Coulomb excitation 2002Zi06,1972Ba90,1976Pa13

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen, Balraj Singh	NDS 164, 1 (2020)	15-Feb-2020

Acknowledgement for modifications made May 06, 2021: evaluators are grateful to Professor H.T. Fortune (University of Pennsylvania) for pointing out mistake in B(E2)(W.u.) value of 52.6-keV transition from 787.4, 2^+ to 734.8, 0^+ level; and to Dr. Adam Hayes (NNDC, BNL) for discussion and advice about analysis of Coulomb excitation data in 2002Zi06 article.

2002Zi06 (also 2002Zi02,2006Wr01): (^{20}Ne,^{20}Ne′γ) E=50 MeV; (^{84}Kr,^{84}Kr′γ) E=250 MeV; (^{136}Xe,^{136}Xe′γ) E=614 MeV at Japan Atomic Energy Research Institute. γ rays were detected with HPGe detectors and scattered particles were detected with PIN-diodes or scintillators. Measured Eγ, Iγ, γ yields, (particle)(γ)-coin. Deduced levels, E2 and M1 matrix elements, from GOSIA analysis.

1978La17: (α,$\alpha'\gamma$) E=8 MeV. (^{12}C,^{12}C′γ) E=24 MeV. Measured Ice for 735 relative to 787γ, deduced B(E2) from the 735, 0^+ state to 787, 2^+.

1976Pa13, 1979Pa11: (α,α') E=8.0 MeV. (^{16}O,^{16}O′) E=36.5 MeV. FWHM=30 keV for α and 140 keV for ^{16}O. Revised analysis given by 1979Pa11.

1972Ba90: (α,$\alpha'\gamma$) E=7.2 MeV; (^{16}O,^{16}O′γ) E=35-44.8 MeV. Beams were produced from the University of Montreal tandem Van de Graaff accelerator. γ rays were detected with a Ge(Li) detectors. Measured Eγ, Iγ, γ yields. Deduced levels, transition strengths.

Other measurements:

2001Ma17: (^{32}S,^{32}S′) E=100 MeV. Measured $\gamma(\theta$,H), (particle)(γ) coin. Deduced g factor for first 2^+ state.

2011Ch23: (^{98}Mo,^{98}Mo′)=240 MeV. Measured g factor of the first 2^+ state.

1978HaYJ (also 1979HaZH): (^{40}Ca,^{40}Ca′) E=150 MeV, measured g factor.

1972SiZX, 1972SiZP: (^{35}Cl,^{35}Cl′) E=100 MeV, measured $T_{1/2}$ by Doppler broadening.

1971WaZP: (α,α'); (^{12}C,^{12}C′); (^{16}O,^{16}O′); (^{35}Cl,^{35}Cl′).

1969He11: (^{16}O,^{16}O′γ). g-factor measurement by recoil-implantation.

1965Ro09: (α,$\alpha'\gamma$) E=6-9 MeV, measured Eγ.

1962Ga13 (also 1962Ga10,1962Er05): (^{14}N,^{14}N′) E=41 MeV.

1958St32: (p,p′) E=1.5-3.3 MeV.

1956Te26: (α,α') E=6-7 MeV.

2011Wr02: deduced electromagnetic reduced matrix elements using GOSIA code.

2008StZT: analysis of recoil-in-vacuum angular distributions and g factors.

^{98}Mo Levels

B(E2) values for levels above 787 from 1972Ba90 have been decreased (evaluator) by 7.1% since the B(E2)(from g.s.) for 787, 2^+ state reported by 1972Ba90 is larger by this amount than in the later work from the same group (1979Pa11,1976Pa13). It is assumed that the difference is due to systematic errors (probably target thickness) in 1972Ba90.

E(level)‡	J^π†	$T_{1/2}$	Comments
0.0	0^+		$\langle Q_0^2\rangle$=0.29 *1*, $\langle\cos(3\delta)\rangle$ =0.10 *3* (2002Zi06, interpreted as triaxial 0^+ state).
734.8 *5*	0^+		$\langle Q_0^2\rangle$=0.29 *3*, $\langle\cos(3\delta)\rangle$ =0.90 *+10−17* (2002Zi06, interpreted as prolate 0^+ state).
787.43 *22*	2^+	3.47 ps *7*	g=+0.485 *29* (2011Ch23) β_2=0.174 *5* (1972Ba90) Q=−0.26 *9* (1979Pa11) g: others: +0.478 *42* (2001Ma17), and 0.495 *67* (reanalysis by 2001Ma17 of 0.49 *8* in 1978HaYJ), +0.34 *18* (1969He11). $T_{1/2}$: from B(E2)(from g.s.)=0.2692 *54* (weighted average in 2016Pr01 evaluation from 0.277 *8* (2002Zi06); 0.267 *4* (1979Pa11, 0.266 *5* in 1976Pa13); 0.286 *14* (1972Ba90); 0.275 *15* (1971WaZP); 0.270 *32* (1962Ga13); 0.26 *4* (1962Er05); 0.270 *32* (1958St32); 0.27 *4* (1956Te26); and B(E2)↑=0.260 *10* deduced from $T_{1/2}$=3.60 ps *14* (Doppler broadening,1972SiZP). Final uncertainty was adjusted to 2%. Value of B(E2) is 0.2695 *57* in 2016Pr01 evaluation, without the inclusion of 2002Zi06 value.

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Coulomb excitation 2002Zi06,1972Ba90,1976Pa13 (continued)

^{98}Mo Levels (continued)

E(level)‡	Jπ†	$T_{1/2}$	Comments
			B(E2)(from 735,0$^+$)=0.130 *+14−34* (2002Zi06). Other: 0.293 *14* (1978La17). Value from 2002Zi06 is preferred as the analysis considers a large dataset of Coulomb excitation yields, with a least-squares fit of these yields, and using some well-known spectroscopic parameters for ^{98}Mo. E2 matrix element (from g.s.)=+0.526 *+8−6* (2002Zi06). E2 matrix element (from 735,0$^+$)=+0.36 *+2−5* (2002Zi06). Diagonal E2 matrix element=−0.06 *3* (2002Zi06). Q: for constructive interference from higher states (as is the general trend for nuclides in this mass region,1976Pa13). For destructive interference Q=+0.09 *9* (1979Pa11). Other: −0.20 *9* or +0.16 *9* for constructive interference and −0.18 *9* or +0.14 *9* for destructive interference (1976Pa13). 1978La17 do not quote measured Q but indicate that the value is ≈70% of that predicted by the rotational model.
1432.30 *24*	2$^+$	1.53 ps *16*	β_2=0.037 *2* (1972Ba90) $T_{1/2}$: from B(E2)(from g.s.)=0.0139 *15* (weighted average of 0.0151 *9* (2002Zi06), 0.0120 *11* (1972Ba90)) and adopted branching. Other B(E2): 1962Ga13. B(E2)(from 735,0$^+$)=0.063 *7* (2002Zi06), 0.032 *11* (1972Ba90). B(E2)(from 787,2$^+$)=0.124 *11* (2002Zi06), 0.134 *24* (1972Ba90). E2 matrix element (from g.s.)=+0.123 *+3−4* (2002Zi06). E2 matrix element (from 735,0$^+$)=+0.251 *9* (2002Zi06). E2 matrix element (from 787,2$^+$)=+0.25 *1* (2002Zi06). M1 matrix element (from 787,2$^+$)=+0.49 *1* (2002Zi06). Diagonal E2 matrix element=−0.025 *+50−48* (2002Zi06).
1510.2 *4*	4$^+$	2.53 ps *5*	$T_{1/2}$: from B(E2)(from 787,2$^+$)=0.204 *4* (2002Zi06). Other B(E2)=0.220 *23* (1972Ba90). B(E2)(from 1432,2$^+$)=0.0180 *25* (2002Zi06). E2 matrix element (from 787,2$^+$)=+1.01 *1* (2002Zi06). E2 matrix element (from 1432,2$^+$)=−0.30 *2* (2002Zi06). Diagonal E2 matrix element=−43 *+6−4* (2002Zi06).
1758.7 *3*	2$^+$	1.42 ps *6*	β_2=0.11 *5* (1972Ba90) $T_{1/2}$: from B(E2)(from 735,0$^+$)=0.097 *3* (2002Zi06) and adopted branching. Other B(E2)=0.10 *9* (1972Ba90). B(E2)(from g.s.)=0.00044 *4* (2002Zi06), <0.0005 (1972Ba90). B(E2)(from 787,2$^+$)=0.0029 *+10−5* (2002Zi06), 0.015 *12* (1972Ba90). B(E2)(from 1432,2$^+$)=0.46 *6* (2002Zi06). B(E2)(from 1510,4$^+$)=0.021 *+4−3* (2002Zi06). E2 matrix element (from g.s.)=−0.021 *1* (2002Zi06). E2 matrix element (from 735,0$^+$)=+0.311 *6* (2002Zi06). E2 matrix element (from 787,2$^+$)=+0.12 *+2−1* (2002Zi06). E2 matrix element (from 1432,2$^+$)=−1.51 *+8−9* (2002Zi06). E2 matrix element (from 1510,4$^+$)=−0.44 *+5−3* (2002Zi06). Diagonal E2 matrix element=−0.3 *1* (2002Zi06). M1 matrix element (from 787,2$^+$)=+0.234 *8* (2002Zi06).
2017.5 *3*	3$^-$	65 ps *7*	β_3=0.220 *11* (1972Ba90) $T_{1/2}$: from B(E3)(from g.s.)=0.124 *12* (1972Ba90) and adopted branching.
2345	6$^+$	5.2 ps *2*	E(level): level from 2002Zi06. $T_{1/2}$: from B(E2)(from 1510,4$^+$)=0.0391 *12* (2002Zi06). E2 matrix element (from 1510,4$^+$)=+0.593 *9* (2002Zi06).

† From Adopted Levels.
‡ From least-squares fit to Eγ data.

$\gamma(^{98}Mo)$

E_i(level)	J^{π}_i	E_γ†	I_γ‡	E_f	J^{π}_f	Mult.#	δ#	α@	$I_{(\gamma+ce)}$	Comments
734.8	0^+	734.8		0.0	0^+	E0				E_γ: from Adopted Gammas.
787.43	2^+	(52.63 5)	6.5×10^{-5} 12	734.8	0^+	[E2]		12.06 18	0.00085 16	B(E2)(W.u.)=9.7 +10−25 E_γ: from the Adopted dataset. Transition expected from Coulomb excitation. $I_{(\gamma+ce)}$: from B(E2)↑=0.130 +14−34 (2002Zi06). Other: 0.00191 9 from B(E2)↑=0.293 14 (1978La17). B(E2)(W.u.) from B(E2)↑=0.130 +14−34 (2002Zi06). Other B(E2)(W.u.)=21.8 11 from B(E2)↑=0.293 14 (1978La17).
		787.5 3	100	0.0	0^+	E2				
1432.30	2^+	644.9 3	100	787.43	2^+	E2+M1	+1.69 16			B(M1)(W.u.)=0.027 3; B(E2)(W.u.)=4.5 8 δ: other: +0.27 2 from E2 and M1 matrix elements of 2002Zi06.
		697.6 5	5.8 16	734.8	0^+	(E2)				
		1432.2 3	82 7	0.0	0^+	E2				
1510.2	4^+	78.0	0.00052 8	1432.30	2^+	[E2]		3.0		B(E2)(W.u.)=15 3 γ expected from B(E2) value of 2002Zi06.
		722.8 3	100	787.43	2^+	E2				
1758.7	2^+	248.5	0.16 3	1510.2	4^+	[E2]				I_γ: deduced from B(E2) values of 2002Zi06.
		326.4	5.7 5	1432.30	2^+	(M1(+E2))	−0.17 22			I_γ: from Adopted Gammas.
		971.3 5	70 15	787.43	2^+	E2+M1	−0.97 14			B(M1)(W.u.)=0.0057 14; B(E2)(W.u.)=1.0 4 δ: other: +0.42 7 from E2 and M1 matrix elements of 2002Zi06.
		1023.7 5	100	734.8	0^+	E2				
		1758.8 5	<4	0.0	0^+					
2017.5	3^-	258.9 5	27 2	1758.7	2^+	(E1)				
		1230.1 3	100	787.43	2^+	(E1)				
		2017.4 5	23 2	0.0	0^+	[E3]				B(E3)(W.u.)=37 6
2345	6^+	835		1510.2	4^+	E2				E_γ: from 2002Zi06.

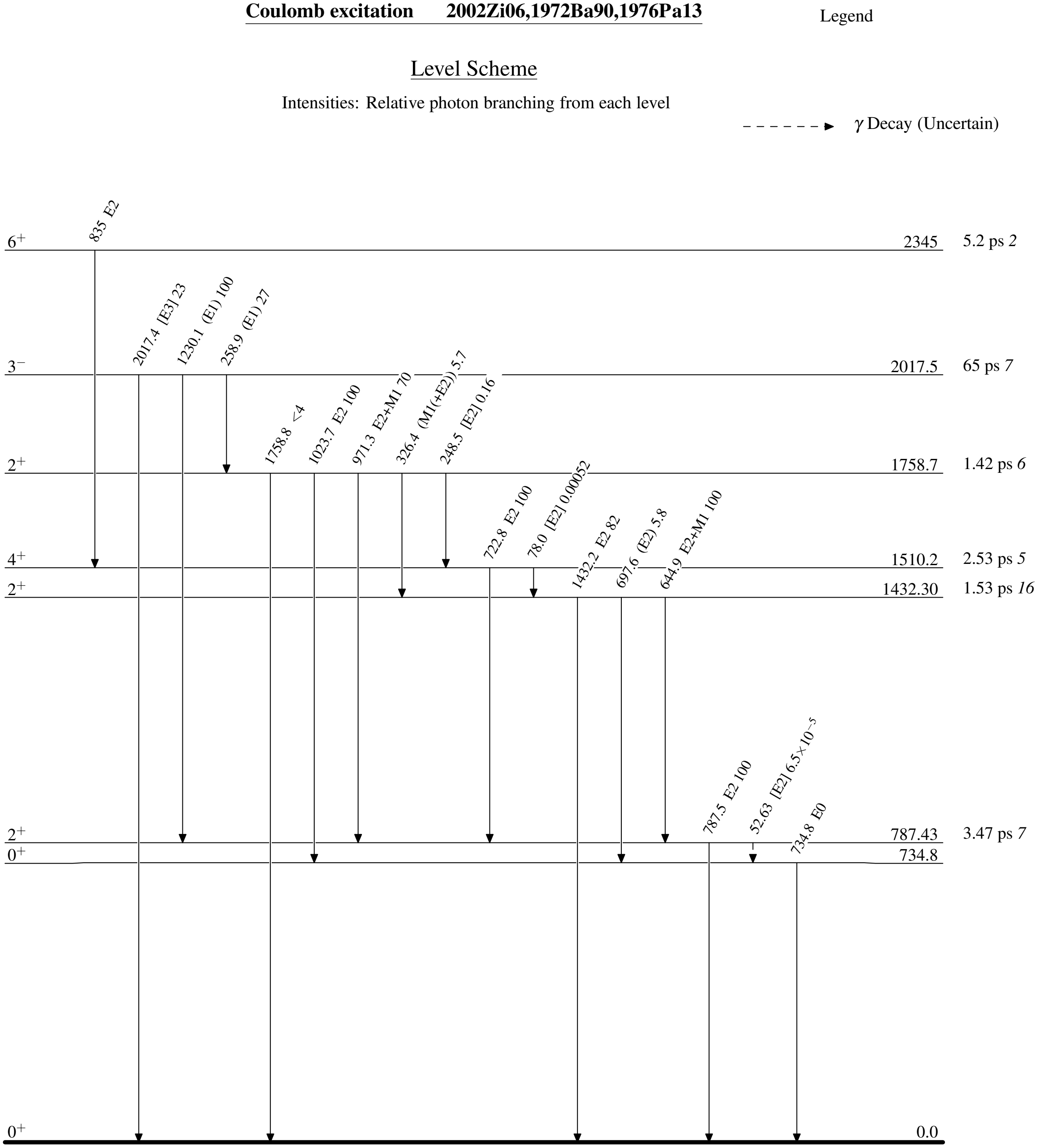
† From 1972Ba90, unless otherwise stated.
‡ Photon branching ratios (1972Ba90).
# From Adopted Gammas.
@ Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with Frozen orbital approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

$^{98}_{42}Mo_{56}$-3

Coulomb excitation 2002Zi06,1972Ba90,1976Pa13

Level Scheme

Intensities: Relative photon branching from each level



$^{98}_{42}Mo_{56}$