Table 12.13 from (2017KE05): Energy levels of ^{12}C [a]

E_x in ^{12}C (MeV ± keV)	J^π ; T	Γ_{cm} (keV)	Decay	Reactions
g.s.	0^+; 0	-	stable	4, 6, 7, 8, 10, 16, 17, 18, 19, 20, 24, 25, 26, 27, 28, 29, 30, 32, 34, 35, 39, 40, 43, 44, 45, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 103, 104, 105, 106, 107, 108
4.43982 ± 0.21	2^+; 0	10.8 ± 0.6 meV	γ	1, 4, 6, 7, 8, 10, 16, 17, 18, 19, 20, 24, 25, 26, 27, 28, 29, 30, 32, 39, 40, 43, 44, 45, 47, 49, 50, 51, 52, 56, 58, 60, 61, 64, 66, 68, 69, 70, 71, 72, 76, 77, 78, 79, 80, 81, 82, 83, 84, 87, 88, 89, 90, 91, 92, 93, 95, 96, 97, 98, 99, 101, 102, 103, 104
7.65407 ± 0.19 [g]	0^+; 0	9.3 ± 0.9 eV	π, γ, α	1, 4, 6, 7, 8, 9, 10, 16, 18, 20, 25, 26, 27, 29, 32, 40, 43, 44, 45, 47, 49, 50, 52, 56, 58, 60, 64, 76, 80, 81, 82, 83, 84, 87, 88, 90, 92, 97, 98, 99

Table 12.13 from (2017KE05): Energy levels of ^{12}C [a] (continued)

E_x in ^{12}C (MeV ± keV)	J^π ; T	Γ_{cm} (keV)	Decay	Reactions
9.641 ± 5	3^-; 0	46 ± 3 [b]	γ, α	1, 4, 6, 7, 8, 9, 16, 18, 20, 24, 25, 26, 27, 29, 30, 39, 40, 43, 44, 45, 47, 49, 50, 52, 56, 58, 60, 64, 66, 80, 81, 83, 84, 88, 90, 97, 98, 99
9.870 ± 60	2^+; 0	850 ± 85	γ, α	38, 45, 50
(9.930 ± 30) [h]	0^+	2710 ± 80		(32), 50, (76)
(10.3 ± 300) [q]	(0^+); 0	3000 ± 700	α	6, 32, 38, 44, 47, 52, 58, 60, 76, 81
10.847 ± 4	1^-; 0	273 ± 5 [c]	α	6, 7, 16, 20, 24, 25, 27, 40, 43, 45, 47, 49, 50, 52, 58, 60, 64, 66, 83, 90
11.836 ± 4	2^-	230 ± 8 [c]	γ, α	6, 7, 16, 18, 24, 25, 27, 39, 40, 44, 45, 47, 50, 58, 64, 83, 90
(12.4)	$(5^+, 4^-, 6^-, 7^+)$	broad	α	16
12.710 ± 6	1^+; 0	18.1 ± 2.8 eV	γ, α	6, 7, 16, 17, 18, 20, 24, 25, 26, 27, 32, 39, 40, 43, 44, 45, 46, 47, 49, 50, 58, 64, 76, 79, 80, 81, 82, 83, 84, 88, 89, 90
(13.3 ± 200)	4^+; 0	1700 ± 200		6, 50
13.316 ± 20	4^-; 0	360 ± 43 [d]	γ, α	8, 16, 25, 39, 44, 45, 58, 60, 64, 83, 90
14.079 ± 5	4^+; 0	272 ± 6 [e]	α	6, 7, 8, 16, 40, 43, 44, 45, 46, 47, 49, 50, 58, 60, 64, 66, 80, 81, 88, 89, 90, 92, 96, 97, 99

Table 12.13 from (2017KE05): Energy levels of ^{12}C [a] (continued)

E_x in ^{12}C (MeV ± keV)	J^π ; T	Γ_{cm} (keV)	Decay	Reactions
15.110 ± 3	1^+; 1	$(43.6 \pm 1) \times 10^{-3}$	γ, α	11, 16, 17, 18, 20, 24, 25, 27, 29, 39, 40, 43, 44, 45, 47, 49, 76, 78, 79, 80, 81, 82, 83, 88, 89, 90
15.44 ± 40 [f]	(2^+; 0)	1770 ± 200 [e]		40, 43, 45, 47, 49, 50, 81
16.1060 ± 0.8	2^+; 1	5.3 ± 0.2	γ, p, α	10, 16, 20, 24, 25, 27, 39, 40, 43, 44, 45, 47, 49, 78, 80, 81, 82, 83, 88, 89, 90, 92
16.62 ± 50	2^-; 1	280 ± 28	γ, p, α	16, 20, 22, 24, 40, 45, 49, 81
17.23	1^-; 1	1150	γ, p, α	20, 22, 24, 39, 49
17.76 ± 20 [i]	0^+; 1	96 ± 5	p, α	10, 20, 22, 40, 81, 88, 92
18.16 ± 70	(1^+; 0)	240 ± 50	γ, p	20, 81
18.35 ± 50 [j]	3^-; 1	220 ± 50	γ, p, α	20, 22, 24, 25, 27, 39, 60
18.35 ± 50 [j]	2^-; $0+1$	350 ± 50	p	21, 22, 24, 25, 27, 39, 40, 43, 45, 46, 47, 49, 50, 60
(18.39)	0^-; (1)	43	p	22
(18.6 ± 100)	(3^-)	$\Gamma_{calc} = 300$		40
18.71	($T = 1$)	100	p, α	20
18.80 ± 40	2^+	100 ± 15	γ, n, p	20, 21, 22, 49, 81, 88
19.2 ± 600	(1^-; 1)	≈ 1100	γ, n, p, α	20, 21, 22, 25, 46, 80
19.40 ± 25	2^-; 1	490 ± 30	γ, p, α	20, (21), 22, 40, 43, 45, 46, 90
19.555 ± 25	4^-; 1	485 ± 40	γ, p, α	24, 25, 40, 43, 49, 90
19.69	1^+	230 ± 35	n, p	21, 22, 43, 46, 49, 50
20.0 ± 100	2^+	375 ± 100	γ, n, p	21, 22, 40, 81
20.27 ± 50	(1^+; 1)	215 ± 45 [e]	n, p	(20), 21, 22, 45, 46, 81

Table 12.13 from (2017KE05): Energy levels of ^{12}C [a] (continued)

E_x in ^{12}C (MeV ± keV)	J^π ; T	Γ_{cm} (keV)	Decay	Reactions
20.553 ± 5	$(3^+; 1)$	300 ± 50	γ, p, α	16, 20, 39, 40, 80, 81, 90
20.60 ± 30	$(3^-; 1)$	280 ± 75 [k]	γ, n, p, α	20, 21, 22, 24, 25, 45, 46, 47, 80, 81, 90
20.99		≈ 370	n, p	21
21.60 ± 100 [l]	$(2^+, 3^-)$; 0	1200 ± 150	γ, n, p, α	20, 21, 22, 40, 41, 45, 46, 49, 50, 66, 81
21.99 ± 50	$1^-; 1$	610 ± 110 [e]	γ, n, p	20, 21, 22, 40, 45, 46, 47
22.37 ± 50	$(1^-; 1)$	290 ± 40	n, p	21, 22, 25, 45, 50, 81, 90
(22.40 ± 200)	(5^-); 1		α	50
22.65 ± 100 [m]	$1^-; 1$	3200	γ, n, p, α	20, 21, 34, 35, 39, 40, 43, 45, 46, 80
23.04	$(2^-; 1)$	60	n, p	(20), 21, 80
23.53 ± 30	$1^-; 1$	238 ± 24	γ, n, p, α	10, 20, 21, 40, 45, 49, 80
23.99 ± 50 [e]	$1^-; 1$	570 ± 120 [e]	γ, n, p	21, 38, 40, 45, 46, 47, 50, 80
24.38 ± 50	$2^+; 0$	671 ± 67	n, p	21, 46
24.41 ± 150		1300 ± 300 [n]	γ, n, p	20, 21
24.90 ± 200		920	n, p	(20), 21, 40, 47
25.3 ± 150	$(1^-; 1)$	510 ± 100	n, p	21, 45, 80
25.40 ± 100 [o]	(1^-)	2 MeV	γ, n, p	13, 20, 34, 35, 40, 49, 50, 66, 80, 81
25.96	2^+	710	n, p, d, α	13, 14, 15, 21, 45, 49
26.80		275	n, p, d, α	14, 15, 20, 21
27.00 ± 300	$(1^-; 1)$	1400 ± 200	γ, p	13, 20, (38), 45, 47, 50
27.595 ± 2.4	$0^+; 2$	≤ 30	p, d, α	10, 88
27.8 ± 200		≈ 350	γ, n, p, ^{3}He	5, 20, 40
28.2	$1^-; 1$	1600	γ, ^{3}He	4
28.83 ± 40		1540 ± 90 [p]	γ, p, d, ^{3}He, α	4, 15, 20, 49, 50

Table 12.13 from (2017KE05): Energy levels of ^{12}C [a] (continued)

E_x in ^{12}C (MeV $\pm$ keV)	J^π ; T	Γ_{cm} (keV)	Decay	Reactions
29.4 ± 300	(2^+; 1)	≈ 800	γ, n, p, t, ^{3}He	4, 20, 38, 39, 45
29.63 ± 50	$T = 2$	≤ 200		88
30.29 ± 30	(2^+; 0), (2^-; 1)	1540 ± 90	γ, ^{3}He, α	1, 4, 40
31.16 ± 30		2100 ± 150	γ, ^{3}He	4
32.29 ± 40		1320 ± 230	γ, n, p, ^{3}He, ^{6}Li	2, 4, 40
33.47 ± 210		1930 ± 50	γ, ^{3}He	4

[a] See also Table 12.14.

[b] Weighted average of (1956DO41, 1962BR10, 2012AL22, 2013KO14) with external errors.

[c] Average of Γ_{lab} values from (1961HI08, 1971RE03) and Γ_{cm} values from (1962BR10, 2012AL22).

[d] Average of Γ_{lab} value from (1971RE03) and Γ_{cm} values from (1962BR10, 1966WA16). See also $\Gamma = 550 \pm 80$ (1961HI08).

[e] Weighted average with external errors.

[f] Mainly from (1983DE53); see also 15380 ± 50 from (1997TE14).

[g] See (1976NO02).

[h] Support for a group at $E_x = 9.93$ MeV is found separately in the ^{12}C(α, α') works of (2003JO07) and (2011IT08). In (2011IT08) the group is suggested as a 0_3^+ and 0_4^+ doublet with $E_x = 9.04 \pm 0.09$ MeV and $\Gamma = 1.45 \pm 0.18$ MeV and $E_x = 10.56 \pm 0.06$ MeV and $\Gamma = 1.42 \pm 0.08$ MeV, 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 $J^\pi = 2^+$ and 0^+ states at $E_x = 11.1 \pm 0.3$ and 11.2 ± 0.3 MeV, 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 $E_x = 9.93 \pm 0.03$ is accepted. See discussion in reaction 50.

[i] See also values in reaction ^{11}B(p, p).

[j] 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 $J^\pi = 2^-$ and 3^-. At present, Γ for the 3^- state is taken from (1971RE03) while Γ of the 2^- state is taken from (1983NE11). However, $J^\pi = (2^+)$ has been reported in (1977BU19, 1987KI16).

[k] From method of best representation averaging technique (2014BI13).

[l] Possible unresolved states with $\Gamma = 1450$ and $\Gamma = 450$ keV.

[m] The GDR: In ^{12}C(γ, p) the resonance appears around 22.5 MeV with $\Gamma \approx 3.2$ MeV; in ^{12}C(γ, n) the resonance is fragmented into two peaks at 22.3 MeV and 23.3 MeV with $\Gamma \approx 1$ MeV and 2 MeV, respectively.

[n] $(2J + 1)\Gamma_{p_0}\Gamma_\gamma/\Gamma = 20.8 \pm 2.8$.

[o] (2005RU16) suggest this Giant Dipole Resonance is fragmented into three components at 25.50, 25.69 and 26.53 MeV with $\Gamma = 0.37$, 0.37 and 1.24 MeV, respectively.

[p] $(2J + 1)\Gamma_{p_0}\Gamma_\gamma/\Gamma = 150 \pm 18$ eV.

[q] 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 $E_{\text{x}} = 7.65$ 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 $E_{\text{x}} = 10.3$ MeV group, and because of still unresolved questions on the $J^{\pi} = 0^{+}$ (and 2^{+}) strength in the $E_{\text{x}} = 9$-13 MeV region. However, future studies may provide different and more complete interpretation of this region. See discussion in reactions 32, 50, 76.