Coulomb excitation **2012Wr03,1985Mu09,1972Ba90**

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 172,1 (2021)	31-Jan-2021

2012Wr03 (also 2011Wr02,2011Wr01,2008Wr01,2006Wr01,2005Wr01): E=76 MeV ^{32}S beam was produced at the U-200P cyclotron at the Heavy Ion Laboratory, University of Warsaw. The target was a 44 mg/cm^2 thick ^{100}Mo foil. The recoiling nuclei were stopped in the target and the depopulating γ rays were detected by the OSIRIS-2 array consisting of 12 HPGe detectors with anti-Compton BGO shields. The scattered projectiles were detected by 45 small silicon detectors, PiN diodes, placed inside a compact spherical chamber of 5 cm radius. Measured Eγ, Iγ, $\gamma(\theta)$, (particle)γ-coin. Deduced levels, reduced matrix elements using the GOSIA code, quadrupole deformation parameters, and quadrupole asymmetry parameter. Comparisons with theoretical predications of the general Bohr Hamiltonian (GBH) model. 2008Wr01 and 2006Wr01 used ^{20}Ne beam at 90 MeV. 2006Wr01 and 2005Wr01 used ^{40}Ar beam at 90 MeV. 2012Wr03 deduced a set of 26 reduced matrix elements with relative signs from the analysis using the GOSIA code by using the following known spectroscopic data from literature as starting input data points in their GOSIA analysis: half-lives of the first three 2^+ states, excited 0^+ state, first two 4^+ states, first 3^- and 6^+ states; δ(E2/M1) mixing ratios for transitions from the second and the third 2^+ states to the first 2^+ states; and γ-ray branching ratios for the decays of the second and third 2^+ states, first 3^- state, and the second 4^+ state, as listed in Table I, II and III, respectively in 2012Wr03.

2001Ma17: beam=100 MeV ^{32}S. Target=^{100}Mo. Measured g factor of the first 2^+ state by transient-field technique.

1986Ho25: beam=350 MeV ^{100}Mo. Target=^{208}Pb. Measured Eγ, Iγ following Coulomb excitation. Deduced levels, B(E2) for first 8^+ to 6^+.

1985Mu09: beams=185−MeV ^{58}Ni, 89-MeV ^{32}S and 42-MeV ^{16}O. Target=^{100}Mo. Measured Eγ, Iγ, $\gamma(\theta)$, particle(θ), and Coulomb excitation. Deduced levels, E2 matrix elements, B(E2), quadrupole moment.

1978HaYJ: beam=130 MeV ^{40}Ca. Target=^{100}Mo. Measured g factor of the first 2^+ state. 1971WaZI is by the same group using 40 and 45 MeV ^{16}O, 95 MeV ^{35}Cl beams. Target=^{100}Mo. B(E2) values deduced.

1977Na06: 8.5 MeV α and 33 MeV ^{16}O. Target=^{100}Mo. Measured quadrupole moment of the first 2^+ state.

1975Bo39: beam=20-61 MeV ^{18}O. Target=^{100}Mo. Measured lifetimes of levels by recoil distance Doppler shift method.

1972Ba90: 7.2 MeV α and 35-45 MeV ^{16}O. Target=^{100}Mo. Measured Eγ, Iγ, Coulomb excitation σ. Deduced levels, B(E2), B(E3). 1976Pa13 is by the same group where quadrupole measurement of the first 2^+ state was measured by Coulomb excitation using beams of 8.0-MeV α and 36-MeV ^{16}O.

1969He11: beam=33-38 MeV ^{16}O. Target=^{100}Mo. Measured g factor of the first 2^+ state by ion implantation perturbed angular correlation technique (IMPAC).

1965Ro09: beam=6-9 MeV α. Target=^{100}Mo. Measured Eγ.

1962Ga13, 1962Ga10, 1962Er05: beam=36, 41 MeV ^{14}N, 41 MeV. Target=^{100}Mo. Measured Eγ, Iγ, $\gamma(\theta)$. Deduced B(E2).

1961St02, 1958St32, 1955St57: beam=8-10 MeV α and 1.5-3.3 MeV protons. Target=^{100}Mo. Measured Eγ, Iγ. Deduced B(E2).

1956Te26: beam=6 MeV α. Target=^{100}Mo. Measured Eγ, Iγ. Deduced B(E2) for the first 2^+ state.

μ measurement: 2001Ma17, 1978HaYJ, 1969He11.

Q measurement: 2011Wr01, 1977Na06, 1976Pa13.

$T_{1/2}$ by recoil-distance Doppler-shift method: 1985Mu09, 1975Bo39.

^{100}Mo Levels

E(level)	J^π[†]	$T_{1/2}$[‡]	Comments
0.0	0^+		Model independent quadrupole overall shape parameter and quadrupole asymmetry parameters deduced from E2 matrix elements are <Q^2>=0.47 *3*, <Q^{3}cos3δ>=0.01 *6*, respectively (2012Wr03).
535.6	2^+	12.4 ps *3*	g=+0.471 *33* (2001Ma17) g−factor: value adopted by 2001Ma17 from weighted average of +0.515 *42* (transient-field technique,2001Ma17) and +0.404 *52* (original value of +0.43 *6* from 1978HaYJ re-evaluated by 2001Ma17 for consistent field parameters). Other: 0.34 *18* (IMPAC method, 1969He11, using $T_{1/2}$(536 level)=10.3 ps *10*). Q: −0.39 *8* (for constructive interference) or −0.13 *8* (for destructive interference) (1977Na06). Other: −0.42 *9* or −0.10 *9* (1976Pa13). B(E2)↑: 0.518 *11* from weighted average of 0.511 *9* (1976Pa13), 0.526 *26* (1972Ba90), 0.61 *6* (1962Ga13), 0.63 *10* (1962Er05), 0.614 *62* (1958St32,1955St57), 0.66 *10* (1956Te26).

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Coulomb excitation 2012Wr03,1985Mu09,1972Ba90 (continued)

^{100}Mo Levels (continued)

E(level)	J^{π}[†]	$T_{1/2}$[‡]	Comments
			$T_{1/2}$: weighted average of 13.6 ps *7* (recoil-distance Doppler-shift method,1975Bo39), and half-lives of 12.56 ps *22* (1976Pa13), 12.2 ps *6* (1072Ba90), 10.5 ps *12* (1962Ga13), 10.2 ps *16* (1962Er05), 10.5 ps *11* (1958St32) and 9.7 ps *15* (1956Te26), deduced from respective B(E2)↑ values determined in the measurement of Coulomb excitation yields. Other: 13.9 ps *4*, deduced by evaluators from B(E2) in 2012Wr03, where 13.6 ps *7* (1975Bo39) was used as input data in their GOSIA analysis. Reduced E2 matrix element from g.s.=+0.68 *1* (2012Wr03). Reduced diagonal E2 matrix element=−0.33 *10* (2012Wr03). Spectroscopic Q=−0.25 *7* (2011Wr01, deduced from reduced diagonal E2 matrix element=−0.33 *10*).
695.1	0^+	2.2 ns *3*	Model independent quadrupole overall shape parameter and quadrupole asymmetry parameters deduced from E2 matrix elements are $<Q^2>$=0.62 *3*, $<Q^3\cos 3\delta>$=0.42 *6*, respectively (2012Wr03). B(E2)(from 536,2^+)=0.038 *6* (1972Ba90). B(E2)(from 536,2^+)=0.0526 *+19−8* (2012Wr03). Reduced E2 matrix element from 536,2+=+0.513 *+9−4* (2012Wr03). $T_{1/2}$: from B(E2) and branching ratio. Other: 1.52 ns *+5−8*, deduced by evaluators from B(E2) in 2012Wr03, where 1.580 ns *40* (1990Ma01) was used as input data in their GOSIA analysis.
1063.8	2^+	6.6 ps *6*	$T_{1/2}$: from weighted average of 7.1 ps *12* (1975Bo39); 6.5 ps *6* (1985Mu09), both measurements used recoil-distance Doppler-shift method; and $T_{1/2}$=5.0 ps *5* from B(E2) in 1972Ba90; 5.3 ps *+3−4*, deduced by evaluators from B(E2) (from 536,2^+ level) in 2012Wr03, where 6.45 ps *58* (1985Mu09) was used as input data in their GOSIA analysis. B(E2)(from 536,2^+)=0.178 *21* (1972Ba90, 528γ assumed pure E2). Others: 1961St02, 1962Ga13, 1962Ga10. B(E2)(from g.s.)=0.0113 *8* (1972Ba90). B(M1(from 536,2^+)=0.0013 *+11−8* (2012Wr03). B(E2)(from g.s.,0^+)=0.0106 *+4−2* (2012Wr03). B(E2)(from 536,2^+)=0.177 *+8−7* (2012Wr03). B(E2)(from 695,0^+)=0.102 *+20−12* (2012Wr03). Reduced E2 matrix element from g.s.,0+=+0.103 *+2−1* (2012Wr03). Reduced E2 matrix element from 536,2+=+0.94 *2* (2012Wr03). Reduced E2 matrix element from 695,0+=−0.32 *+3−2* (2012Wr03). Reduced M1 matrix element from 536,2+=+0.08 *3* (2012Wr03). Reduced diagonal E2 matrix element=+1.20 *+10−8* (2012Wr03).
1136.1	4^+	3.8 ps *3*	$T_{1/2}$: from weighted average of 3.8 ps *5* (1975Bo39) and 3.83 ps *34* (1985Mu09), both measurements used recoil-distance Doppler-shift method. Other: 3.67 ps *+12−16*, deduced by evaluators from B(E2) (from 536,2^+ level) in 2012Wr03, where 3.83 ps *34* (1985Mu09) was used as input data in their GOSIA analysis. B(E2)(from 536,2^+)=0.444 *41* (1985Mu09), 0.351 *30* (1972Ba90). B(E2)(from 1064,2^+)<0.008 (1985Mu09). B(E2)(from 536,2^+)=0.354 *+16−11* (2012Wr03). B(E2)(from 1064,2^+)=0.119 *+43−29* (2012Wr03). Reduced E2 matrix element from 536,2+=+1.33 *+3−2* (2012Wr03). Reduced E2 matrix element from 1064,2+=+0.77 *+13−10* (2012Wr03). Reduced diagonal E2 matrix element=−0.35 *18* (2012Wr03).
1463.9	2^+	2.9 ps *7*	$T_{1/2}$: Other: 2.25 ps *+9−10*, deduced by evaluators from B(E2) (from 695, 0^+ level) in 2012Wr03, where 2.93 ps *68* (1985Mu09) was used as input data in their GOSIA analysis. B(E2)(from g.s.)<0.0009 (1985Mu09). B(E2)(from 536,2^+)=0.023 *10* (1985Mu09). B(E2)(from 694,0^+)=0.38 *16* (1985Mu09). B(E2)(from 1064,2^+)<0.072 (1985Mu09). B(E2)(from 1136,4^+)=0.03 *2* (1985Mu09). B(M1)(from 536,2^+)=0.00816 *24* (2012Wr03). B(E2)(from g.s.,0^+)=0.00026 *+11−9* (2012Wr03). B(E2)(from 536,2^+)=0.00098 *+21−16* (2012Wr03). B(E2)(from 695,0^+)=0.256 *+8−6* (2012Wr03). B(E2)(from 1064,2^+)=0.032 *+29−17* (2012Wr03). B(E2)(from 1136,4^+)=0.077 *+13−7* (2012Wr03).

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Coulomb excitation 2012Wr03,1985Mu09,1972Ba90 (continued)

^{100}Mo Levels (continued)

E(level)	Jπ†	T1/2‡	Comments
			Reduced E2 matrix element from g.s.,0+=−0.016 *3* (2012Wr03).
			Reduced E2 matrix element from 536,2+=−0.070 *+7−6* (2012Wr03).
			Reduced E2 matrix element from 695,0+=+0.506 *+8−6* (2012Wr03).
			Reduced E2 matrix element from 1064,2+=+0.40 *+15−13* (2012Wr03).
			Reduced E2 matrix element from 1136,4+=+0.83 *+7−4* (2012Wr03).
			Reduced M1 matrix element from 536,2+=+0.202 *3* (2012Wr03).
			Reduced diagonal E2 matrix element=−0.24 *+12−7* (2012Wr03).
1771.4	(4+)	2.5 ps *4*	T1/2: other: 1.78 ps *+17−19*, deduced by evaluators from B(E2) (from 1064,2+ level) in 2012Wr03, where 2.45 ps *41* (1985Mu09) was used as input data in their GOSIA analysis.
			B(E2)(from 1064,2+)=0.158 *25* (1985Mu09).
			B(E2)(from 1136,4+)=0.084 *14* (1985Mu09).
			B(E2)(from 536,2+)=0.00079 *+76−27* (2012Wr03).
			B(E2)(from 1064,2+)=0.208 *+17−12* (2012Wr03).
			B(E2)(from 1136,4+)=0.109 *11* (2012Wr03).
			Reduced E2 matrix element from 536,2+=0.063 *+25−12* (2012Wr03).
			Reduced E2 matrix element from 1064,2+=+1.02 *+4−3* (2012Wr03).
			Reduced E2 matrix element from 1136,4+=+0.99 *5* (2012Wr03).
1847.1	6+	1.20 ps *17*	T1/2: other: 1.21 ps *+9−8*, deduced by evaluators from B(E2) (from 1136,4+ level) in 2012Wr03, where 1.20 ps *17* (1985Mu09) was used as input data in their GOSIA analysis.
			B(E2)(from 1136,4+)=0.41 *10* (1985Mu09). Other: 1986Ho25.
			B(E2)(from 1136,4+)=0.372 *+25−24* (2012Wr03).
			Reduced E2 matrix element from 1136,4+=+1.83 *6* (2012Wr03).
1908.3	3−	12.0 ps *30*	T1/2: other: 20 ps *5* from B(E3)=0.144 *15* (weighted average of values from 1985Mu09 and 1972Ba90). 2012Wr03 used 12.0 ps *30* (1985Mu09) in their GOSIA analysis.
			B(E3)(from g.s.)=0.154 *15* (1985Mu09), 0.132 *17* (1972Ba90).
			B(E1)(from 536)=3.2×10−8 *16* (1985Mu09).
			B(E1)(from 1064)=3.9×10−7 *23* (1985Mu09).
			B(E1)(from 536,2+)=0.00054 *+13−10* (2012Wr03).
			B(E1)(from 1064,2+)=0.0051 *+14−6* (2012Wr03).
			B(E3)(from g.s.,0+)=0.194 *9* (2012Wr03).
			B(E3)(from 536,2+)=0.022 *+4−5* (2012Wr03).
			Absolute reduced E3 matrix element from g.s.,0+=+0.44 *1* (2012Wr03).
			Absolute reduced E3 matrix element from 536,2+=+0.33 *+3−4* (2012Wr03).
			Absolute reduced E1 matrix element from 536,2+=+0.052 *+6−5* (2012Wr03).
			Absolute reduced E1 matrix element from 1064,2+=+0.16 *+2−1* (2012Wr03).
2626.2 *10*	8+	0.58 ps *9*	T1/2: from B(E2)↓=0.34 *5* (1986Ho25).

† From the Adopted Levels.

‡ From recoil-distance Doppler-shift method (1985Mu09), unless noted otherwise.

γ(^{100}Mo)

Ei(level)	Jiπ	Eγ†	Iγ†	Ef	Jfπ	Mult.†	δ†	α‡	I(γ+ce)†	Comments
535.6	2+	535.6	100	0.0	0+	E2		0.00387		
695.1	0+	159.5	100 *1*	535.6	2+	E2		0.222		
		695.1		0.0	0+	E0			15 *2*	
1063.8	2+	368.8	1.7 *2*	695.1	0+					
		528.2	100 *2*	535.6	2+	E2+M1	+4.4 *+15−9*			Other δ(E2/M1)=+5.2 *+33−15*, deduced by evaluators from E2 and M1 matrix elements in 2012Wr03, where δ=+4.4 *15* was used as input in their GOSIA analysis.
		1063.8	38 *1*	0.0	0+	E2				

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Coulomb excitation 2012Wr03,1985Mu09,1972Ba90 (continued)

$\gamma(^{100}Mo)$ (continued)

E_i(level)	J_i^π	E_γ[†]	I_γ[†]	E_f	J_f^π	Mult.[†]	δ[†]	Comments
1136.1	4^+	600.5		535.6	2^+	(E2)		
1463.9	2^+	327	3.5 *15*	1136.1	4^+			
		400.2	5.8 *11*	1063.8	2^+			
		768.8	100 *1*	695.1	0^+	E2		
		928.3	73 *1*	535.6	2^+	M1+E2	−0.27 *2*	Other δ(E2/M1)=−0.27 *+8−6*, deduced by evaluators from E2 and M1 matrix elements in 2012Wr03, where δ=−27 *2* was used as input in their GOSIA analysis.
1771.4	(4^+)	635.3	55 *3*	1136.1	4^+			
		707.7	100 *2*	1063.8	2^+	(E2)		
1847.1	6^+	711.0	100	1136.1	4^+	(E2)		
1908.3	3^-	844.4	100 *1*	1063.8	2^+	[E1]		
		1372.7	46 *4*	535.6	2^+			
		1908.2	4.6 *10*	0.0	0^+	[E3]		E_γ,I_γ: from the Adopted Gammas.
2626.2	8^+	779.6		1847.1	6^+	(E2)		B(E2)↓=0.34 *5* (1986Ho25) B(E2) deduced from ratio of yields of 780γ (8^+ to 6^+ transition) and 711γ (6^+ to 4^+ transition). Evaluators assume that the B(E2) value given by 1986Ho25 is B(E2)↓.

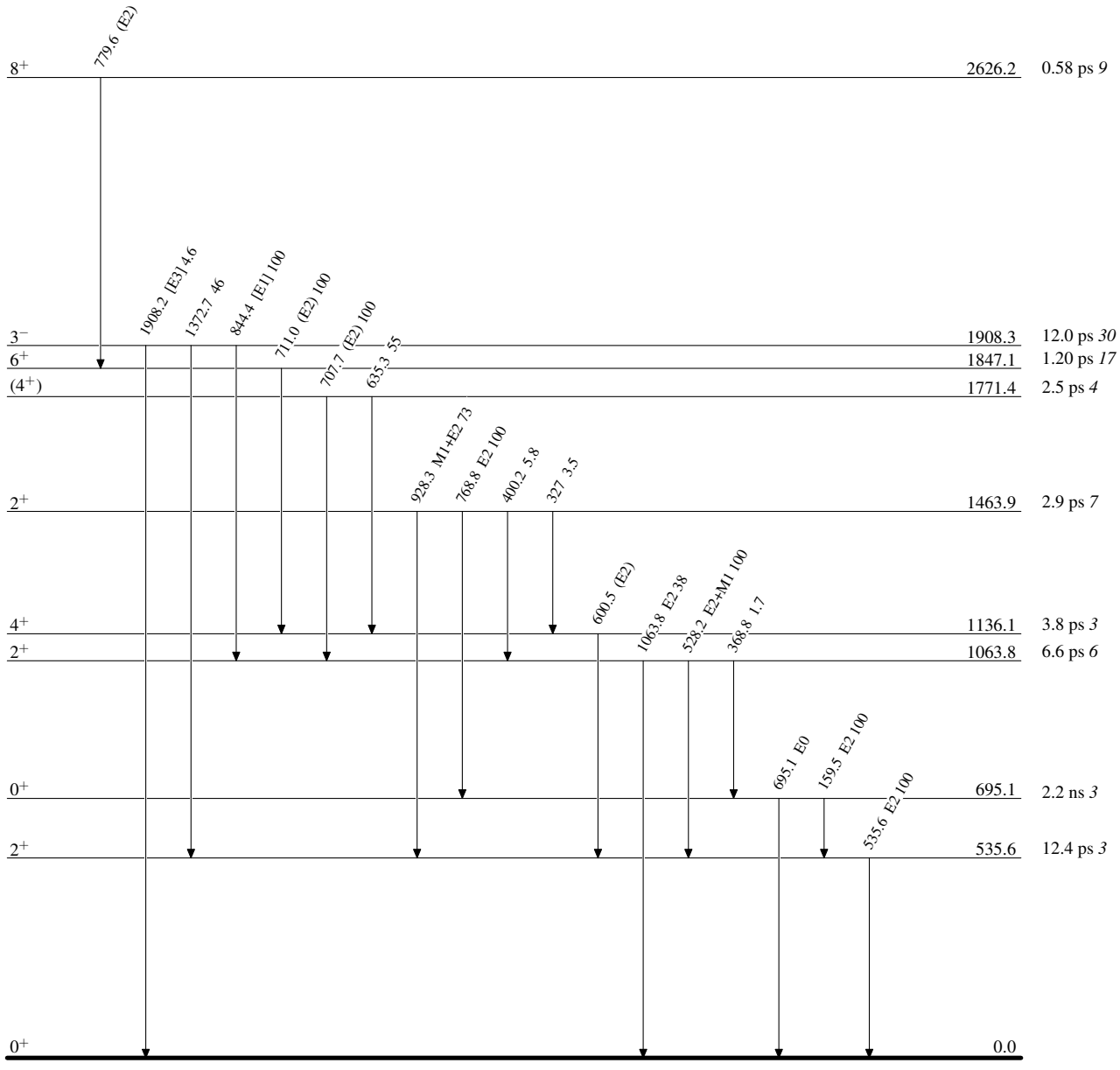
[†] From the Adopted Levels, Gammas dataset. Energies are rounded values.

[‡] Total theoretical internal conversion coefficients, calculated using the BrIcc code (2008Ki07) with "Frozen Orbitals" approximation based on γ-ray energies, assigned multipolarities, and mixing ratios, unless otherwise specified.

Coulomb excitation 2012Wr03,1985Mu09,1972Ba90

Level Scheme

Intensities: Relative photon branching from each level



$^{100}_{42}Mo_{58}$