

Adopted Levels, Gammas 2017Ke05

Type	Author	History	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

¹²C 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 β ⁻ α 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 ^π	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).	

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Adopted Levels, Gammas 2017Ke05 (continued) ^{12}C Levels (continued)

<u>E(level)</u>	<u>J^{π}</u>	<u>T_{1/2}</u>	<u>XREF</u>	<u>Comments</u>
9641 5	3 ⁻	46 keV 3	DE GHIJ MNOP TUVWXY	<p>Γ: Using $\Gamma_{\pi}/\Gamma=(6.7\ 6)\times 10^{-6}$ (average of 1972Ob01,1977Ro05,1977Al31) and $\Gamma_{E0}=\Gamma_{\pi}=(62.3\ \mu\text{eV}\ 20)$ (see discussion in 2010Ch17,2011Vo16). $\Gamma_{\text{rad}}/\Gamma=(\Gamma_{\gamma}+\Gamma_{\pi})/\Gamma=(4.16\ 11)\times 10^{-4}$. From $10^4\times\Gamma_{\text{rad}}/\Gamma=3.3\ 9$ (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 $(2.82\ 29)\times 10^{-4}$ (1963Se23) is a statistical outlier; including this value yields the average $(3.99\ 18)\times 10^{-4}$ that is the weighted average using the external uncertainty. The value in (1990Aj01) did not use the corrected (1975Da08) value. In (2014Fr09), the value $(4.19\ 10)\times 10^{-4}$ is deduced by rounding the above values to the nearest tenth. $\Gamma_{\text{rad}}=3.87\ \text{meV}\ 39$ and $\Gamma_{E2}=\Gamma_{\gamma}=3.81\ \text{meV}\ 39$. Decay mechanisms were analyzed in (2017Sm03); the decay is >99.92% via sequential α-decay to $^8\text{Be}_{\text{g.s.}}$ 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). XREF: Others: AA, AC, AD, AE, AF, AT, AJ, AK, AL, AM, AN, AO, AP, AQ, AR, AV, AX, AY, BA, BB, BC, BG, BH, BI %IT<4.1×10^{-5}; %$\alpha\approx 100$ T=0 E(level): From average of (1956Do41,1962Br10, 1960Fo01,1965Ha17,1969Su03). $\Gamma_{\text{rad}}/\Gamma<4.1\times 10^{-7}$ (1974Ch32). This implies $\Gamma_{\text{rad}}<19\ \text{meV}$. Γ: Weighted average of (1956Do41,1962Br10,2012Al22,2013Ko14) with external errors.</p>
9870 60	2 ⁺	850 keV 85		<p>XREF: Others: AE, AF, AK %IT$\approx 7.1\times 10^{-6}$; %$\alpha\approx 100$ T=0 E(level),Γ: From average of (2011It08,2011Zi01,2013Zi03). $\Gamma_{\gamma 0}=60\ \text{meV}\ 10$ (2013Zi03); deduced from photobreakup.</p>
9930?# 30	0 ⁺	2710 keV 80	Z	<p>XREF: Others: AF, AK E(level),Γ: Support for a group at $E_x=9.93\ \text{MeV}$ is found separately in the $^{12}\text{C}(\alpha,\alpha')$ works of (2003Jo07) and (2011It08). In (2011It08) the group is suggested as a J^{π}=0₃⁺ and 0₄⁺ doublet with $E_x=9.04\ \text{MeV}\ 9$ and $\Gamma=1.45\ \text{MeV}\ 18$ and $E_x=10.56\ \text{MeV}\ 6$ and $\Gamma=1.42\ \text{MeV}\ 8$, 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 $E_x=11.1\ \text{MeV}\ 3$ and $11.2\ \text{MeV}\ 3$,</p>

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Adopted Levels, Gammas 2017Ke05 (continued) ^{12}C Levels (continued)

E(level)	J^π	$T_{1/2}$	XREF						Comments
10.3×10 ³ ? 3	(0 ⁺)	3.0 MeV 7	AB		N		Z	<p>respectively. Differences in assumptions and analysis techniques may suggest the $J^\pi = 0^+$ 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.</p> <p>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 $J^\pi=0^+$ 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 $J^\pi=0^+$ (and 2^+) strength in the $E_x=9-13$ MeV region. However, future studies may provide different and more complete interpretation of this region.</p>	
10847 4	1 ⁻	273 keV 5	D	GH	MN		TUV X	<p>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 $\Gamma_{\text{c.m.}}$ values from (1962Br10,2012Al22).</p>	
11836 4	2 ⁻	230 keV 8	D	GH	MNO		TUV XY	<p>XREF: Others: AA, AD, AE, AF, AI, AJ, AK, AL, AN, AP, AX, BC $\%IT > 0$; $\% \alpha \approx 100$ E(level): From (1962Br10,1965OI01,2012Al22). Γ: From average of (1961Hi08, 1962Br10, 1965OI01, 1971Re03, 2012Al22). $\% \alpha \approx 100$</p>	
12400?	(5 ⁺ ,4 ⁻ ,6 ⁻ ,7 ⁺)						N	<p>$T_{1/2}$: Broad. E(level),$T_{1/2}$: From (2012Al22). $\% \alpha \approx 100$</p>	
12710 [†] 6	1 ⁺	18.1 eV 28	AB	GH	MNOP		TUVWXY	<p>XREF: Others: AA, AC, AD, AE, AG, AI, AJ, AL, AN, AP, AT, AV, AW, AX, AY, BA, BB, BC $\%IT=2.2$; $\% \alpha=97.8$ $T=0$; $\Gamma_\alpha=17.7$ eV 28; $\Gamma_{\gamma_0}/\Gamma=1.93 \times 10^{-2}$ 12 E(level): From (1961Hi08,1962Br10,1965Ha17, 1965Pe17,1969Su03). Γ: From $\Gamma_{\gamma_0}/\Gamma=1.93 \times 10^{-2}$ 12 (1977Ad02) and $\Gamma_{\gamma_0}=0.35$ eV 5 (1974Ce01). $\Gamma_\alpha/\Gamma=0.978$ 1 (1977Ad02), which implies $\Gamma_\alpha=17.7$ eV 28.</p>	

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Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)						
E(level)	J^π	$T_{1/2}$	XREF			Comments
$13.3 \times 10^3 \gamma^\#$ 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; % α ≈100 T=0 E(level): From average of (1961Hi08, 1962Br10, 2012Al22).
14079 5	4^+	272 keV 6	GHI	MN	T	Γ : From (1962Br10, 1966Wa16, 1971Re03). XREF: Others: AA, AD, AE, AG, AJ, AK, AL, AN, AO, AP, AQ, AV, AX, BA, BB, BC, BD, BF, BG, BI % α ≈100 T=0 E(level): From average of (1962Br10, 2012Al22). Γ : From (1962Br10, 1966Wa16, 2012Al22).
15110^\dagger 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; $\Gamma\alpha$ =1.8 eV 4; $\Gamma\gamma$ =41.8 eV 12 E(level): From average of (1955Ma76, 1958Ka31, 1962Br10, 1965Ha17, 1969Su03, 1974Pa01). Γ : Using $\Gamma\gamma_0$ =38.5 eV 8 (1983De53), the value $\Gamma\gamma$ =41.8 eV 9 is deduced from the measured γ branching ratios of (1972Al03). Then, using $\Gamma\alpha/\Gamma$ =0.041 9 (1974Ba42) one obtains $\Gamma\alpha$ =1.79 eV 39 and Γ =43.6 eV 10. Also see $\Gamma\alpha/\Gamma$ =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 % α ≈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 $\Gamma\gamma$ =14.4 eV 17; Γ_p =21.5 eV 33; $\Gamma\alpha$ =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). $\Gamma\gamma$: Using Γ =5.3 keV 2, $\Gamma_{\gamma 1}/\Gamma$ = 2.42×10^{-3} 29 (1977Ad02), the γ -ray branching ratios to $^{12}\text{C}^*(0, 4.4, 9.64, 12.72)$ (1977Ad02), and $\Gamma_{\gamma}(16.11 \rightarrow 10.8)$ =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). $\Gamma\alpha$: From $\Gamma_{\alpha 0}/\Gamma_{\alpha 1}$ =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

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Adopted Levels, Gammas 2017Ke05 (continued) ^{12}C Levels (continued)

<u>E(level)</u>	<u>J^{π}</u>	<u>T_{1/2}</u>	<u>XREF</u>	<u>Comments</u>
17230	1 ⁻	1.15 MeV	P RSTU YZ	$\Gamma_p=140$ keV; $\Gamma_\alpha=140$ keV; $\Gamma_\gamma=8$ eV E(level), Γ : From (1997Te14). $\Gamma_{p0}/\Gamma=0.5$, $\Gamma_\alpha/\Gamma=0.5$ (1965Se06). $\Gamma_\alpha\approx\Gamma_{\alpha1}$, $\Gamma_{\alpha0}<0.27$ keV (1965Se06). $\Gamma_\gamma\approx\Gamma_{\gamma1}=8$ eV. $\Gamma_{\gamma0}=4.8\times 10^{-2}$ eV 8 (1965Se06,1983De53). $\%IT=4.3\times 10^{-3}$; $\%p=87$; $\%\alpha=13$ T=1 $\Gamma_p=1.0$ MeV; $\Gamma_\alpha=150$ keV; $\Gamma_\gamma\approx 50$ eV E(level), Γ : From (1965Se05). $\Gamma_{p0}=1$ MeV, $\Gamma_{\alpha0}=10$ keV, $\Gamma_{\alpha1}=140$ keV, $\Gamma_{\gamma0}=44$ eV $\Gamma_{\gamma1}=5$ eV, (2J+1) $\Gamma_{\gamma0}\geq 115$ eV (1965Se06).
17760 20	0 ⁺	96 keV 5	K P RS	XREF: Others: AA, AV, BA, BD $\%IT=4.0\times 10^{-3}$; $\%p=82$; $\%\alpha=17.4$ T=1 E(level): From (1974Pa01). Γ : From (1982Ha12). $\Gamma_{p0}\approx 76$ keV, $\Gamma_{\alpha0}\approx 4.6$ keV, $\Gamma_{\alpha1}\approx 11.4$ keV (1965Se06).
18160 70	(1 ⁺)	240 keV 50	P	$\Gamma_\gamma(\rightarrow 12.71$ MeV)=3.7 eV 15 (1982Ha12). XREF: Others: AA, AV $\%IT>0$; $\%p<100$ T=(0) E(level), Γ : From $^{13}\text{C}(p,d)$: (1987Le24,1984Sm04), respectively. (2J+1) $\Gamma_\gamma(\rightarrow 15.1)\geq 2.8$ eV 6 (1972Su08).
18350 [‡] 50	3 ⁻	220 keV 50	P RSTU XY	XREF: Others: AJ, AK $\%IT>0$; $\%p=22$; $\%\alpha=78$ T=1 $\Gamma_{p0}/\Gamma=0.22$, $\Gamma_{\alpha0}/\Gamma=0.21$, $\Gamma_{\alpha1}/\Gamma=0.57$, $\Gamma_{\gamma0}<1.5$ eV, $\Gamma_{\gamma1}=3.2$ eV (1965Se06). $\Gamma_\gamma(\rightarrow ^{12}\text{C}^*(9640))=5.7$ 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 $\%p\approx 100$ T=0+1 E(level),T _{1/2} : See comments above for $E_x=18350$ J ^{π} =3 ⁻ .
18390?	0 ⁻	43 keV	PQRS	$\%p\approx 100$ T=(1) E(level), Γ : From (1965Se06). $\Gamma_{p0}/\Gamma=0.79$, $\Gamma_{p1}/\Gamma=0.21$ (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).

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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 B ⁺ p references in (1980Aj01). $\Gamma_{p0}=97$ keV, $\Gamma_{p1}=2$ keV, $\Gamma_n=1.1$ 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). $\Gamma_{p0}=300$ keV, $\Gamma_{p1}=400$ keV, $\Gamma_n=150$ 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 $J^\pi=2^+$ $\Gamma=1.1$ 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

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Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)				
E(level)	J^π	$T_{1/2}$	XREF	Comments
20600 30	(3^-)	280 keV 75	PQRSTU	T=(1) E(level): From (2012Al22). Γ : From (1984Hi06). XREF: Others: AA, AE, AV %IT>0; %n>0; %p=68; % α =32
20990		\approx 370 keV	Q	T=(1) E(level): From average of (1975As06, 1977Bu19, 1983Ne11, 1984Sm04). Γ : From $^{11}\text{B}(p,g)$ references in (1975Aj02, 1980Aj01), $^{11}\text{B}(p,n)$ references in (1968Aj02), (1975As06, 1977Bu19, 1983Bo19, 1987Le24). XREF: Others: AG %n<100; %p<100
21.60×10^3 10	$(2^+, 3^-)$	1.20 MeV 15	PQRS	E(level), Γ : From (1981Ho13). XREF: Others: AB, AE, AG, AH, AJ, AK, AQ %IT>0; %n<100; %p<100; % α <100
21990 50	1^-	0.61 MeV 11	QRS	T=0 E(level), Γ : Possibly unresolved states with $\Gamma=1.4$ MeV 2 and $\Gamma=0.43$ MeV 8; see discussion in (1977Bu19) and see (1961Le11, 1964Ba16, 1972Fa07, 1976Kn05, 1983Bo19, 1997Te14). XREF: Others: AA, AE, AH, AI %IT>0; %n<100; %p<100
22370 50	(1^-)	290 keV 40	QR U	T=1 E(level): From (1997Te14). Γ : From average of (1977Bu19, 1997Te14). XREF: Others: AE, BC %n<100; %p<100
22.40×10^3 ? 20	(5^-)			T=(1) E(level): From average of $^{11}\text{B}(^3\text{He}, d)$ values given in (1975Aj02) and (1977Bu19, 1976Va07). Γ : From average of $^{11}\text{B}(^3\text{He}, d)$ values from references in (1975Aj02) and (1977Bu19). XREF: Others: AJ, AK % $\alpha \approx$ 100
22.65×10^3 10	1^-	3.2 MeV	PQ S Z	T=1 E(level), J^π : From (2014Ma37). XREF: Others: AA, AC, AE, AH %IT=0.08; %n<100; %p<100; % α <100
23040	(2^-)	60 keV	QRS	T=1 E(level): From average of values given in (1974Pa01, 1977Bu19, 1984B112, 1997Te14) and values from $^{12}\text{C}(e, e')$ given in (1975Aj02). Γ : From (1964Al20). See other values reported in (1965Ov01, 1974Pa01, 1977Bu19, 1984B112, 1997Te14) and $^{12}\text{C}(e, e')$ given in (1975Aj02). %n<100; %p<100
				T=(1) E(level): From average of (1965Ov01, 1975Va04).

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Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)							
E(level)	J^π	$T_{1/2}$	XREF			Comments	
23530 30	1^-	238 keV 24	K	PQ	S	Γ : From (1965Ov01). 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).	
23990 50	1^-	0.57 MeV 12		Q		Γ : From (1977Bu19, 1997Te14). XREF: Others: AA, AE, AH, AK, BC %IT>0; %n<100; %p<100 T=1 E(level): From average of (1976Va07, 1977Bu19, 1997Te14).	
24380 50	2^+	671 keV 67		Q		Γ : From (1976Va07, 1997Te14). 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 $^{12}\text{C}(\gamma, n)$ (1975Ah06). Γ : See resonances in $^{11}\beta(p, \gamma)$ and $^{11}\beta(p, \alpha)$ reactions in Table 12.11 (1990Aj01). %n<100; %p<100; %d<100; % α <100 E(level): From (1965Ov01). Γ : From (2005Ga59).
25960	2^+	710 keV	L	PQ			%IT>0; %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 $^{11}\beta^+p$.
27.0×10^3 3	(1^-)	1.4 MeV 2	L	P		Z	Γ : From $^{11}\text{B}(p, n)$ references in (1975Aj02). XREF: Others: AE, AI, AK %IT>0; %p<100 T=(1) E(level), Γ : From (1977Bu19). XREF: Others: BA %IT>0; % α =19.6; %p=27.4; %d=2.8 T=2 E(level), Γ : From (1978Ro08). $\Gamma_{p0}/\Gamma=0.030$ 22. $\Gamma_{p1}/\Gamma=0.080$ 23. $\Gamma_{p2}/\Gamma=0.0$ 33. $\Gamma_{p3}/\Gamma=0.084$ 32. $\Gamma_{p4+5}/\Gamma=0.08$ 5. $\Gamma_d/\Gamma=0.028$ 20.
27595.0 24	0^+	≤ 30 keV	E	K			

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Adopted Levels, Gammas 2017Ke05 (continued)

^{12}C Levels (continued)						
E(level)	J^π	$T_{1/2}$	XREF			Comments
27.8×10 ³ 2		≈350 keV	F	P	S	and $\Gamma_{\alpha 0}/\Gamma = 0.105$ 30. Partial widths from (1979Fr04). XREF: Others: AA %IT>0; %n<100; %p<100; % ³ He<100; %α<100 E(level): From (1969Gu05). Γ: From (1963Du12,1965Di06). %IT>1.7×10 ⁻³ ; % ³ He≈100 T=1
28200	1 ⁻	1.6 MeV	E			E(level),Γ: From (1972B117). XREF: Others: AI, AJ, AK %IT>0; %p<100; %d<100; % ³ He<100; %α<100 E(level): From (1972Li29,1974Sh01).
28830 40		1.54 MeV 9	E	L	P	XREF: Others: AE %IT>0; %n<100; %p<100; % ³ H<100; % ³ He<100 T=(1) E(level): From (1977Bu19). Γ: From (2008Af04). XREF: Others: BA %α≈20; %p=80 T=2 E(level),Γ: From (1976As01) $\Gamma_p/\Gamma=0.8$ 2, $\Gamma_{p0}/\Gamma=0.4$, $\Gamma_\alpha/\Gamma\approx 0.2$.
29.4×10 ³ 3	(2 ⁺)	≈800 keV	F	P	YZ	XREF: Others: AA %IT>0; %n<100; %p<100; % ³ He<100; %α<100 E(level): From (1972Li29,1974Sh01). XREF: Others: AA %IT>0; %n<100; %p<100; % ³ He<100 Also decays via ⁶ Li emission. E(level),Γ: From (1972Li29, 1974Sh01). %IT>0; % ³ He<100
29630 50		≤200 keV				E(level),Γ: From (1976As01) $\Gamma_p/\Gamma=0.8$ 2, $\Gamma_{p0}/\Gamma=0.4$, $\Gamma_\alpha/\Gamma\approx 0.2$. XREF: Others: AA %IT>0; % ³ He<100; %α<100 T=(0,1) E(level),Γ: From (1972Li29, 1974Sh01). %IT>0; % ³ He<100
30290 30	(2 ⁺ ,2 ⁻)	1.54 MeV 9	C E			E(level),Γ: From (1972Li29, 1974Sh01). %IT>0; % ³ He<100 E(level),Γ: From (1972Li29, 1974Sh01). XREF: Others: AA %IT>0; %n<100; %p<100; % ³ He<100
31160 30		2.10 MeV 15	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). %IT>0; % ³ He<100
32290 40		1.32 MeV 23	C E			E(level),Γ: From (1972Li29, 1974Sh01). %IT>0; % ³ He<100
33.47×10 ³ 21		1.93 MeV 5	E			E(level),Γ: From (1972Li29, 1974Sh01).

† See discussion on the charge-dependent matrix element between $^{12}\text{C}^*(12710,15110)$ in Table 12.18 (2017Ke05).

‡ See discussion in (1983Ne11).

Decay mode not specified.

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

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Adopted Levels, Gammas 2017Ke05 (continued)

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

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Adopted Levels, Gammas 2017Ke05 (continued) $\gamma(^{12}\text{C})$ (continued)

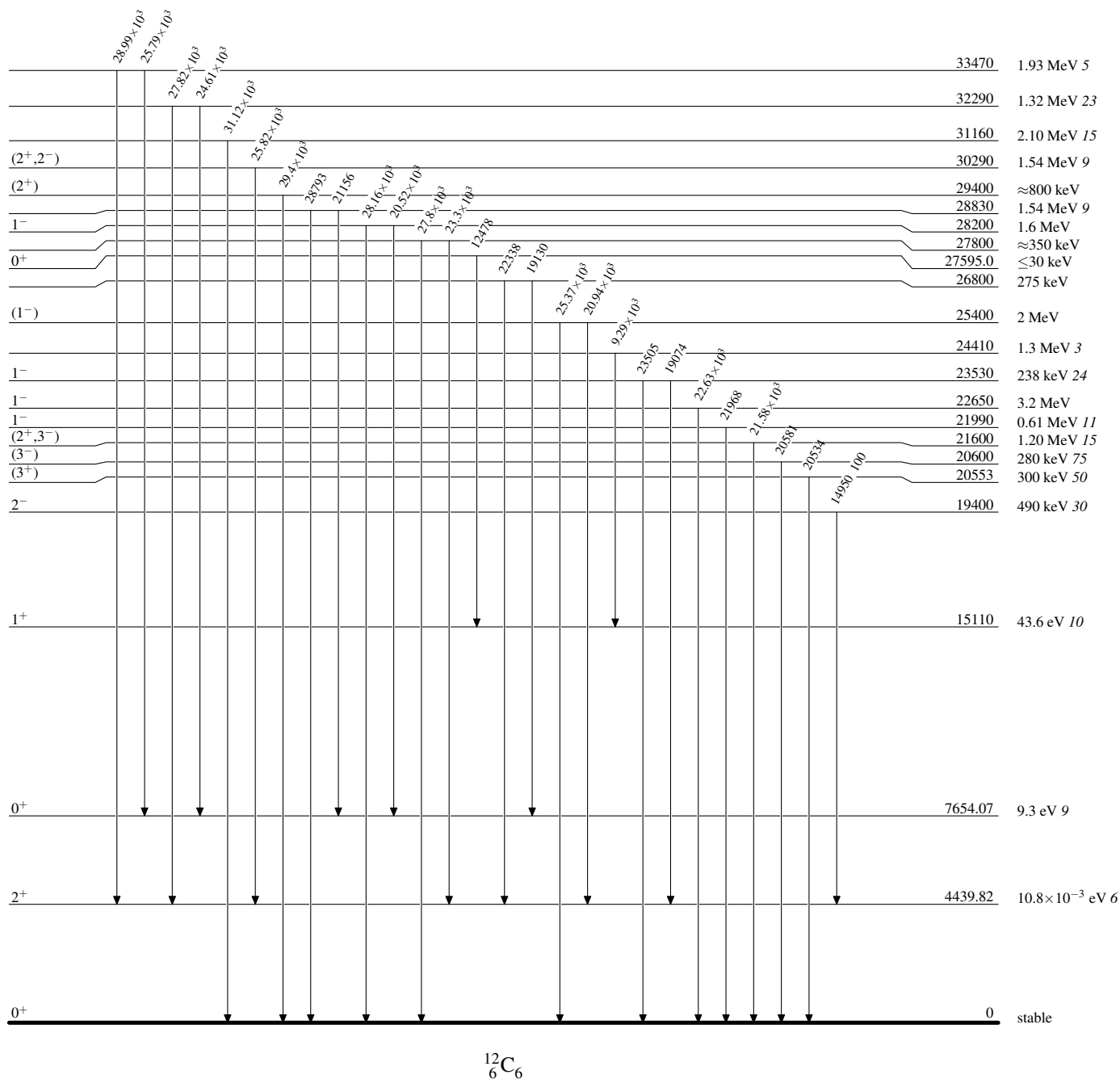
<u>$E_i(\text{level})$</u>	<u>J_i^π</u>	<u>E_γ^\dagger</u>	<u>E_f</u>	<u>J_f^π</u>
33.47×10^3		25.79×10^3	7654.07	0^+
		28.99×10^3	4439.82	2^+

[†] From level energy difference; recoil correction applied.

[‡] Γ data based on $\Gamma_{\gamma 0}$ of (1983De53) and on branching ratios of (1972A103): $^{12}\text{c}^*(15110)$ to $^{12}\text{c}^*(0,4439,7654,12710)$ are (92.2)%, (2.3.3)%, (2.6.7)%, (1.4.4)%, respectively. In addition, an undetected branching of 1.6% to $^{12}\text{c}^*(10300)$ is indicated in the β^- decay work of (1972A103). See also (1980Aj01).

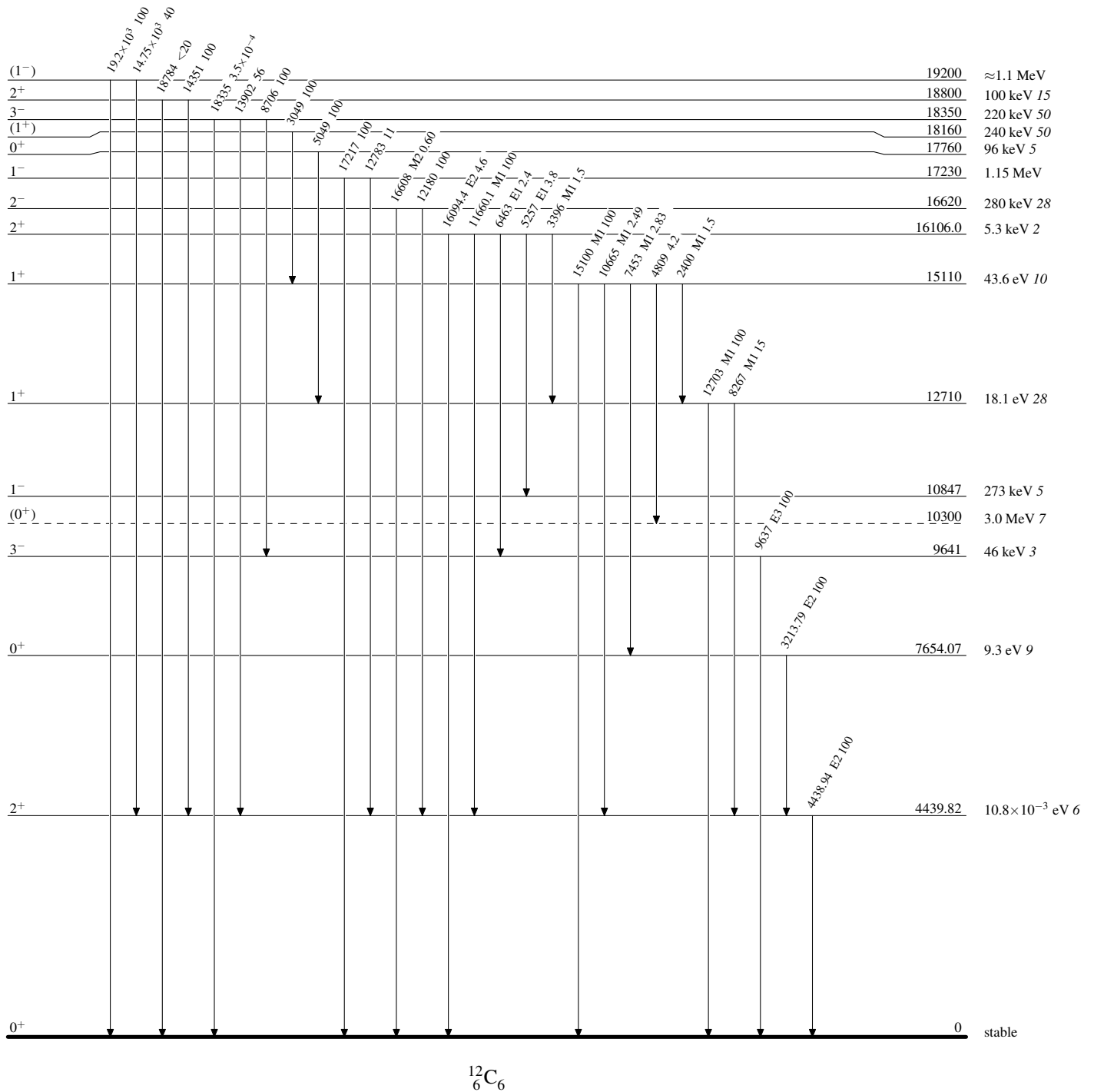
Adopted Levels, Gammas 2017Ke05Level Scheme

Intensities: Relative photon branching from each level

 $^{12}\text{C}_6$

Adopted Levels, Gammas 2017Ke05Level Scheme (continued)

Intensities: Relative photon branching from each level

 $^{12}\text{C}_6$