<200 keV	K	
14667 *20*	(4^+)	57 keV *15*	D FG J	%n=100
14868[†] *20*	$(6^+,5^-)$		D FGHI K	XREF: Others: AB
15200[†] *23*	4^-		D FG K PQ	
15370?[†] *30*			D	
15440 *40*	(3^-)		D J	%n=100
16020? *50*	(4^+)		D J	%n=100
16430[†] *16*			D FGH	
16570?[†] *40*			D	
16715 *30*	(1^+)	≈200 keV	B D F	%IT=?; %n=?
17300 *30*	4^-		D FG PQRS	
17500?	(1^+)	≈200 keV	B	%IT=?; %n=?
17950[†] *40*			D	
18100[†] *40*			D	
18500[†]			K	$T_{1/2}$: Γ=broad.
20400[†]			X	$T_{1/2}$: Γ=wide.
21400?[†]			F	
221×10^2 *1*	(2^-)		P	T=2 T: tentative.
23288[†] *15*		≈50 keV	F K	
244×10^2 *1*	4^-	<300 keV	PQ	T=2 T: tentative.
24500[†]			K Q	$T_{1/2}$: Γ=wide.

[†] Decay mode not specified.

Adopted Levels, Gammas 1991Aj01 (continued)

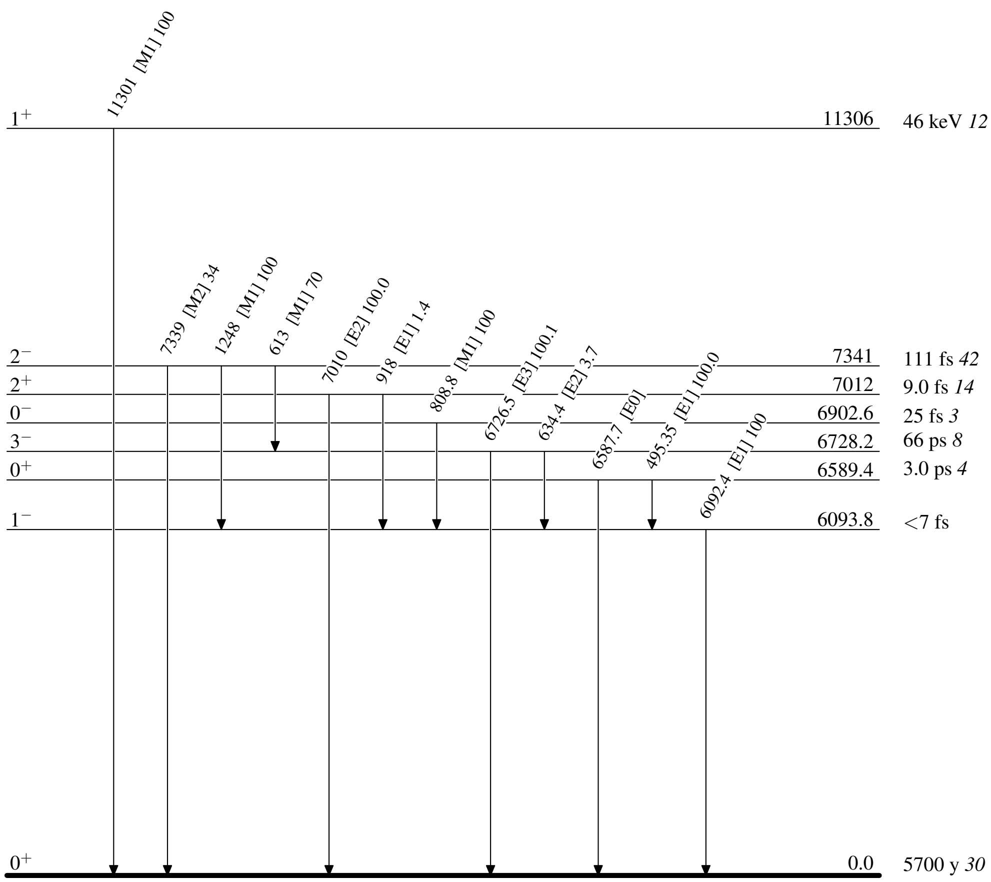
$\gamma(^{14}C)$

E_i(level)	J^π_i	E_γ	I_γ	E_f	J^π_f	Mult.	$I_{(\gamma+ce)}$	Comments
6093.8	1^-	6092.4 *2*	100	0.0	0^+	[E1]		B(E1)(W.u.)>7.3×10^{-4}
6589.4	0^+	495.35 *10*	100.0 *1*	6093.8	1^-	[E1]		B(E1)(W.u.)=0.0032 *4*
		6587.7 *2*		0.0	0^+	[E0]	1.1 *1*	$I_{(\gamma+ce)}$: this decay mode is due entirely to internal pairs.
6728.2	3^-	634.4 *13*	3.7 *13*	6093.8	1^-	[E2]		B(E2)(W.u.)=1.5 *6*
		6726.5 *13*	100.1 *13*	0.0	0^+	[E3]		B(E3)(W.u.)=2.4 *3*
6902.6	0^-	808.8 *3*	100	6093.8	1^-	[M1]		B(M1)(W.u.)=1.6 *2*
7012	2^+	918 *4*	1.4 *7*	6093.8	1^-	[E1]		B(E1)(W.u.)=0.0023 *12*
		7010 *4*	100.0 *7*	0.0	0^+	[E2]		B(E2)(W.u.)=1.8 *3*
7341	2^-	613 *3*	70 *7*	6728.2	3^-	[M1]		B(M1)(W.u.)=0.29 *10* δ: δ(E2/M1)=−0.07 *30*.
		1248 *3*	100 *7*	6093.8	1^-	[M1]		B(M1)(W.u.)=0.049 *20* δ: δ(E2/M1)=0.04 *9*.
		7339 *3*	34 *7*	0.0	0^+	[M2]		B(M2)(W.u.)=0.38 *15*
11306	1^+	11301 *15*	100	0.0	0^+	[M1]		B(M1)(W.u.)=0.22 *5*

Adopted Levels, Gammas 1991Aj01

Level Scheme

Intensities: Relative photon branching from each level



$^{14}_{6}C_{8}$