

$^{238}\text{U}(^{76}\text{Ge}, ^{76}\text{Ge}'\gamma)$ **2013To05**

Type	Author	History	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, Jun Chen and Ameenah R. Farhan		NDS 194,3 (2024)	8-Jan-2024

Above-barrier ($\approx 33\%$) Coulomb excitation and heavy-ion inelastic scattering.

2013To05: E=530 MeV ^{76}Ge beam provided by ATLAS accelerator at ANL facility. Measured $E\gamma$, $I\gamma$, $\gamma\gamma$, $\gamma\gamma(\theta)$ using Gammasphere array with 100 Compton-suppressed HPGe detectors. Delayed γ spectra were also measured from decay of ^{76}Ga formed in the reaction. Evidence of rigid triaxial deformation in the low-lying states from determination of staggering parameter. Comparison with shell-model calculations.

2013Lo04: E(^{76}Ge)=540 MeV from LNL Tandem-ALPI accelerator complex at INFN in Legnaro. Projectile-like reaction products were analyzed at the focal plane of PRISMA magnetic spectrometer. ^{238}U target was 1.4 mg/cm² thick evaporated on a backing of 1.2 mg/cm² thick Ta. Time-of-flight of residues was measured between a microchannel plate (MCP) and parallel-plate avalanche counters (PPAC). The arrangement allowed residue identification by Z, A and charge Q. Prompt γ rays were detected by AGATA Demonstrator comprised of four triple cluster modules. Measured (^{76}Ge) γ -coin, lifetimes of levels by RDDS method using Cologne-type plunger device. Lifetime measurement of first 2⁺ state in ^{76}Ge used as a test case.

2017Do13: E(^{76}Ge)=577 MeV from LNL Tandem-ALPI accelerator complex at INFN in Legnaro. Projectile-like reaction products were analyzed at the focal plane of PRISMA magnetic spectrometer. ^{238}U target was 1.4 mg/cm² thick evaporated on a backing of 1.2 mg/cm² thick Ta, with 4.2 mg/cm² Nb degrader foil. Time-of-flight of residues was measured between a microchannel plate (MCP) and parallel-plate avalanche counters (PPAC). The arrangement allowed residue identification by Z, A and charge Q. Prompt γ rays were detected by AGATA array of Ge crystals. Measured (^{76}Ge ions) γ -coin, lifetimes of levels by RDDS method using Cologne-type plunger device.

^{76}Ge Levels

E(level)	J ^{π}	T _{1/2}	Comments
0.0 [†]	0 ⁺		
562.9 [†] 1	2 ⁺	18.44 ps 42	T _{1/2} : From RDDS (2013Lo04).
1108.4 [#] 2	2 ⁺		
1410.1 [†] 3	4 ⁺	2.22 ps 7	T _{1/2} : RDDS method (2017Do13). Mean lifetime $\tau=3.2$ ps 1, weighted average (by evaluators) of $\tau=3.5$ ps 2 for unshifted peak, 3.1 ps 1 for shifted peak, and 3.2 ps 1 by conventional method.
1539.43 [@] 22	3 ⁺		
2021.6 [#] 3	4 ⁺		
2453.8 [†] 4	6 ⁺		
2487.2 [@] 3	5 ⁺		
2669.2 3			
2733.4 4	4 ⁺		
2958.6 [‡] 4	5 ⁻		
2988.2 4			
3033.9 [#] 4	6 ⁺		
3235.9 4	(6 ⁺)		
3437.0 5			
3533.0 [@] 5	7 ⁺		
3536.1 5			
3543.4 [†] 5	8 ⁺		
3632.9 5	(2 ⁺)		
3728.1 [‡] 5	(7 ⁻)		
3783.9 5			
4129.9 [#] 6	8 ⁺		
4130.5 6			
4311.2 5			
4547.0 [@] 7	9 ⁺		

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$^{238}\text{U}(^{76}\text{Ge}, ^{76}\text{Ge}'\gamma)$ **2013To05 (continued)**

^{76}Ge Levels (continued)

E(level)	J^π
4613.1 [†] 7	10 ⁺
4687.0 [‡] 5	(9 ⁻)
4720.8 6	
5450.17 [†] 8	(12 ⁺)
5843.4 [‡] 7	(11 ⁻)

[†] Band(A): g.s. band.

[‡] Band(B): Band based on 5⁻.

Band(C): γ band, even spin.

@ Band(c): γ band, odd spin.

$\gamma(^{76}\text{Ge})$								
$E_i(\text{level})$	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult. [†]	δ^\dagger	Comments
562.9	2 ⁺	562.9 1	100	0.0	0 ⁺			
1108.4	2 ⁺	545.5 3	100	562.9	2 ⁺	(M1+E2)	+2.1 4	δ : from (545.5 γ)(562.9 γ)(θ): $A_2=-0.30$ 1, $A_4=+0.27$ 2.
1410.1	4 ⁺	1108.4 3 847.2 4	75 8 100	0.0 562.9	0 ⁺ 2 ⁺			B(E2)=0.0537 31 for unshifted peak, 0.0607 20 for shifted peak, and 0.0588 18 for conventional method (2017Do13).
1539.43	3 ⁺	431.0 3	65 7	1108.4	2 ⁺	(M1+E2)	+1.8 4	δ : from (431.0 γ)(1108.4 γ)(θ): $A_2=+0.16$ 5, $A_4=-0.06$ 1. Or less likely +0.37 8 from $A_2=+0.17$ 4, $A_4=-0.010$ 4.
		976.5 3	100	562.9	2 ⁺	(M1+E2)	+2.5 2	δ : from (976.5 γ)(562.9 γ)(θ): $A_2=+0.09$ 2, $A_4=-0.07$ 1. Or less likely +0.23 4 from $A_2=+0.09$ 2, $A_4=-0.004$ 4.
2021.6	4 ⁺	482.2 6 611.6 4 913.2 4	15 8 85 15 100	1539.43 1410.1 1108.4	3 ⁺ 4 ⁺ 2 ⁺	(M1+E2)	+0.50 8	E_γ : consistent with previous observation of a 913.2 5 gamma in (n,n' γ), but not with 911.40 10 reported in ^{76}Ga decay study.
2453.8	6 ⁺	1043.7 3	100	1410.1	4 ⁺			
2487.2	5 ⁺	465.6 4 947.8 4	10 8 100	2021.6 1539.43	4 ⁺ 3 ⁺			
2669.2		1077.2 [‡] 4 647.5 4 1129.7 4	5 5 21 3 100	1410.1 2021.6 1539.43	4 ⁺ 4 ⁺ 3 ⁺			
2733.4	4 ⁺	1259.1 4 1193.9 4	59 6 90 20	1410.1 1539.43	4 ⁺ 3 ⁺			
2958.6	5 ⁻	1625.0 4 1548.5 4	100	1108.4 1410.1	2 ⁺ 4 ⁺	D(+Q)	0.0 4	
2988.2		319.0 3 500.9 4	100	2669.2 2487.2	5 ⁺			
3033.9	6 ⁺	534.4 4 546.6 4 580.1 4	25 10 20 20 60 15	2453.8 2487.2 2453.8	6 ⁺ 5 ⁺ 6 ⁺	D+Q	+1 4	
		1012.2 4 1623.8 4	100	2021.6 1410.1	4 ⁺ 4 ⁺			
3235.9	(6 ⁺)	782.1 4 1825.8 4	40 15 40 30	1410.1 2453.8 1410.1	4 ⁺ 6 ⁺ 4 ⁺			

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$^{238}\text{U}(^{76}\text{Ge}, ^{76}\text{Ge}'\gamma)$ **2013To05 (continued)** $\gamma(^{76}\text{Ge})$ (continued)

$E_i(\text{level})$	J_i^π	E_γ	I_γ	E_f	J_f^π	Mult. [†]	Comments
3437.0		767.8 4	100	2669.2			
3533.0	7 ⁺	499.1 [‡] 4	20 20	3033.9	6 ⁺		
		1045.7 4	100	2487.2	5 ⁺		
3536.1		547.9 4	100	2988.2			
3543.4	8 ⁺	1089.6 4	100	2453.8	6 ⁺		
3632.9	(2 ⁺)	2524.4 4	100	1108.4	2 ⁺		E_γ : observed in delayed γ data, and very weakly in prompt γ data.
3728.1	(7 ⁻)	769.5 4	30 20	2958.6	5 ⁻		
		1274.3 4	100	2453.8	6 ⁺	D+Q	δ : +9 7 or +0.2 6.
3783.9		750.0 4	100	3033.9	6 ⁺		
		825.3 4	25 20	2958.6	5 ⁻		
4129.9	8 ⁺	1096.0 4	100	3033.9	6 ⁺		
4130.5		894.6 4	100	3235.9	(6 ⁺)		
4311.2		775.1 4	70 20	3536.1			
		1323.0 4	100	2988.2			
4547.0	9 ⁺	1014.0 4	100	3533.0	7 ⁺		
4613.1	10 ⁺	1069.7 4	100	3543.4	8 ⁺		
4687.0	(9 ⁻)	958.9 4	100	3728.1	(7 ⁻)		
		1143.6 4	40 30	3543.4	8 ⁺		
4720.8		936.9 4	100	3783.9			
		992.7 [‡] 4	5 5	3728.1	(7 ⁻)		
5450.1?	(12 ⁺)	837.0 [‡] 4	100	4613.1	10 ⁺		
5843.4	(11 ⁻)	1156.4 4	100	4687.0	(9 ⁻)		

[†] From $\gamma\gamma(\theta)$ (2013To05). For large mixing ratios, (M1+E2) is assigned in contrast to (E1+M2), based on RUL for E2 and M2 transitions, assuming that none of the excited states is a long-lived.

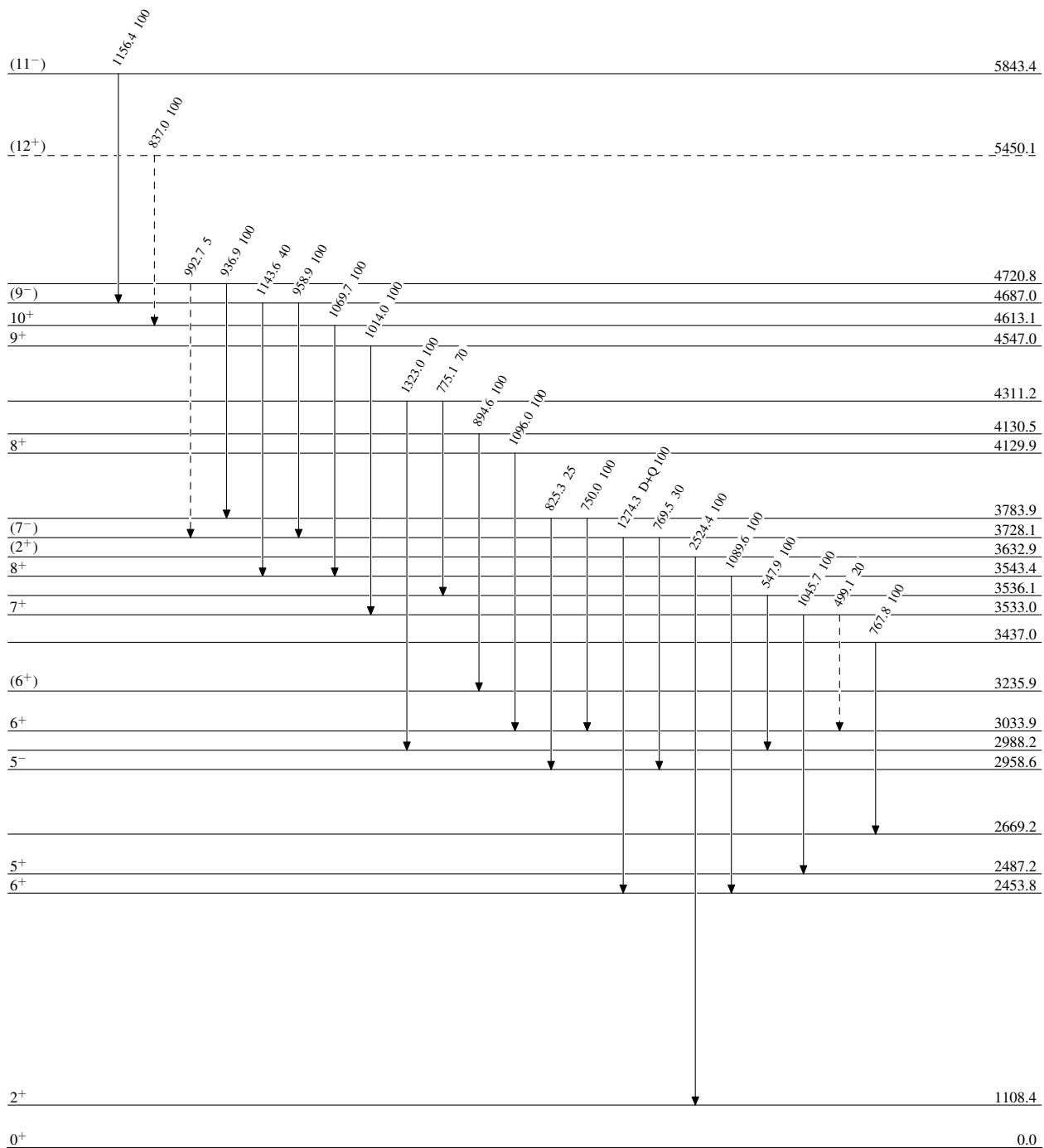
[‡] Placement of transition in the level scheme is uncertain.

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Legend

Level Scheme

Intensities: Relative photon branching from each level

-----► γ Decay (Uncertain) $^{76}_{32}\text{Ge}_{44}$

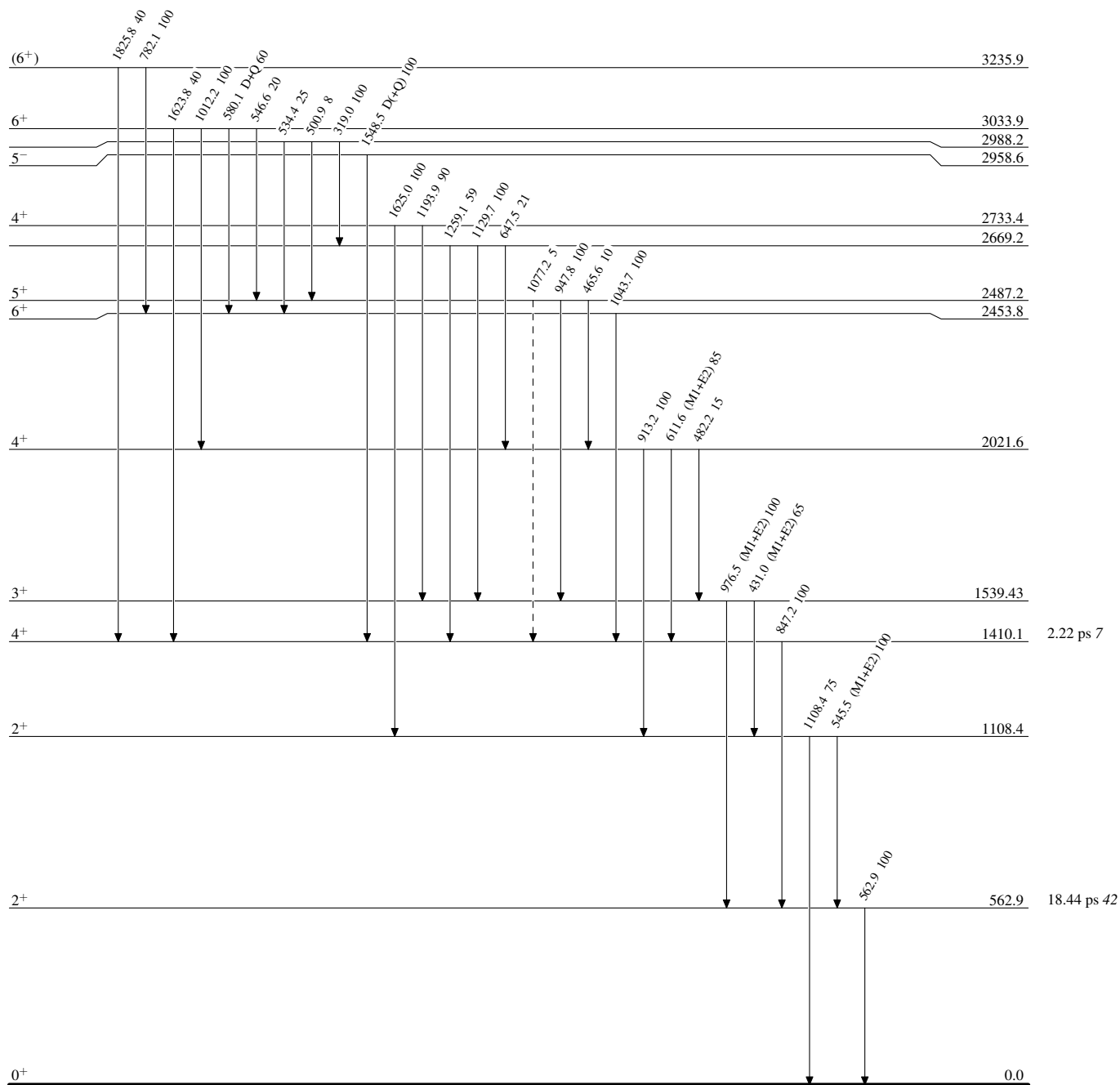
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Legend

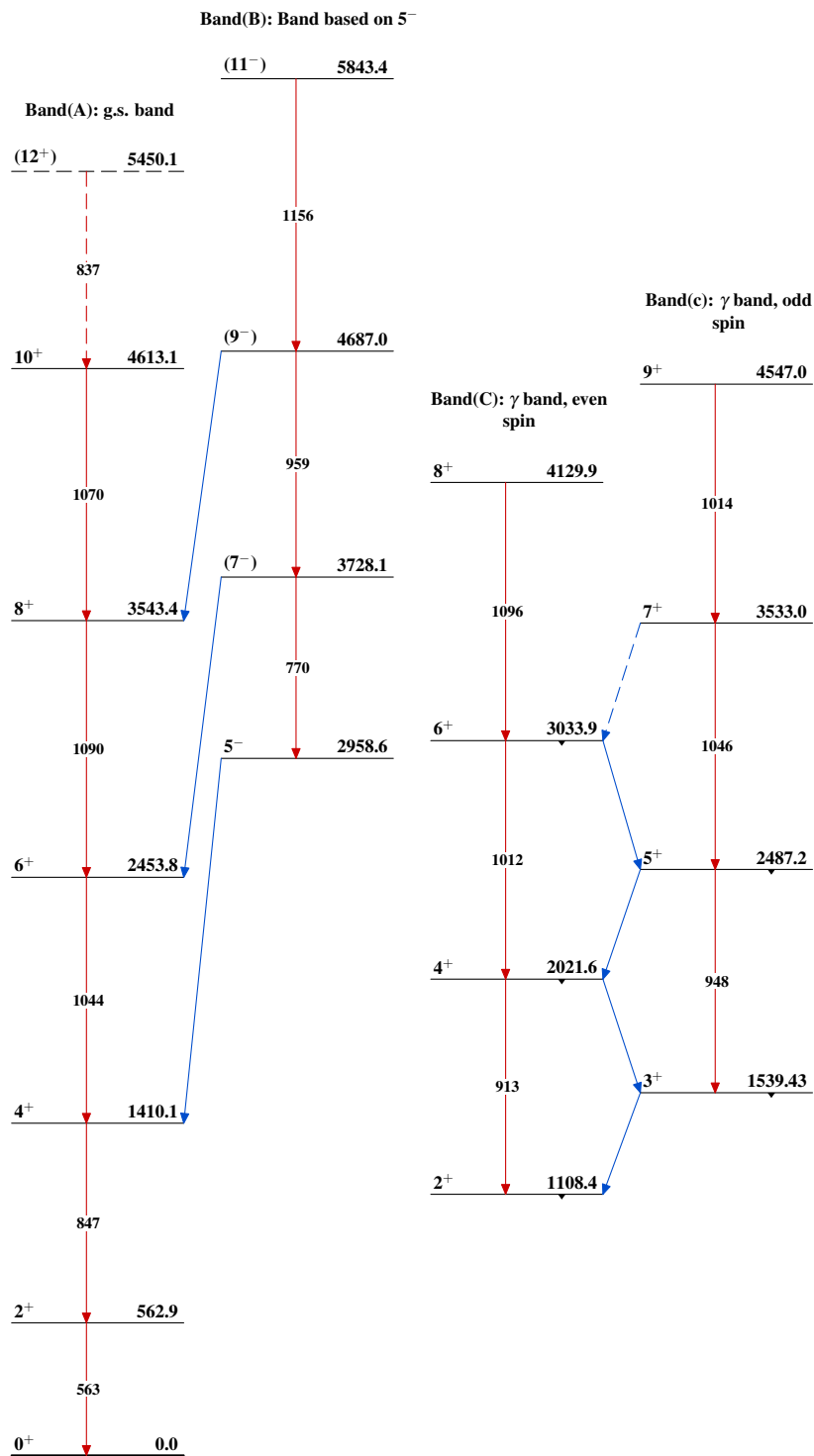
Level Scheme (continued)

Intensities: Relative photon branching from each level

-----▶ γ Decay (Uncertain)



$^{76}_{32}\text{Ge}_{44}$

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