^{40}Ca(^{32}S,2αpγ) 2001We11

Type	Author	History Citation	Literature Cutoff Date
Full Evaluation	Jun Chen	NDS 196,17 (2024)	30-Sep-2023

2001We11: E=140 MeV ^{32}S beam was produced from the Tandem XTU accelerator at the Legnaro National Laboratory. Target was a 0.4 mg/cm^2 ^{40}Ca on a 3 mg/cm^2 Au backing. γ rays were detected with the 4π spectrometer GASP consisting of 40 Compton-suppressed large-volume Ge detectors and an 80 segment BGO multiplicity filter. Measured Eγ, Iγ, γγ-coin, γ(θ), γγ(θ)(DCO). Deduced levels, J, π, band structure, γ-ray multipolarities. Comparisons with Total Routhian Surface calculations.

1991Ba20: E=96 MeV ^{32}S beam was from the University of Pennsylvania tandem Van de Graaff accelerator. Measured Eγ, Iγ, particle-γ-coin. This reaction was used to confirm the identification of ^{63}Ga for ^{40}Ca(^{28}Si,αpγ) and (^{29}Si,αpnγ) measurements also by 1991Ba20. Data reported in 1991Ba20 are primarily from (^{29}Si,αpnγ). See that dataset for details.

Additional information 1.

1996MiZU: E=140 MeV ^{32}S beam was produced from the JAERI tandem accelerator. γ rays were detected with an array of 11 ACS-Ge detectors and charged particles were detected with a Silicon ball of 21 Si detectors around target. Measured Eγ, Iγ, γγ-coin, particle-γ-coin. Deduced levels, J, π, band structures.

All data are from 2001We11, unless otherwise noted.

The level scheme above 4040 level proposed by 2001We11 is partially different from those proposed by 2021Ru07 in ^{40}Ca(^{28}Si,αpγ) due to different placements of some γ transitions, as noted under comments. The latter is much more complete and has been adopted in Adopted Levels, Gammas by the evaluator.

^{63}Ga Levels

E(level)†	Jπ‡	$T_{1/2}$	Comments
0.0	3/2$^-$		Jπ: from Adopted Levels.
75.25 *18*	5/2$^-$		
443.18 *16*			
722.31 *16*			
1152.50 *22*	9/2$^-$		
1421.70 *16*	7/2$^-$		
2046.25[a] *21*	9/2$^+$	<2 ns	
2940.26[a] *29*	13/2$^+$		
4080.2[a] *4*	17/2$^+$		
4958.6[@] *4*	(21/2$^+$)		Jπ: from 1996MiZU.
5242.9? *5*			
5715.2[a] *4*	21/2$^+$		
5852.5[d] *4*	19/2$^-$		
6250.7?[#] *6*			
6501.1[d] *4*	23/2$^-$		
6984.5?[&a] *5*	25/2$^+$		
7654.7 *5*			
7710.0[d] *5*	27/2$^-$		
7914.3[e] *5*	25/2$^-$		
8411.1?[&a] *5*	29/2$^+$		
9014.6[@b] *5*			
9039.9[d] *5*	31/2$^-$		
9254.6[e] *5*	(29/2$^-$)		
9634.7?[#] *6*			
10333.0?[&a] *6*	(33/2$^+$)		
10826.2[@b] *6*			
10868.6[d] *5*	35/2$^-$		
10964.1[@c] *5*	35/2$^{(-)}$		E(level): the order of 1868γ-1924γ from 12832 level is reversed in Adopted Levels, Gammas, making an intermediate level at 10908 instead.

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^{40}Ca(^{32}S,2αpγ) 2001We11 (continued)

^{63}Ga Levels (continued)

E(level)[†]	Jπ[‡]	Comments
10979.6[e] 5	(33/2⁻)	
12743.2[e] 6	(37/2⁻)	
12830.5[a] 9		With the orders of 2497.4γ-1921.9γ cascade from this level and 1868.3γ-1924.3γ cascade from 12832 level being reversed in Adopted Levels, Gammas as adopted from 2021Ru07, the two close levels proposed by 2001We11 are considered as a single level at 10833 in Adopted Levels as adopted from 2021Ru07 and the doublet of 1921.9γ+1924.3γ for a peak structure at around 1922 reported in 2001We11 is considered as a single transition of 1924.8γ seen in 2021Ru07, also considering that it is unclear how the γ doublet is determined in 2001We11.
12832.3[c] 5	39/2⁻	E(level): see comment at 12830.5 level.
13039.2[@b] 8		
14463.3[c] 6	43/2⁻	

[†] From a least-squares fit to γ-ray energies.
[‡] From 2001We11 deduced based on measured γ(θ), γγ(DCO), γγ(ADO), band assignments and known assignments of low-lying states, unless otherwise noted. When considered in the Adopted Levels, parentheses are used around the assignment if there are no strong supporting arguments.
[#] Level considered questionable by the evaluator due to the de-exciting transition not seen in a more complete study by 2021Ru07.
[@] Level not considered in Adopted Levels due to de-exciting transition being placed differently in Adopted Levels, Gammas, as adopted from a more complete level scheme by 2021Ru07.
[&] The order of 2497γ-1922γ-1427γ-1269γ cascade from 12831 level to 5716 level in 2001We11 is considered tentative by 2001We11 and has been changed to 1922γ-1427γ-1269γ-2497γ in Adopted Levels, Gammas as adopted from 2021Ru07, making three intermediate levels at 10908, 9483, 8214 in the Adopted Levels, instead of 10333, 8411, 6985 here in this dataset.
[a] Band(A): Band based on 2046, 9/2⁺ level.
[b] Seq.(E): Sequence based on 9015 level cascade.
[c] Band(B): Band based on 10965, 35/2⁻ level.
[d] Band(C): Band based on 5853, 19/2⁻ level.
[e] Band(D): Band based on 7914, 25/2⁻ level.

γ(^{63}Ga)

R=Angular distribution asymmetry (ADO) for values given under comments. Expected values are ≈1.1 for a stretched quadrupole transition and ≈0.6 for a stretched dipole transition (2001We11).
For DCO values under comments, expected values are ≈1.0 for a stretched quadrupole transition and ≈0.5 for a stretched dipole transition, with gates on stretched quadrupole transitions. For dipole transitions with ΔJ=0 and small mixing ratios (δ<0.5), DCO is also ≈1.0 (2001We11).

Eγ[†]	Iγ[†]	Ei(level)	Jiπ	Ef	Jfπ	Mult.[&]	Comments
75.2 2		75.25	5/2⁻	0.0	3/2⁻		
279.2 4	0.2 1	722.31		443.18			
443.1 2	2.5 2	443.18		0.0	3/2⁻		
609.6 3	0.9 1	5852.5	19/2⁻	5242.9?			
624.6 2	16.1 5	2046.25	9/2⁺	1421.70	7/2⁻	D	See comment for 1422.6γ from 1422 level about the placement of 624.6γ-1422.6γ cascade. DCO=0.63 9. R=0.77 4.
648.7 2	78.8 24	6501.1	23/2⁻	5852.5	19/2⁻	Q	1996MiZU place 1772γ-649γ cascade from 6502 level to feed the 4081 level, making an intermediate level at 4730, as also proposed in 1991Ba20 who state the proposed order of the two transitions are tentative. The order of two

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^{40}Ca(^{32}S,2αpγ) 2001We11 (continued)

γ(^{63}Ga) (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.&	Comments
							transitions is reversed in 2001We11 and 2021Ru07 with the intermediate level at 5853 which is adopted by the evaluator. DCO=1.09 *5*. R=1.13 *2*.
699.3 *2*	2.4 *1*	1421.70	7/2$^-$	722.31			
722.2 *2*	2.6 *7*	722.31		0.0	3/2$^-$		
785.7 *2*	6.3 *2*	6501.1	23/2$^-$	5715.2	21/2$^+$	D	DCO=0.68 *9*. R=0.67 *3*.
878.4 *2*	3.3 *2*	4958.6	(21/2$^+$)	4080.2	17/2$^+$		Placed from 8214 level in Adopted Levels, Gammas.
893.7 *2*	57.5 *19*	2046.25	9/2$^+$	1152.50	9/2$^-$		Mult.: either Q with ΔJ=2 or D with ΔJ=0 (2001We11). DCO=1.07 *4*. R=1.05 *1*.
894.0 *2*	100.0 *31*	2940.26	13/2$^+$	2046.25	9/2$^+$	Q	DCO=1.07 *4*. R=1.05 *1*.
978.4 *2*	2.2 *1*	1421.70	7/2$^-$	443.18			
1077.2 *2*	34.6 *15*	1152.50	9/2$^-$	75.25	5/2$^-$	Q	DCO=0.93 *8*. R=1.01 *2*.
1139.9 *2*	93.9 *29*	4080.2	17/2$^+$	2940.26	13/2$^+$	Q	DCO=0.97 *7*. R=1.17 *4*.
1153.6 *2*	5.8 *2*	7654.7		6501.1	23/2$^-$		
1208.9 *2*	73.7 *22*	7710.0	27/2$^-$	6501.1	23/2$^-$	Q	DCO=1.12 *5*. R=1.20 *2*.
1269.2 *2*	2.9 *2*	6984.5?	25/2$^+$	5715.2	21/2$^+$	Q	R=0.94 *3*. placed from 9483 level by 2021Ru07 in ^{40}Ca(^{28}Si,αpγ), which is adopted in Adopted Levels, Gammas.
1292.1@a *4*	1.5 *1*	6250.7?		4958.6	(21/2$^+$)		
1304.6 *2*	3.2 *1*	9014.6		7710.0	27/2$^-$		Placed from 10162 level in Adopted Levels, Gammas.
1329.7 *2*	47.2 *14*	9039.9	31/2$^-$	7710.0	27/2$^-$	Q	DCO=1.15 *7*. R=1.28 *3*.
1341.9‡ *5*	1.0 *1*	9254.6	(29/2$^-$)	7914.3	25/2$^-$		E_γ: uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1340.3.
1413.4 *3*	2.3 *1*	7914.3	25/2$^-$	6501.1	23/2$^-$	D	R=0.38 *3*.
1422.6‡ *2*	12.3 *7*	1421.70	7/2$^-$	0.0	3/2$^-$	Q	E_γ: uncertainty multiplied by a factor of 2 in the fitting; level-energy difference=1421.68. R=0.95 *5*. 1996MiZU place a 1421γ-626γ cascade from the 2046 level to g.s., making a level at E=626 with J^π=(5/2$^-$), as in 1991Ba20 who state the order of the two transitions are uncertain. The 626 level is not seen in other studies. The order of the two transitions is reversed in 2001We11, thus making a level at E=1422 instead, which is confirmed in a more detailed γγ-coin measurement by 2021Ru07 in (^{28}Si,αpγ) and adopted by the evaluator.
1426.6 *2*	4.4 *4*	8411.1?	29/2$^+$	6984.5?	25/2$^+$	Q	R=1.22 *12*. Placed from 10908 level in Adopted Levels, Gammas.
1544.7 *3*	2.9 *1*	9254.6	(29/2$^-$)	7710.0	27/2$^-$		
1631.0 *2*	8.5 *3*	14463.3	43/2$^-$	12832.3	39/2$^-$	Q	R=1.25 *8*.

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^{40}Ca(^{32}S,2αpγ) 2001We11 (continued)

$\gamma(^{63}Ga)$ (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Mult.&	Comments
1634.9 *2*	13.3 *5*	5715.2	$21/2^+$	4080.2	$17/2^+$	Q	DCO=1.36 *17*. R=1.30 *6*.
1725.4 *4*	1.1 *1*	10979.6	$(33/2^-)$	9254.6	$(29/2^-)$		
1763.5 *3*	4.3 *2*	12743.2	$(37/2^-)$	10979.6	$(33/2^-)$		
1772.3 *2*	71.8 *22*	5852.5	$19/2^-$	4080.2	$17/2^+$	D	Placed from 6501 level in 1996MiZU. See comment for 648.7γ from 6501 level. DCO=0.55 *4*. R=0.60 *1*.
1811.5 *3*	3.2 *1*	10826.2		9014.6			Placed from 11974 level in Adopted Levels, Gammas.
1828.6 *2*	18.2 *6*	10868.6	$35/2^-$	9039.9	$31/2^-$	Q	DCO=1.08 *12*. R=1.22 *4*.
1864.0# *3*	4.0 *2*	12743.2	$(37/2^-)$	10868.6	$35/2^-$	D	E_γ: very poor fit and omitted in the fitting; level-energy difference=1874.6, which may imply 1864.0 is a misprint. R=0.40 *2*.
1868.3 *2*	9.1 *3*	12832.3	$39/2^-$	10964.1	$35/2^{(-)}$		The order of 1868γ-1924γ from 12832 level is reversed in Adopted Levels, Gammas. R=0.40 *2* is inconsistent with $\Delta J=2$ from level scheme, but consistent with $\Delta J=1$ in Adopted Level, Gammas with the reversed order of the γ cascade mentioned above.
1921.9 *4*	2.4 *1*	10333.0?	$(33/2^+)$	8411.1?	$29/2^+$	Q	R=1.05 *9*. The doublet of 1921.9γ from 10333 level and 1924.3γ from 10964 level proposed in 2001We11 in this dataset is considered as a single transition of 1924.8γ from 12833 level in 2021Ru07 as adopted in Adopted Levels, Gammas.
1924.3 *2*	9.6 *3*	10964.1	$35/2^{(-)}$	9039.9	$31/2^-$	Q	R=1.02 *6*. Placed from 12833 level in Adopted Levels, Gammas. See also comments for 1921.9γ from 10333 level.
1939.5 *3*	2.2 *1*	10979.6	$(33/2^-)$	9039.9	$31/2^-$		
1963.6 *2*	3.6 *1*	12832.3	$39/2^-$	10868.6	$35/2^-$	Q	R=0.93 *6*.
1971[a]		2046.25	$9/2^+$	75.25	$5/2^-$		E_γ: from 1996MiZU only.
1980.0@a *3*	2.4 *1*	9634.7?		7654.7			
2213.0 *6*	0.7 *1*	13039.2		10826.2			Placed from 16757 level in Adopted Levels, Gammas.
2306.0‡ *7*	0.6 *5*	5242.9?		2940.26	$13/2^+$		E_γ: uncertainty multiplied by a factor of 3 in the fitting; level-energy difference=2302.6.
2497.4 *6*	0.9 *3*	12830.5		10333.0?	$(33/2^+)$		Placed from 8214 level in Adopted Levels, Gammas.

† From 2001We11, unless otherwise noted.
‡ Poor fit; uncertainty multiplied by a factor in the fitting.
# Very poor fit and omitted in the fitting.
@ Transition not seen in a more complete study by 2021Ru07 and considered questionable by the evaluator.
& Deduced by the evaluator based on measured DCO ratios and/or angular asymmetry ratios in 2001We11 as given under comments, unless otherwise noted. Assignments are not explicitly listed in 2001We11.
[a] Placement of transition in the level scheme is uncertain.

^{40}Ca(^{32}S,2αpγ) 2001We11

Level Scheme

Intensities: Relative I_γ

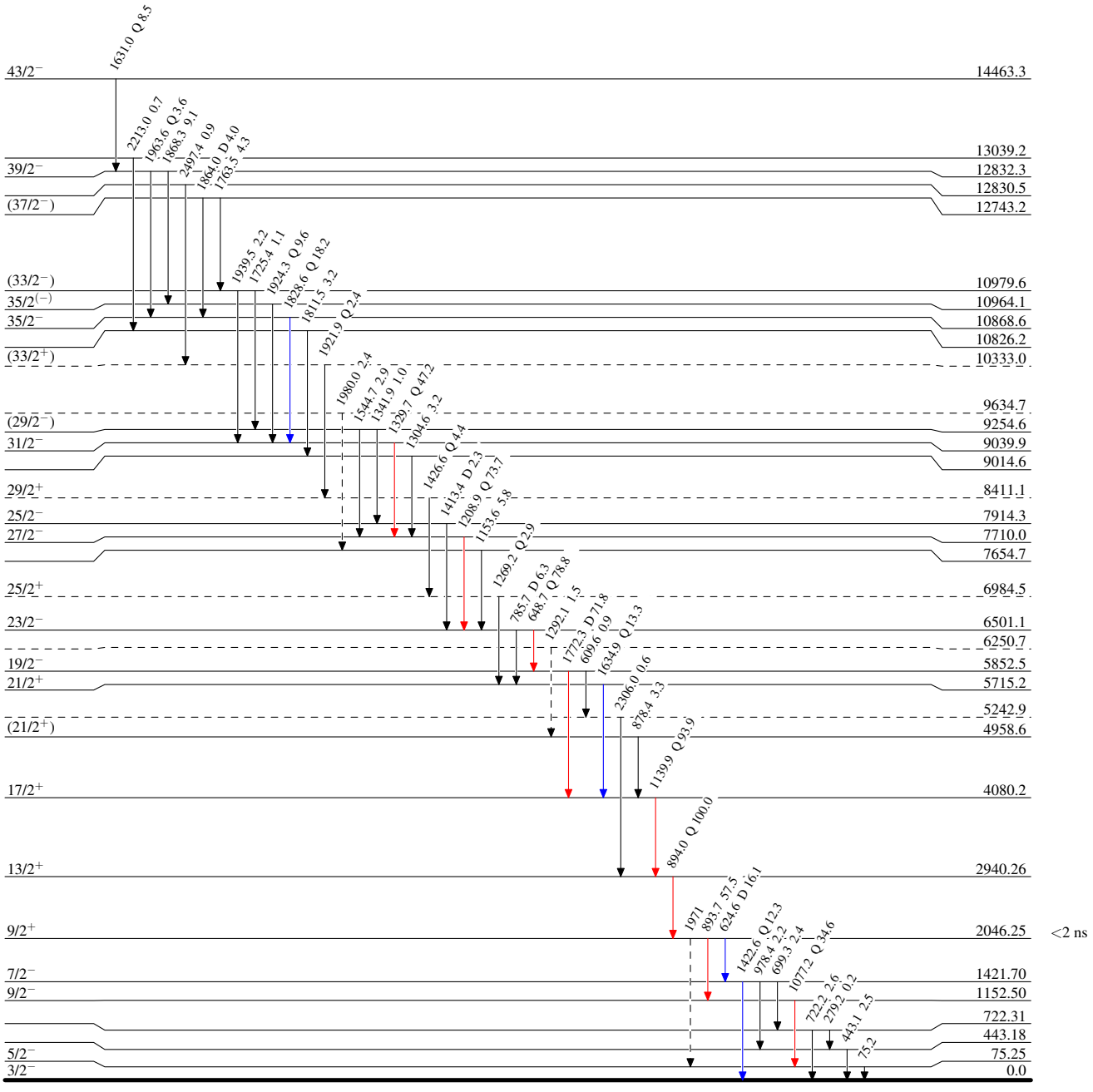
Legend

$I_\gamma < 2\% \times I_\gamma^{max}$

$I_\gamma < 10\% \times I_\gamma^{max}$

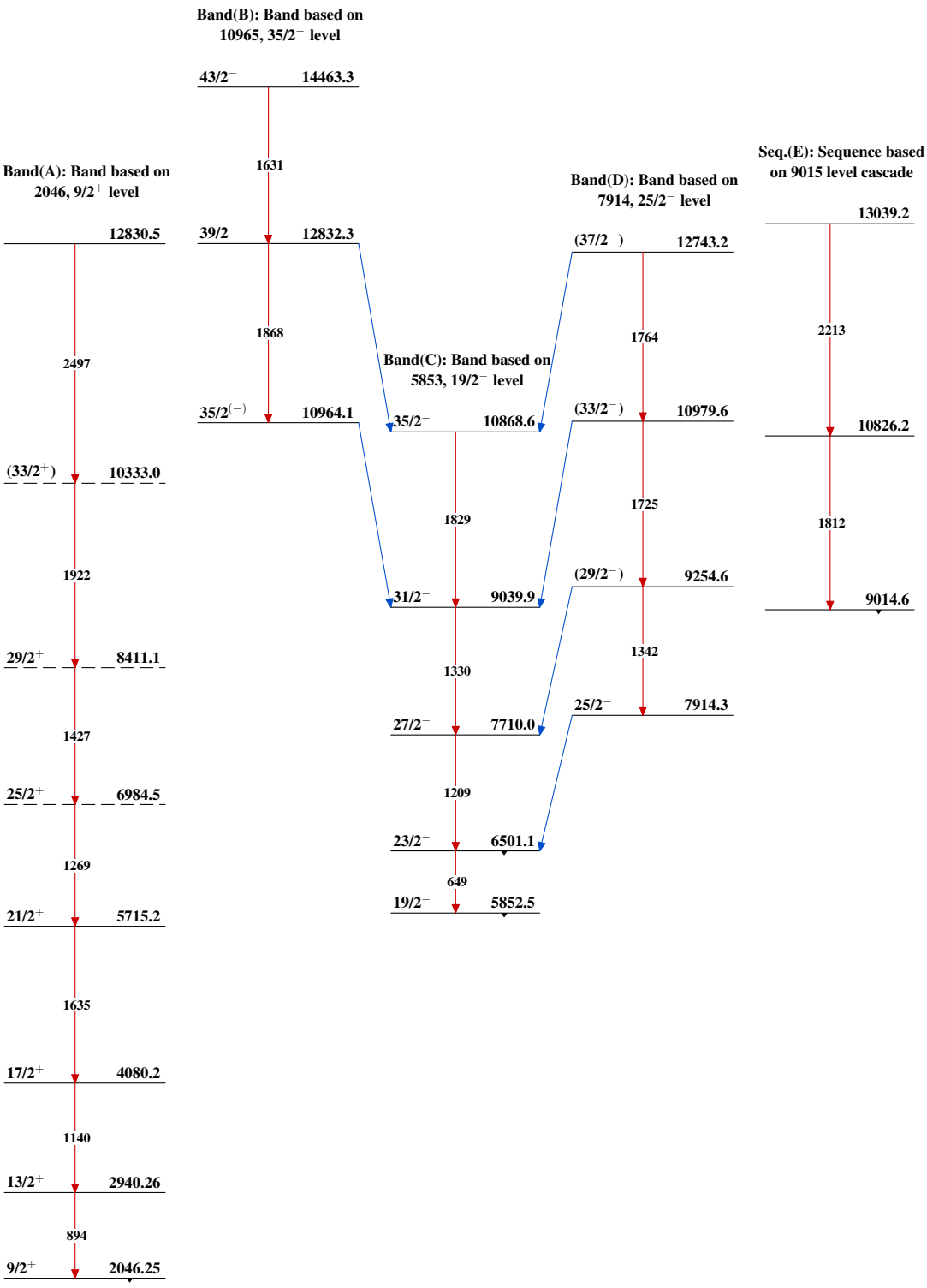
$I_\gamma > 10\% \times I_\gamma^{max}$

γ Decay (Uncertain)



$^{63}_{31}Ga_{32}$

^{40}Ca(^{32}S,2αpγ) 2001We11



$^{63}_{31}Ga_{32}$