^{138}Ba(α,4nγ) 1978Mu09,1976Lu05

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 146, 1 (2017)	30-Sep-2017

1978Mu09: E=70 MeV α beam was produced from the Julich isochronous cyclotron JULIC. Target was 99.8% enriched ^{138}Ba. γ rays were detected with 2 Ge(Li) detectors. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma(\theta)$, γ(t). Deduced levels, J, π, halflives, γ-ray multipolarities.

1976Lu05: E=45-59 MeV α beam was produced from the IKO synchrocyclotron. Target was 99.8% enriched ^{138}Ba in the form of $Ba(NO_3)_2$. γ rays were detected with 2 Ge(Li) detectors. Measured Eγ, Iγ, $\gamma\gamma$-coin, $\gamma(\theta)$. Deduced levels, J, π. Comparisons with theoretical predictions.

1976Lu07: same measurement in 1976Lu05. Measured γ(t). Deduced half-life of the 3538,10$^+$ isomer.

1980Ba68: Measured Eγ, I$\gamma(\theta$,H,t). Deduced g-factor.

The higher spin data from 1978Mu09 and 1976Lu05 are not as reliable as those from the ^{124}Sn(^{18}O,4nγ) dataset (1999Zh28) or the ^{136}Ba(α,2nγ) dataset (1987Lo12), where a larger number of Ge detectors was used.

Level scheme is taken from 1978Mu09, unless otherwise noted.

^{138}Ce Levels

E(level)[†]	J$^\pi$[@]	$T_{1/2}$	Comments
0.0	0$^+$		
788.5 *3*	2$^+$		
1826.1 *5*	4$^+$		
2128.7 *5*	7$^-$	8.73 ms *20*	$T_{1/2}$: from Adopted Levels. Configuration=$\nu d_{3/2}^{-1} h_{11/2}^{-1}$ (1976Lu05).
2137.3[‡] *8*	4$^+$		
2216.7 *5*	5$^-$		
2293.2 *5*	6$^+$		
2764.3[‡] *11*	6$^-$		
3108.1 *5*	8$^+$		
3538.1 *6*	10$^+$	81 ns *5*	g=−0.170 *3* (1980Ba68) $T_{1/2}$: weighted average of 84 ns *5* from γ(t) in 1978Mu09 and 78 ns *5* from γ(t) in 1976Lu07. g-factor is measured using TDPAD (1980Ba68). Configuration=$\nu h_{11/2}^{-2}$ (1976Lu05).
3941.1 *7*	11$^+$		
4358.4 *7*	12$^+$		
4973.1 *8*	13$^+$		
5088.1 *7*	(12$^+$)		J$^\pi$: 12$^-$ in Adopted Levels from mult(1146.9γ)=E1 based on γ(DCO) and γ(pol) in (^{12}C,4nγ).
5212.5 *8*	(13$^+$)		J$^\pi$: 13$^-$ in Adopted Levels from mult(854.2γ)=E1 based on γ(DCO) and γ(pol) in (^{12}C,4nγ).
5310.8 *8*	14$^+$		
5411.1 *8*	14$^-$		
5564.9 *8*	15$^+$		
5730.5?[#] *11*	15$^-$		
6012.4 *9*	16$^+$		

[†] From a least-squares fit to γ-ray energies.
[‡] From 1976Lu07 only.
[#] From probable coincidence relationships of 319.3γ (1978Mu09).
[@] From Adopted Levels, unless otherwise noted.

^{138}Ba(α,4nγ) 1978Mu09,1976Lu05 (continued)

$\gamma(^{138}Ce)$

Values of A_2 and A_4 are from 1978Mu09. Values of A_2 (A_4=0) are also available in 1976Lu05.

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult. @	Comments
76.5# *3*	1.02 *15*	2293.2	6^+	2216.7	5^-	(E1)	A_2=+0.15 *6*; A_4=−0.01 *9* I_γ: 0.94 *10* (1976Lu05).
79.0‡	≤0.10‡	2216.7	5^-	2137.3	4^+		
88.0‡	0.12‡ *3*	2216.7	5^-	2128.7	7^-		
98.3 *3*	1.35 *17*	5310.8	14^+	5212.5	(13^+)		A_2=−0.13 *4*; A_4=−0.06 *6* E_γ: a 97.9γ is placed by 1976Lu05 from a level at 4708. I_γ: 0.77 *8* (1976Lu05).
124.4 *3*	0.35 *10*	5212.5	(13^+)	5088.1	(12^+)	(M1+E2)	A_2=−0.16 *6*; A_4=−0.06 *9* E_γ: a 124.8γ is placed by 1976Lu05 from a level at 2418. I_γ: 0.22 *3* (1976Lu05).
164.6# *3*	0.87 *14*	2293.2	6^+	2128.7	7^-	(E1)	A_2=−0.19 *5*; A_4=−0.03 *8* I_γ: 1.96 *18* (1976Lu05).
x174.0‡&	0.31‡ *3*						E_γ: tentatively placed by 1976Lu05 from a level at 3710.
198.6# *3*		5411.1	14^-	5212.5	(13^+)		E_γ: a 196.7γ is in the γ spectrum in Fig1 of 1976Lu05 but not placed.
x202.4‡	0.07‡ *3*						E_γ: placed by 1976Lu05 from a level at 2418.
x229.0‡&	0.22‡ *3*						E_γ: placed by 1976Lu05 from the level at 3941.
254.1# *3*	1.33 *40*	5564.9	15^+	5310.8	14^+		A_2=+0.03 *10*; A_4=−0.07 *15* E_γ: a 252.4γ is placed by 1976Lu05 from a level at 4610. I_γ: 1.35 *12* (1976Lu05).
302.7# *3*	5.11 *66*	2128.7	7^-	1826.1	4^+	E3	A_2=−0.03 *4*; A_4=+0.01 *6* I_γ: 13.1 *10* (1976Lu05).
319.3& *3*	0.55 *10*	5730.5?	15^-	5411.1	14^-	(M1+E2)	A_2=−0.26 *7*; A_4=−0.08 *11* E_γ: a doublet of 318.4+321.6 is marked in the γ spectrum in Fig1 of 1976Lu05 but not assigned to ^{138}Ce.
337.7# *3*	1.21 *60*	5310.8	14^+	4973.1	13^+		A_2=−0.23 *5*; A_4=−0.07 *8* E_γ: a 336.6γ is in the γ spectrum in Fig1 of 1976Lu05 but not placed.
390.7# *3*	2.13 *50*	2216.7	5^-	1826.1	4^+	E1	A_2=−0.02 *4*; A_4=−0.02 *6* I_γ: 1.58 *15* (1976Lu05).
403.0 *3*	5.01 *45*	3941.1	11^+	3538.1	10^+	(M1+E2)	A_2=−0.10 *4*; A_4=−0.06 *6* I_γ: 4.7 *4* (1976Lu05).
417.4 *3*	4.06 *36*	4358.4	12^+	3941.1	11^+	(M1+E2)	A_2=−0.23 *3*; A_4=−0.04 *5* I_γ: 3.9 *4* (1976Lu05).
430.0 *3*	4.78 *43*	3538.1	10^+	3108.1	8^+		A_2=+0.18 *3*; A_4=−0.03 *5*
447.5# *3*	0.80 *20*	6012.4	16^+	5564.9	15^+	(M1+E2)	A_2=−0.34 *8*; A_4=−0.04 *12* E_γ: a 448.4γ is in the γ spectrum in Fig1 of 1976Lu05 but not placed.
467.0 *3*	0.52 *7*	2293.2	6^+	1826.1	4^+	(E2)	A_2=+0.28 *6*; A_4=−0.24 *9* I_γ: 0.62 *6* (1976Lu05).
547.6‡	≤0.10‡	2764.3	6^-	2216.7	5^-		
614.6 *3*	0.87 *14*	4973.1	13^+	4358.4	12^+	(M1+E2)	A_2=−0.39 *7*; A_4=+0.02 *11* E_γ: a 614.8γ is placed by 1976Lu05 from a level at 2743.6. I_γ: 1.10 *10* (1976Lu05).

Continued on next page (footnotes at end of table)

^{138}Ba(α,4nγ) 1978Mu09,1976Lu05 (continued)

$\gamma(^{138}Ce)$ (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult. @	Comments
x669.4‡&	≤0.24‡						E_γ: placed by 1976Lu05 from a level at 4610.
x691.0‡&	‡						E_γ: placed by 1976Lu05 from the level at 3108.
788.5 *3*	9.97 *79*	788.5	2^+	0.0	0^+	E2	A_2=+0.14 *3*; A_4=−0.02 *5* I_γ: 18.8 *15* (1976Lu05).
815.0 *3*	3.69 *36*	3108.1	8^+	2293.2	6^+		A_2=+0.23 *4*; A_4=−0.07 *6* I_γ: 4.6 *4* (1976Lu05).
819.0‡&	0.33‡ *12*	4358.4	12^+	3538.1	10^+		
854.2 *3*	2.11 *26*	5212.5	(13^+)	4358.4	12^+	(M1+E2)	A_2=−008 *6*; A_4=−0.05 *9* E_γ: a 855.5γ is placed by 1976Lu05 from a level at 4796. I_γ: 1.79 *15* (1976Lu05).
979.3 *3*	0.88 *14*	3108.1	8^+	2128.7	7^-		A_2=−0.33 *7*; A_4=+0.04 *11* I_γ: 1.96 *17* (1976Lu05).
1037.6 *3*	9.10 *73*	1826.1	4^+	788.5	2^+	E2	A_2=+0.16 *3*; A_4=−0.02 *5* I_γ: 18.1 *14* (1976Lu05).
1146.9 *3*	0.52 *9*	5088.1	(12^+)	3941.1	11^+	(M1+E2)	A_2=−0.27 *5*; A_4=−0.21 *22* E_γ: 1147.4 γ is tentatively placed by 1976Lu05 from a level at 5505. I_γ: 0.59 *14* (1976Lu05).
x1200.4‡&	0.90‡ *15*						E_γ: placed by 1976Lu05 from the level at 3941.
1348.3‡	0.61‡ *11*	2137.3	4^+	788.5	2^+		
x1416.4‡&	0.83‡ *16*						E_γ: tentatively placed by 1976Lu05 from a level at 3710.

† From 1978Mu09, unless otherwise noted. Note that most values of intensities from 1976Lu05 are consistent with values from 1978Mu09, except for intensities of 164.6γ, 302.7γ, 788.5γ, 979.3γ, 1037.6γ.

‡ From 1976Lu05. Uncertainties in γ-ray energies are not given in 1976Lu05. Intensities from 1976Lu05 are normalized to I(430γ)=4.78 in 1978Mu09 with I(430γ)=100 *6* in 1976Lu05.

Contaminated with other lines.

@ From 1978Mu09, based on $\gamma(\theta)$.

& Placement of transition in the level scheme is uncertain.

x γ ray not placed in level scheme.

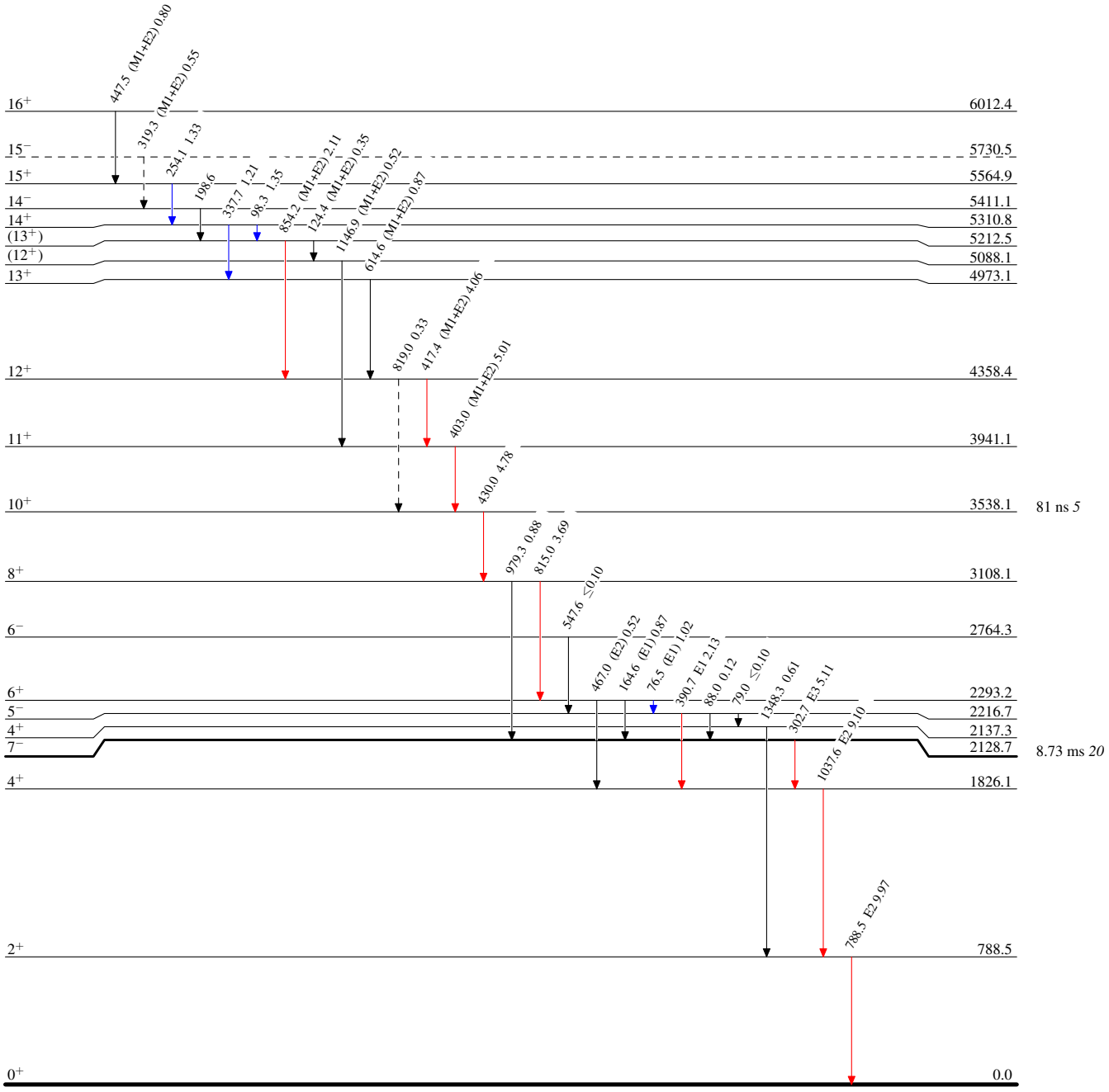
^{138}Ba(α,4nγ) 1978Mu09,1976Lu05

Level Scheme

Intensities: Relative I_γ

Legend

- $I_\gamma < 2\% \times I_\gamma^{max}$
- $I_\gamma < 10\% \times I_\gamma^{max}$
- $I_\gamma > 10\% \times I_\gamma^{max}$
- γ Decay (Uncertain)



$^{138}_{58}Ce_{80}$