^{209}Bi(α,4nγ) 1975Be39,1990Mu04

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	J. Chen # and F. G. Kondev	NDS 126, 373 (2015)	30-Sep-2013

1975Be39: E=42-51 MeV α particles were produced from the Stockholm 225-cm cyclotron. Targets were metallic Bi. γ-rays were detected by a coaxial Ge(Li) detector (θ=90°−150°) and conversion electrons were detected by a Si(Li) detector in a spectrometer (FWHM=2.1 keV at about 500 keV). Measured Eγ, Iγ, γ(q), γ(t), E(ce), I(ce), pulsed beam. Deduced levels, J$^\pi$, γ-branchings, γ-ray transition multipolarities, conversion coefficients, half-lives, g-factors. ce data of 1975Be39 also reported in 1975Li12.

1990Mu04: E=44-54 MeV α particles were produced from the Variable Energy Cyclotron at Calcutta. An extremely pure rolled Bi target was use. γ-rays were detected by two N-type Ge detectors at θ=90°, 106°, 120° and 130°. Measured Eγ, Iγ, γ(q), $\gamma\gamma$-coin. Deduced levels, J$^\pi$, γ-ray transition multipolarities.

Others:

1990Ha30,1991Sc15: α beams were produced at the cyclotron Cyclone at Louvain-la-neuve at Belgium. Detectors were placed in 0° and 90°. Measured quadrupole moments using the Level Mixing spectroscopy (LEMS) method.

1983Ma08: E= 60 MeV α particles were produced from the VICKSI accelerator at the Hahn-Meitner-Institut. γ-rays were detected with Ge(Li) detectors (θ=0° to 90°). Measured Eγ, γ(θ,H,t). Deduced half-lives, quadrupole moments of isomers.

1983Ha51: E=45 MeV α particles were produced from the cyclotron at Karlsruhe. A target of≈2 mg/cm^2 Bi evaporated onto a 4 mg/cm^2 Cu foil was used. Measured Eγ, Iγ, γ(θ). Deduced levels, quadrupole moment ratio of Q(^{209}At)/Q(^{210}At).

Additional information 1.

^{209}At Levels

Additional information 2.

E(level)†	J$^\pi$‡	$T_{1/2}$	Comments
0.0	9/2$^-$		J$^\pi$: from Adopted Levels. Q: Q(^{209}At)/Q(^{210}At)=1.47 *7* (1983Ha51). configuration=$\pi(1h_{9/2})^{+1}$.
577.07 *12*	11/2$^-$#		configuration=$\pi(1h_{9/2})^{+1}\otimes2^+$.
725.08 *10*	13/2$^-$#		configuration=$\pi(1h_{9/2})^{+1}\otimes2^+$.
1321.59 *14*	17/2$^-$#		configuration=$\pi(1h_{9/2})^{+3}$.
1427.69 *17*	21/2$^-$#	25 ns *1*	g=0.88 *6* (1975Be39) Q=0.78 *8* (1983Ma08) Q: measured using the TDPAD method (1983Ma08). $T_{1/2}$: weighted average of 25 ns *1* from 106γ(t), 148γ(t), 577γ(t), 596γ(t) 725γ(t) in 1975Be39 and 24 ns *2* from 596γ(t) and 725γ(t) in 1983Ma08. g-factor: from γ(θ,H,t) using the TDPAD method with Knight-shift and diamagnetic shielding corrections applied (1975Be39). configuration=$\pi(1h_{9/2})^{+3}$.
1851.78 *20*	23/2$^-$#		configuration=$\pi(1h^2_{9/2}2f^1_{7/2})^{+3}$.
1907.5 *6*	19/2$^-$		
2075.6 *6*	(19/2$^-$)		
2183.2 *6*			
2238.2 *4*	25/2$^-$		
2402.5 *8*			
2429.2 *3*	29/2$^+$#	0.794 μs *20*	g=1.061 *10* Q=1.50 *15* (1983Ma08) Q: measured using the TDPAD method (1983Ma08). $T_{1/2}$: from 424γ(t) in 1983Ma08. Other: 0.88 μs *10* from 577γ(t), 596γ(t), and 725γ(t) in 1975Be39. configuration=$\pi(1h^2_{9/2}1i^1_{13/2})^{+3}$. g-factor: weighted average of 1.061 *10* (1987Ca23) and 1.060 *20* (1975Be39) using the TDPAD method.

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^{209}Bi(α,4nγ) 1975Be39,1990Mu04 (continued)

^{209}At Levels (continued)

E(level)[†]	Jπ[‡]	Comments
2605.8 6	25/2+	
2611.4 3	25/2−	
2677.4 8		
2683.8 7	(27/2−)	
3188.2 4	31/2+	
3292.8 8	(29/2−)	
3592?	33/2+	E(level): the relative order of the 405.4γ and 583.7γ has not been established. These cascade transitions could define a level at 3771 instead of at 3592.
3748.3 6	(33/2+)	
3812.2 6	(35/2+,33/2+)	
3898.7 6	33/2+	
4176	35/2+	
4376.2 8		
4506?		
4696.5 8		

[†] From a least-squares fit to γ-ray energies.
[‡] From 1990Mu04, except where noted otherwise.
[#] Assignments are also from 1975Be39 based on stretched-cascade arguments and the absence or presence of crossover transitions, and the γ-ray transition multipolarity arguments.

γ(^{209}At)

Additional information 3.

Eγ[‡]	Iγ[@]	Ei(level)	Jπi	Ef	Jπf	Mult.[a]	α[†]	Comments
106.1[#] 1	11.8[#]	1427.69	21/2−	1321.59	17/2−	E2[b]	6.03	α(K)=0.393 6; α(L)=4.17 7; α(M)=1.119 17; α(N+..)=0.351 6 α(N)=0.289 5; α(O)=0.0566 9; α(P)=0.00572 9 Mult.: α(exp)=6.3 8 from an intensity balance at the 1321.6 level using delayed intensities (1975Be39).
148.0[#] 1	5.9[#]	725.08	13/2−	577.07	11/2−	M1[b]	3.96	α(K)=3.21 5; α(L)=0.574 9; α(M)=0.1359 20; α(N+..)=0.0438 7 α(N)=0.0352 5; α(O)=0.00754 11; α(P)=0.001041 15 Mult.: α(exp)=3.9 5, A_2=−0.044 43 from 1975Be39.
326.9 5	3.8 2	2402.5		2075.6	(19/2−)	M1	0.435	
386.5 5	10.7 6	2238.2	25/2−	1851.78	23/2−	M1+E2	0.17 11	
405.4[d] 5	9.2 10	3592?	33/2+	3188.2	31/2+	M1	0.243	
424.1[#] 1	62[#]	1851.78	23/2−	1427.69	21/2−	M1[b]	0.215	α(K)=0.1749 25; α(L)=0.0307 5; α(M)=0.00725 11; α(N+..)=0.00233 4 α(N)=0.00188 3; α(O)=0.000402 6; α(P)=5.55×10^{-5} 8 Mult.: α(exp)=0.23 2 from intensity balance in delayed spectrum, α(K)exp/α(L)exp=5.9 4, A_2=−0.123 14 from 1975Be39.
445.6 5	7.8 4	2683.8	(27/2−)	2238.2	25/2−	M1	0.188	

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^{209}Bi(α,4nγ) 1975Be39,1990Mu04 (continued)

γ(^{209}At) (continued)

E_γ[‡]	I_γ[@]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[a]	α[†]	Comments
494.2 *5*	3.5 *2*	2677.4		2183.2				
560.1 *5*	6.1 *5*	3748.3	(33/2$^+$)	3188.2	31/2$^+$			
564.0 *5*	5.6 *5*	4376.2		3812.2	(35/2$^+$,33/2$^+$)			
577.0[#] *2*	40[#]	577.07	11/2$^-$	0.0	9/2$^-$	M1[b]	0.0947	α(K)=0.0771 *11*; α(L)=0.01341 *19*; α(M)=0.00317 *5*; α(N+..)=0.001019 *15* α(N)=0.000820 *12*; α(O)=0.0001755 *25*; α(P)=2.43×10^{-5} *4* Mult.: α(K)exp/α(L)exp=2.0 *2* and A_2=−0.133 *22* for the 577.0+577.4 doublet from 1975Be39.
577.4[#] *2*	50[#]	2429.2	29/2$^+$	1851.78	23/2$^-$	E3[b]	0.0750	α(K)=0.0417 *6*; α(L)=0.0248 *4*; α(M)=0.00649 *10*; α(N+..)=0.00207 *3* α(N)=0.001686 *24*; α(O)=0.000343 *5*; α(P)=4.01×10^{-5} *6* Mult.: α(exp)=0.07 *1* from intensity balances, and also α(K)exp/α(L)exp=2.0 *2* and A_2=−0.133 *22* for the 577.0+577.4 doublet from 1975Be39.
583.7[d] *5*	11.5 *7*	4176	35/2$^+$	3592?	33/2$^+$	M1	0.0919	
585.9 *5*	7.2 *5*	1907.5	19/2$^-$	1321.59	17/2$^-$	M1(+E2)	0.06 *4*	
596.5[#] *1*	100	1321.59	17/2$^-$	725.08	13/2$^-$	E2	0.0224	α(K)=0.01609 *23*; α(L)=0.00474 *7*; α(M)=0.001182 *17*; α(N+..)=0.000377 *6* α(N)=0.000306 *5*; α(O)=6.31×10^{-5} *9*; α(P)=7.76×10^{-6} *11* Mult.: α(exp)=0.0222, α(K)exp/α(L)exp=3.3 *3*, A_2=−0.091 *12* from 1975Be39.
609.0 *5*	7.3 *10*	3292.8	(29/2$^-$)	2683.8	(27/2$^-$)			
624.0 *5*	6.4 *4*	3812.2	(35/2$^+$,33/2$^+$)	3188.2	31/2$^+$	M1	0.0770	
710.5 *5*	5.5 *3*	3898.7	33/2$^+$	3188.2	31/2$^+$	M1	0.0548	
725.1[#] *1*	82.5[#]	725.08	13/2$^-$	0.0	9/2$^-$	E2[b]	0.01471	α(K)=0.01104 *16*; α(L)=0.00277 *4*; α(M)=0.000682 *10*; α(N+..)=0.000218 *3* α(N)=0.0001763 *25*; α(O)=3.67×10^{-5} *6*; α(P)=4.63×10^{-6} *7* Mult.: α(exp)=0.016 *3*, α(K)exp/α(L)exp=4.5 *4*, A_2=+0.091 *8* from 1975b39. γ-branching: I(148γ)/I(725γ)=0.072 from singles spectrum; 0.051

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^{209}Bi(α,4nγ) 1975Be39,1990Mu04 (continued)

γ(^{209}At) (continued)

E_γ[‡]	I_γ[@]	E_i(level)	J^π_i	E_f	J^π_f	Mult.[a]	α[†]	Comments
								from delayed spectrum; 0.054 *18* from authors′ deduced I(γ+ce) for the 725.1γ and 577.0γ based on intensity-balance arguments, the requirement I(γ+ce 148.0γ)=I(γ+ce 577.0γ), and adopted α′s.
754.0[c] *5*	18[c] *2*	2075.6	(19/2$^-$)	1321.59	17/2$^-$			
754.0[c] *5*	18[c] *2*	2605.8	25/2$^+$	1851.78	23/2$^-$			
755.5 *5*	11 *1*	2183.2		1427.69	21/2$^-$	M1	0.0467	
759.0[c] *2*	41[c&] *4*	3188.2	31/2$^+$	2429.2	29/2$^+$	M1	0.0461	
759.0[cd] *2*	41[c&] *4*	4506?		3748.3	(33/2$^+$)	M1	0.0461	
759.6 *2*	22 *2*	2611.4	25/2$^-$	1851.78	23/2$^-$	M1	0.0460	
797.8 *5*	3.2 *2*	4696.5		3898.7	33/2$^+$			
810.4 *5*	7.3 *4*	2238.2	25/2$^-$	1427.69	21/2$^-$	E2	0.01171	

† Additional information 4.

‡ From 1990Mu04. The evaluators have assigned uncertainties of 0.2 keV for strong γ-rays and 0.5 keV for weak γ-rays based on the γ-spectrum in 1990Mu04, unless otherwise noted.

From 1975Be39, γ-ray intensities normalized to I(596γ)=100.

@ From 1990Mu04, normalized to I(596γ)=100, unless otherwise noted.

& From intensity balance at the 3747 level, Iγ(759γ from 4506) is expected to be <66. The major fraction of the intensity of this transition thus appears to be from the 3187 level (1990Mu04).

a From 1990Mu04, except where noted otherwise. Authors′ assignments are based on $\gamma(\theta)$. Since the basis for distinguishing M1 from E1, etc., is not stated, the assignments are tentative.

b From ce data in 1975Be39.

c Multiply placed with undivided intensity.

d Placement of transition in the level scheme is uncertain.

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Level Scheme

Intensities: Relative I_γ

& Multiply placed: undivided intensity given