^{138}Ba(^{31}P,4nγ) 1995Sc39

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 194,460 (2024)	31-Oct-2022

1995Sc39: E=155 MeV ^{31}P beam was produced from the NBI heavy-ion tandem plus booster accelerator. γ rays were detected with 20 Compton suppressed Ge detectors and an inner ball of 60 BaF_2 scintillators. Measured Eγ, Iγ, $\gamma\gamma$-coin. Deduced high-spin levels, J, π, superdeformed band and other normal-deformed bands. The authors also report data from ^{150}Sm(^{19}F,4nγ) reaction. See ^{150}Sm(^{19}F,4nγ) dataset.
Theory for SD band: 1999Xi02.

^{165}Lu Levels

E(level)[†]	J$^\pi$[‡]	Comments
0.0+x[&]	3/2$^+$	Additional information 1. E(level): x≈20 keV; see the Adopted Levels for comments.
5.39+x[a] *21*	5/2$^+$	
23.2+x[d] *3*	7/2$^+$	
141.45+x[b] *20*	7/2$^+$	
147.70+x[@] *13*	5/2$^+$	
182.3+x[c] *3*	9/2$^+$	
195.39+x[&] *11*	7/2$^+$	
305.57+x[a] *19*	9/2$^+$	
366.4+x[d] *3*	11/2$^+$	
432.70+x[@] *14*	9/2$^+$	
499.23+x[b] *19*	11/2$^+$	
519.60+x[&] *15*	11/2$^+$	
574.0+x[c] *3*	13/2$^+$	
711.23+x[a] *19*	13/2$^+$	
802.1+x[d] *3*	15/2$^+$	
821.13+x[@] *18*	13/2$^+$	
943.33+x[&] *17*	15/2$^+$	
955.33+x[b] *20*	15/2$^+$	
1048.7+x[c] *3*	17/2$^+$	
1197.31+x[a] *20*	17/2$^+$	
1291.98+x[@] *19*	17/2$^+$	
1310.5+x[d] *3*	19/2$^+$	
1445.40+x[&] *20*	19/2$^+$	
1478.41+x[b] *21*	19/2$^+$	
1587.0+x[c] *3*	21/2$^+$	
1740.05+x[a] *21*	21/2$^+$	
1818.53+x[@] *22*	21/2$^+$	
1871.6+x[d] *3*	23/2$^+$	
1879.3+x[#] *7*	(21/2$^+$)	
1990.14+x[&] *23*	23/2$^+$	
2048.2+x[b] *3*	23/2$^+$	
2166.7+x[c] *3*	25/2$^+$	
2222.8+x[#] *6*	25/2$^+$	
2263.9+x[g] *3*	(25/2$^+$)	
2294.39+x[a] *22*	25/2$^+$	

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^{138}Ba(^{31}P,4nγ) 1995Sc39 (continued)

^{165}Lu Levels (continued)

E(level)†	Jπ‡	E(level)†	Jπ‡	E(level)†	Jπ‡	E(level)†	Jπ‡
2348.76+x@ 23	25/2+	3417.4+xd 3	35/2+	4888.5+xe 3	45/2+	6997.6+xe 4	57/2+
2458.6+xd 3	27/2+	3436.4+xf 3	35/2+	5153.3+xg 7	(45/2+)	7439.0+xf 4	59/2+
2538.59+x& 24	27/2+	3682.6+xc 3	37/2+	5220.6+xf 3	47/2+	7562.9+xg 8	(57/2+)
2612.2+xb 4	27/2+	3705.1+xe 4	37/2+	5325.8+xd 15	47/2+	7837.4+xe 4	61/2+
2709.1+xg 4	(29/2+)	3815.9+xg 4	(37/2+)	5539.4+xe 4	49/2+	8330.7+xf 5	63/2+
2730.19+xc 24	29/2+	3970.1+xd 6	39/2+	5899.6+xf 4	51/2+	8470.4+xg 9	(61/2+)
2753.47+xa 24	29/2+	3980.9+xf 3	39/2+	5904.1+xg 7	(49/2+)	8755.1+xe 5	65/2+
2956.65+xd 24	31/2+	4269.8+xe 3	41/2+	6101.6+xd 18	51/2+	9305.7+xf 6	67/2+
3180.5+xc 3	33/2+	4457.2+xg 7	(41/2+)	6236.0+xe 4	53/2+	9432.7+xg 10	(65/2+)
3200.8+xe 3	33/2+	4579.2+xf 3	43/2+	6632.0+xf 4	55/2+		
3233.6+xg 4	(33/2+)	4613.8+xd 11	43/2+	6707.6+xg 8	(53/2+)		

† From a least-squares fit to Eγ data. Reduced χ^2=2.8 is somewhat larger than critical χ^2=1.5 at 95% confidence level. Three Eγ values are poorly fitted: 475.01 from 2294 level; 224.33 from 3180 level, and 214.1 from 3417 level; the last one deviating by 2.5 keV was omitted from the fitting procedure.

‡ From 1995Sc39, based on rotational-band assignments and γ(θ) data in earlier (1988Fr22,1984Jo05) studies. The assignments are consistent with those in the Adopted Levels, except that all are given in parentheses there due to lack of strong supporting arguments for low-lying levels.

Level which the SD band is based on is not supported in more recent studies (2004Sc14), the transition connected with this level is placed elsewhere. This level is omitted in the Adopted Levels.

@ Band(A): π1/2[411] band, α=+1/2.

& Band(a): π1/2[411] band, α=−1/2.

a Band(B): π5/2[402] band, α=+1/2.

b Band(b): π5/2[402] band, α=−1/2.

c Band(C): π7/2[404] band, α=+1/2.

d Band(c): π7/2[404] band, α=−1/2.

e Band(D): 3-quasiparticle band, α=+1/2.

f Band(d): 3-quasiparticle band, α=−1/2.

g Band(E): SD (triaxial), π1/2[660] band, α=+1/2. The in−band transitions are confirmed in 2004Sc14 but the band head is assigned at a different level 2409+x, which is adopted in Adopted Levels.

γ(^{165}Lu)

Eγ†	Iγ†	Ei(level)	J_i^π	Ef	J_f^π	Comments
136.10 12	10.0 10	141.45+x	7/2+	5.39+x	5/2+	
147.67 14	10.0 10	147.70+x	5/2+	0.0+x	3/2+	
159.18 11	10.0 10	182.3+x	9/2+	23.2+x	7/2+	
164.28 12	43.3 16	305.57+x	9/2+	141.45+x	7/2+	
184.27 11	85.7 19	366.4+x	11/2+	182.3+x	9/2+	
193.80 12	41.9 11	499.23+x	11/2+	305.57+x	9/2+	
195.41 11	83.3 32	195.39+x	7/2+	0.0+x	3/2+	
207.59 12	61.5 11	574.0+x	13/2+	366.4+x	11/2+	
212.17 14	25.7 9	711.23+x	13/2+	499.23+x	11/2+	
214.07 16	13.2 5	519.60+x	11/2+	305.57+x	9/2+	
214.14 26	10.4 5	3417.4+x	35/2+	3200.8+x	33/2+	Eγ: poor fit; level-energy difference=216.6, Eγ not used in the fitting procedure.
224.33 16	15.4 5	3180.5+x	33/2+	2956.65+x	31/2+	Eγ: poor fit; level-energy difference=223.81.
226.52 14	27.7 7	2956.65+x	31/2+	2730.19+x	29/2+	

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^{138}Ba(^{31}P,4nγ) 1995Sc39 (continued)

$\gamma(^{165}Lu)$ (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π
228.18 *14*	46.0 *9*	802.1+x	15/2$^+$	574.0+x	13/2$^+$
231.88 *20*	8.5 *6*	943.33+x	15/2$^+$	711.23+x	13/2$^+$
235.60 *3*	26.5 *6*	3436.4+x	35/2$^+$	3200.8+x	33/2$^+$
237.23 *14*	19.7 *6*	3417.4+x	35/2$^+$	3180.5+x	33/2$^+$
237.39 *16*	14.9 *8*	432.70+x	9/2$^+$	195.39+x	7/2$^+$
241.82 *15*	17.3 *6*	1197.31+x	17/2$^+$	955.33+x	15/2$^+$
244.11 *14*	25.2 *6*	3200.8+x	33/2$^+$	2956.65+x	31/2$^+$
244.33 *15*	17.3 *7*	955.33+x	15/2$^+$	711.23+x	13/2$^+$
246.69 *13*	33.8 *7*	1048.7+x	17/2$^+$	802.1+x	15/2$^+$
262.00 *14*	28.3 *7*	1310.5+x	19/2$^+$	1048.7+x	17/2$^+$
262.05 *18*	11.1 *6*	1740.05+x	21/2$^+$	1478.41+x	19/2$^+$
265.33 *14*	20.1 *6*	3682.6+x	37/2$^+$	3417.4+x	35/2$^+$
268.63 *20*	16.2 *6*	3705.1+x	37/2$^+$	3436.4+x	35/2$^+$
271.40 *14*	36.1 *7*	2730.19+x	29/2$^+$	2458.6+x	27/2$^+$
275.23 *95*	7.1 *4*	3980.9+x	39/2$^+$	3705.1+x	37/2$^+$
276.52 *13*	38.5 *7*	1587.0+x	21/2$^+$	1310.5+x	19/2$^+$
281.10 *16*	13.4 *6*	1478.41+x	19/2$^+$	1197.31+x	17/2$^+$
284.49 *15*	17.6 *7*	1871.6+x	23/2$^+$	1587.0+x	21/2$^+$
284.96 *17*	15.2 *9*	432.70+x	9/2$^+$	147.70+x	5/2$^+$
287.64 *95*	14.9 *7*	3970.1+x	39/2$^+$	3682.6+x	37/2$^+$
288.46 *15*	10.6 *5*	4269.8+x	41/2$^+$	3980.9+x	39/2$^+$
291.80 *14*	24.2 *6*	2458.6+x	27/2$^+$	2166.7+x	25/2$^+$
295.04 *14*	28.6 *6*	2166.7+x	25/2$^+$	1871.6+x	23/2$^+$
299.85 *95*	14.2 *5*	4269.8+x	41/2$^+$	3970.1+x	39/2$^+$
300.12 *15*	17.4 *10*	305.57+x	9/2$^+$	5.39+x	5/2$^+$
301.53 *95*	16.3 *6*	821.13+x	13/2$^+$	519.60+x	11/2$^+$
309.08 *20*	16.3 *8*	4579.2+x	43/2$^+$	4269.8+x	41/2$^+$
309.36 *15*	38.0 *9*	4888.5+x	45/2$^+$	4579.2+x	43/2$^+$
318.58 *13*	30.7 *5*	5539.4+x	49/2$^+$	5220.6+x	47/2$^+$
324.18 *12*	83.2 *17*	519.60+x	11/2$^+$	195.39+x	7/2$^+$
331.86 *14*	25.0 *5*	5220.6+x	47/2$^+$	4888.5+x	45/2$^+$
335.99 *14*	22.9 *6*	6236.0+x	53/2$^+$	5899.6+x	51/2$^+$
343.03 *12*	120.9 *31*	366.4+x	11/2$^+$	23.2+x	7/2$^+$
343.50 *32*	10.0 *10*	2222.8+x	25/2$^+$	1879.3+x	(21/2$^+$)
348.32 *20*	11.0 *5*	1291.98+x	17/2$^+$	943.33+x	15/2$^+$
357.56 *16*	24.5 *9*	499.23+x	11/2$^+$	141.45+x	7/2$^+$
360.06 *14*	22.8 *5*	5899.6+x	51/2$^+$	5539.4+x	49/2$^+$
365.94 *20*	9.1 *5*	6997.6+x	57/2$^+$	6632.0+x	55/2$^+$
388.46 *14*	33.4 *10*	821.13+x	13/2$^+$	432.70+x	9/2$^+$
391.71 *11*	142.6 *24*	574.0+x	13/2$^+$	182.3+x	9/2$^+$
395.84 *18*	13.9 *5*	6632.0+x	55/2$^+$	6236.0+x	53/2$^+$
398.62 *20*	13.3 *6*	7837.4+x	61/2$^+$	7439.0+x	59/2$^+$
404.85 *20*	18.2 *10*	2753.47+x	29/2$^+$	2348.76+x	25/2$^+$
405.57 *16*	23.0 *11*	711.23+x	13/2$^+$	305.57+x	9/2$^+$
418.06 *14*	20.1 *4*	2956.65+x	31/2$^+$	2538.59+x	27/2$^+$
423.70 *12*	75.0 *13*	943.33+x	15/2$^+$	519.60+x	11/2$^+$
435.61 *12*	183.0 *25*	802.1+x	15/2$^+$	366.4+x	11/2$^+$
435.82 *16*	20.8 *8*	2730.19+x	29/2$^+$	2294.39+x	25/2$^+$
436.27 *44*	8.0 *9*	955.33+x	15/2$^+$	519.60+x	11/2$^+$
441.98 *28*	5.9 *5*	7439.0+x	59/2$^+$	6997.6+x	57/2$^+$
444.10 *15*	26.8 *8*	943.33+x	15/2$^+$	499.23+x	11/2$^+$
445.28 *24*	14.9 *9*	2709.1+x	(29/2$^+$)	2263.9+x	(25/2$^+$)
445.41 *27*	3.8 *9*	2263.9+x	(25/2$^+$)	1818.53+x	21/2$^+$
448.60 *27*	5.9 *6*	1740.05+x	21/2$^+$	1291.98+x	17/2$^+$
450.08 *13*	43.6 *9*	3180.5+x	33/2$^+$	2730.19+x	29/2$^+$

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^{138}Ba(^{31}P,4nγ) 1995Sc39 (continued)

$\gamma(^{165}Lu)$ (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π	Comments
455.88 *18*	24.2 *10*	955.33+x	$15/2^+$	499.23+x	$11/2^+$	
458.97 *15*	40.5 *11*	2753.47+x	$29/2^+$	2294.39+x	$25/2^+$	
460.51 *15*	32.7 *10*	3417.4+x	$35/2^+$	2956.65+x	$31/2^+$	
470.65 *18*	32.6 *10*	3200.8+x	$33/2^+$	2730.19+x	$29/2^+$	
470.89 *15*	38.3 *11*	1291.98+x	$17/2^+$	821.13+x	$13/2^+$	
474.73 *12*	163.6 *20*	1048.7+x	$17/2^+$	574.0+x	$13/2^+$	
475.01 *24*	10.4 *6*	2294.39+x	$25/2^+$	1818.53+x	$21/2^+$	E_γ: poor fit; level-energy difference=475.85.
479.83 *17*	23.0 *8*	3436.4+x	$35/2^+$	2956.65+x	$31/2^+$	
480.02 *40*	6.9 *6*	3233.6+x	$(33/2^+)$	2753.47+x	$29/2^+$	
486.10 *15*	34.7 *11*	1197.31+x	$17/2^+$	711.23+x	$13/2^+$	
486.38 *40*	7.4 *8*	2709.1+x	$(29/2^+)$	2222.8+x	$25/2^+$	
493.21 *31*	5.2 *7*	8330.7+x	$63/2^+$	7837.4+x	$61/2^+$	
498.27 *18*	23.0 *7*	2956.65+x	$31/2^+$	2458.6+x	$27/2^+$	
502.04 *16*	34.2 *10*	3682.6+x	$37/2^+$	3180.5+x	$33/2^+$	
502.07 *12*	98.2 *15*	1445.40+x	$19/2^+$	943.33+x	$15/2^+$	
508.41 *12*	197.1 *20*	1310.5+x	$19/2^+$	802.1+x	$15/2^+$	
523.49 *18*	27.3 *13*	1478.41+x	$19/2^+$	955.33+x	$15/2^+$	
523.63 *95*	5.0 *8*	2263.9+x	$(25/2^+)$	1740.05+x	$21/2^+$	
524.44 *20*	11.5 *9*	3233.6+x	$(33/2^+)$	2709.1+x	$(29/2^+)$	
526.14 *17*	38.0 *11*	1818.53+x	$21/2^+$	1291.98+x	$17/2^+$	
530.23 *20*	18.5 *8*	2348.76+x	$25/2^+$	1818.53+x	$21/2^+$	
538.25 *12*	174.9 *18*	1587.0+x	$21/2^+$	1048.7+x	$17/2^+$	
542.58 *16*	34.7 *11*	1740.05+x	$21/2^+$	1197.31+x	$17/2^+$	
544.65 *15*	33.9 *10*	3980.9+x	$39/2^+$	3436.4+x	$35/2^+$	
544.73 *13*	92.9 *14*	1990.14+x	$23/2^+$	1445.40+x	$19/2^+$	
548.45 *15*	36.7 *9*	2538.59+x	$27/2^+$	1990.14+x	$23/2^+$	
552.90 *95*	36.5 *10*	3970.1+x	$39/2^+$	3417.4+x	$35/2^+$	
554.59 *15*	33.7 *13*	2294.39+x	$25/2^+$	1740.05+x	$21/2^+$	
561.03 *13*	151.6 *20*	1871.6+x	$23/2^+$	1310.5+x	$19/2^+$	
562.48 *35*	5.0 *7*	3980.9+x	$39/2^+$	3417.4+x	$35/2^+$	
563.56 *14*	84.0 *16*	2730.19+x	$29/2^+$	2166.7+x	$25/2^+$	
564.03 *23*	16.3 *9*	2612.2+x	$27/2^+$	2048.2+x	$23/2^+$	
564.04 *95*	<0.5	4269.8+x	$41/2^+$	3705.1+x	$37/2^+$	
569.75 *18*	22.9 *11*	2048.2+x	$23/2^+$	1478.41+x	$19/2^+$	
579.74 *12*	165.0 *18*	2166.7+x	$25/2^+$	1587.0+x	$21/2^+$	
582.36 *18*	21.5 *11*	3815.9+x	$(37/2^+)$	3233.6+x	$(33/2^+)$	
587.02 *13*	110.8 *19*	2458.6+x	$27/2^+$	1871.6+x	$23/2^+$	
587.46 *21*	14.3 *9*	4269.8+x	$41/2^+$	3682.6+x	$37/2^+$	
587.66 *95*	6.8 *15*	2753.47+x	$29/2^+$	2166.7+x	$25/2^+$	
598.55 *15*	40.7 *10*	4579.2+x	$43/2^+$	3980.9+x	$39/2^+$	
608.84 *20*	18.1 *10*	2348.76+x	$25/2^+$	1740.05+x	$21/2^+$	
609.29 *95*	18.9 *7*	4579.2+x	$43/2^+$	3970.1+x	$39/2^+$	
618.51 *15*	44.7 *8*	4888.5+x	$45/2^+$	4269.8+x	$41/2^+$	
641.3 *5*		4457.2+x	$(41/2^+)$	3815.9+x	$(37/2^+)$	E_γ: this gamma ray is not listed in Table 1 of 1995Sc39, but is listed in level-scheme Fig. 1 as 641. This γ is placed from the 4988+x level in (^{30}Si,4nγ) and adopted in Adopted Gammas.
641.44 *17*	37.9 *11*	5220.6+x	$47/2^+$	4579.2+x	$43/2^+$	
643.70 *95*	29.1 *12*	4613.8+x	$43/2^+$	3970.1+x	$39/2^+$	
651.13 *15*	45.3 *10*	5539.4+x	$49/2^+$	4888.5+x	$45/2^+$	
679.18 *18*	24.2 *7*	5899.6+x	$51/2^+$	5220.6+x	$47/2^+$	
696.10 *20*	19.7 *9*	5153.3+x	$(45/2^+)$	4457.2+x	$(41/2^+)$	
696.73 *17*	29.8 *9*	6236.0+x	$53/2^+$	5539.4+x	$49/2^+$	
712.00 *95*	26.0 *9*	5325.8+x	$47/2^+$	4613.8+x	$43/2^+$	
732.95 *20*	23.6 *8*	6632.0+x	$55/2^+$	5899.6+x	$51/2^+$	

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^{138}Ba(^{31}P,4nγ) 1995Sc39 (continued)

$\gamma(^{165}Lu)$ (continued)

E_γ †	I_γ †	E_i(level)	J_i^π	E_f	J_f^π
750.73 *20*	20.6 *9*	5904.1+x	$(49/2^+)$	5153.3+x	$(45/2^+)$
761.39 *18*	31.1 *8*	6997.6+x	$57/2^+$	6236.0+x	$53/2^+$
775.80 *95*	18.0 *8*	6101.6+x	$51/2^+$	5325.8+x	$47/2^+$
803.52 *26*	14.0 *7*	6707.6+x	$(53/2^+)$	5904.1+x	$(49/2^+)$
806.93 *20*	28.6 *9*	7439.0+x	$59/2^+$	6632.0+x	$55/2^+$
839.50 *22*	22.1 *8*	7837.4+x	$61/2^+$	6997.6+x	$57/2^+$
855.31 *25*	14.9 *7*	7562.9+x	$(57/2^+)$	6707.6+x	$(53/2^+)$
891.77 *25*	17.9 *8*	8330.7+x	$63/2^+$	7439.0+x	$59/2^+$
907.47 *34*	9.1 *7*	8470.4+x	$(61/2^+)$	7562.9+x	$(57/2^+)$
917.66 *24*	20.3 *8*	8755.1+x	$65/2^+$	7837.4+x	$61/2^+$
962.30 *37*	8.0 *7*	9432.7+x	$(65/2^+)$	8470.4+x	$(61/2^+)$
974.98 *31*	14.0 *8*	9305.7+x	$67/2^+$	8330.7+x	$63/2^+$

† From 1995Sc39, with energies from (^{31}P,4nγ) and (^{19}F,4nγ) results combined.

^{138}Ba(^{31}P,4nγ) 1995Sc39

Level Scheme

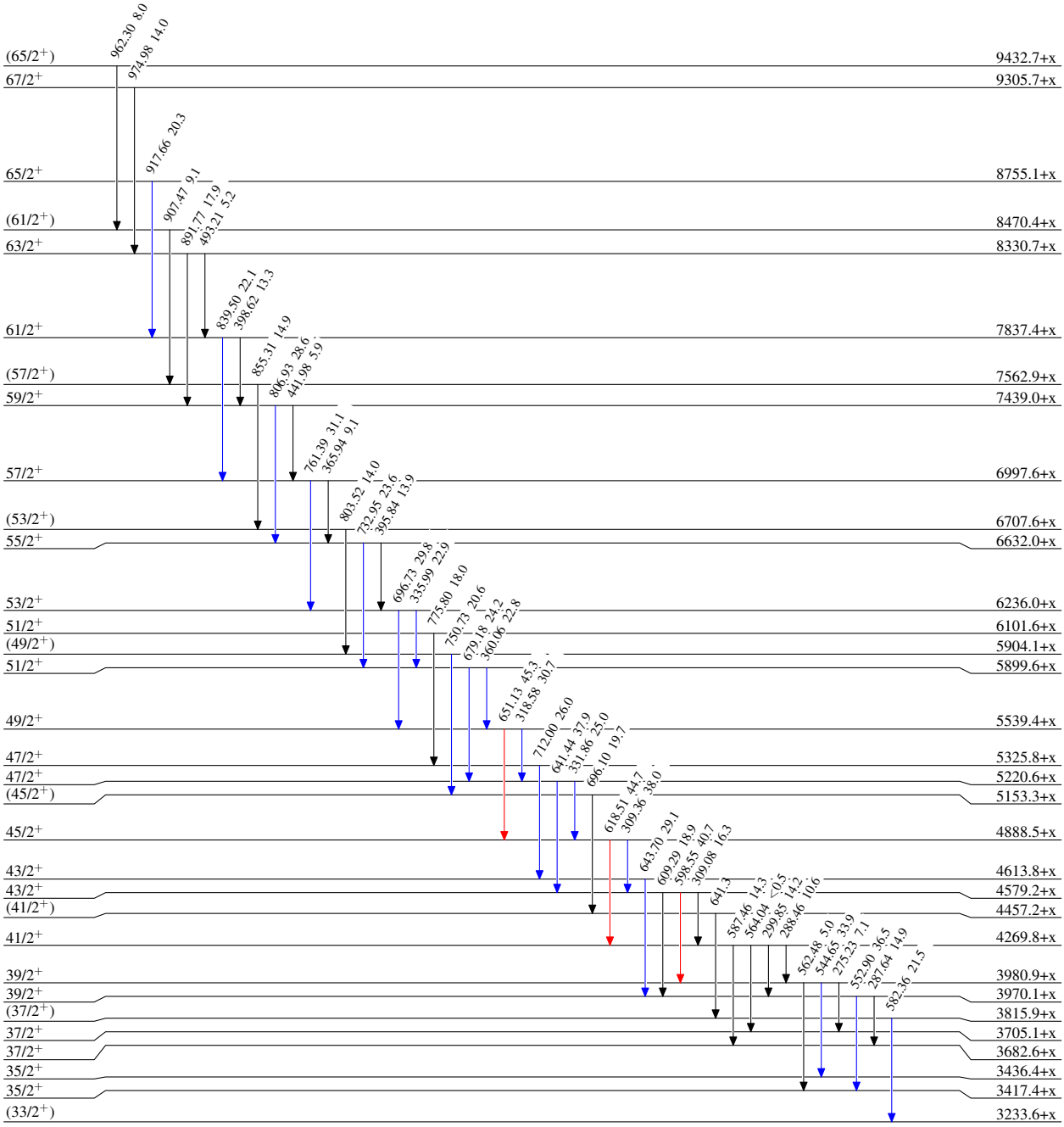
Intensities: Relative I_γ

Legend

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

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

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



$^{165}_{71}Lu_{94}$

^{138}Ba(^{31}P,4nγ) 1995Sc39

Level Scheme (continued)

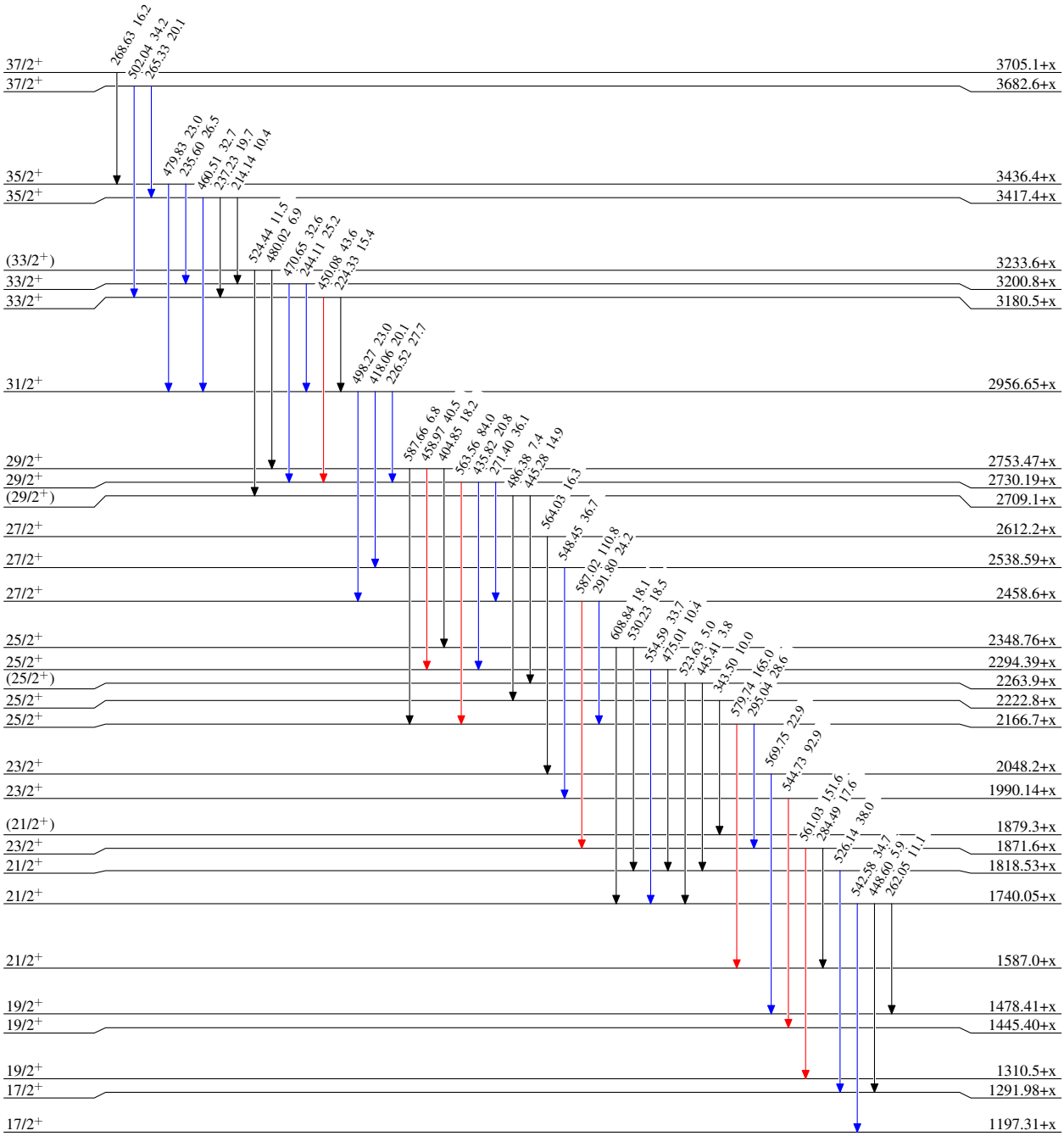
Intensities: Relative I_γ

Legend

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

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

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

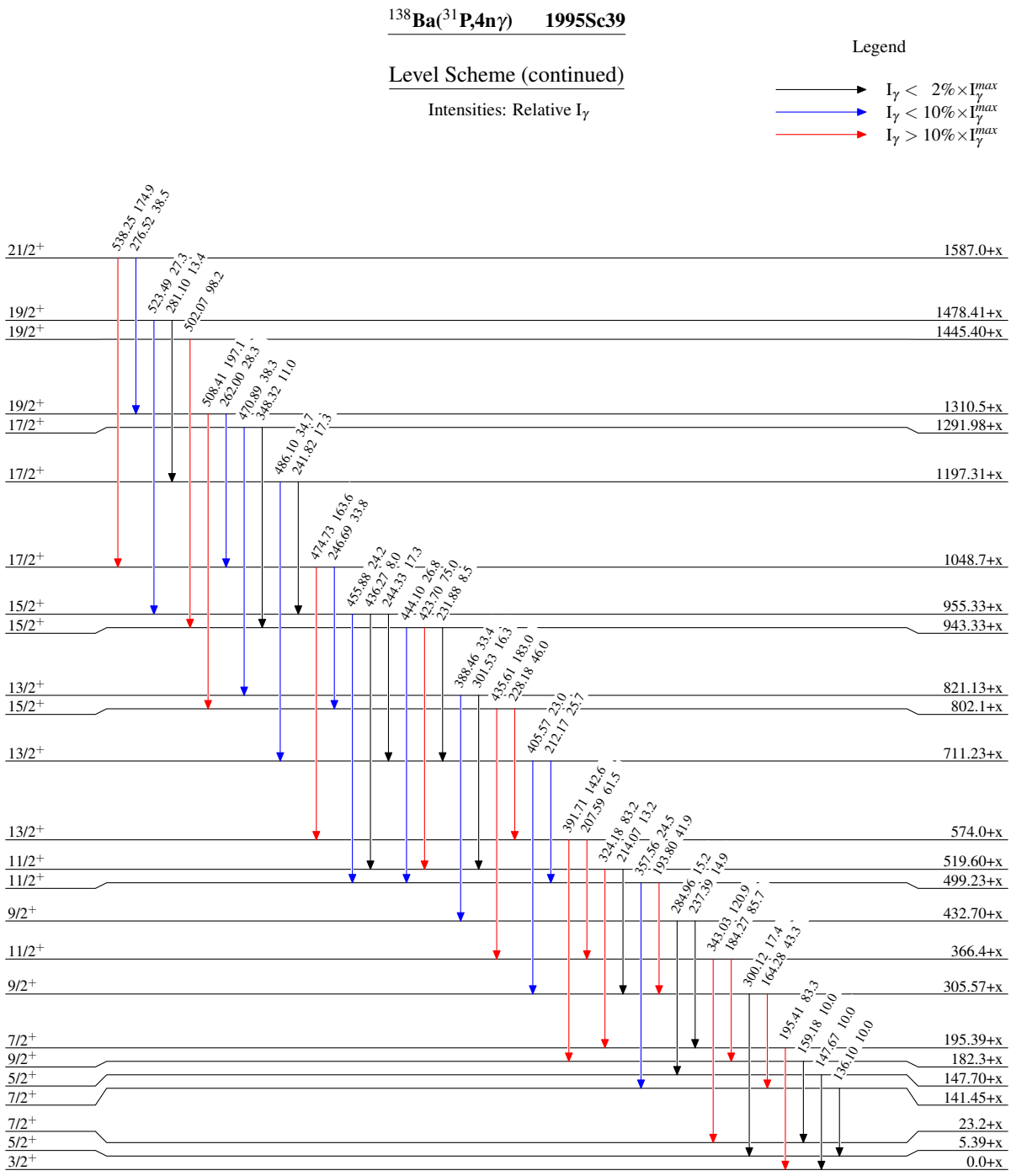


$^{165}_{71}Lu_{94}$

^{138}Ba(^{31}P,4nγ) 1995Sc39

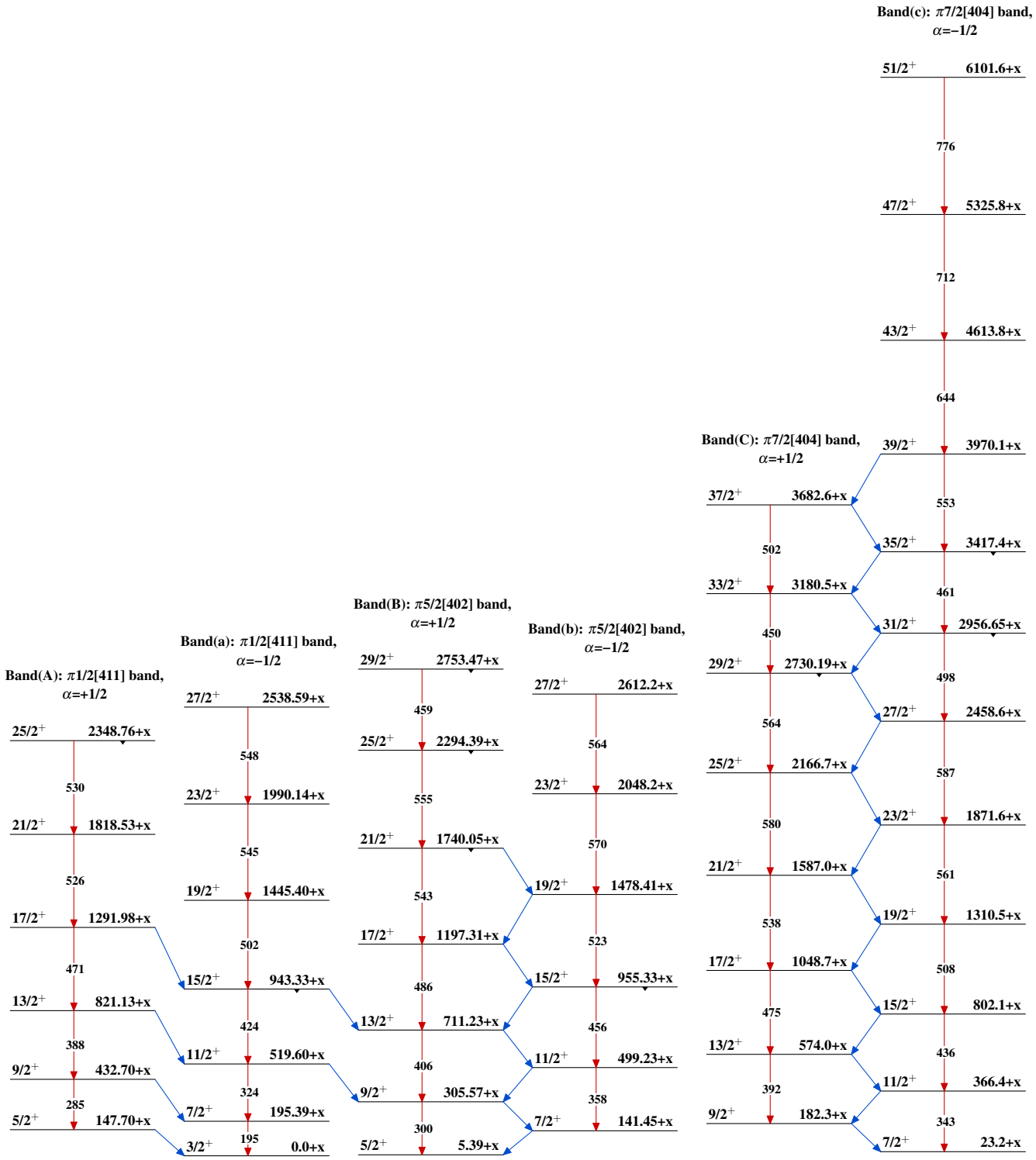
Level Scheme (continued)

Intensities: Relative I_γ



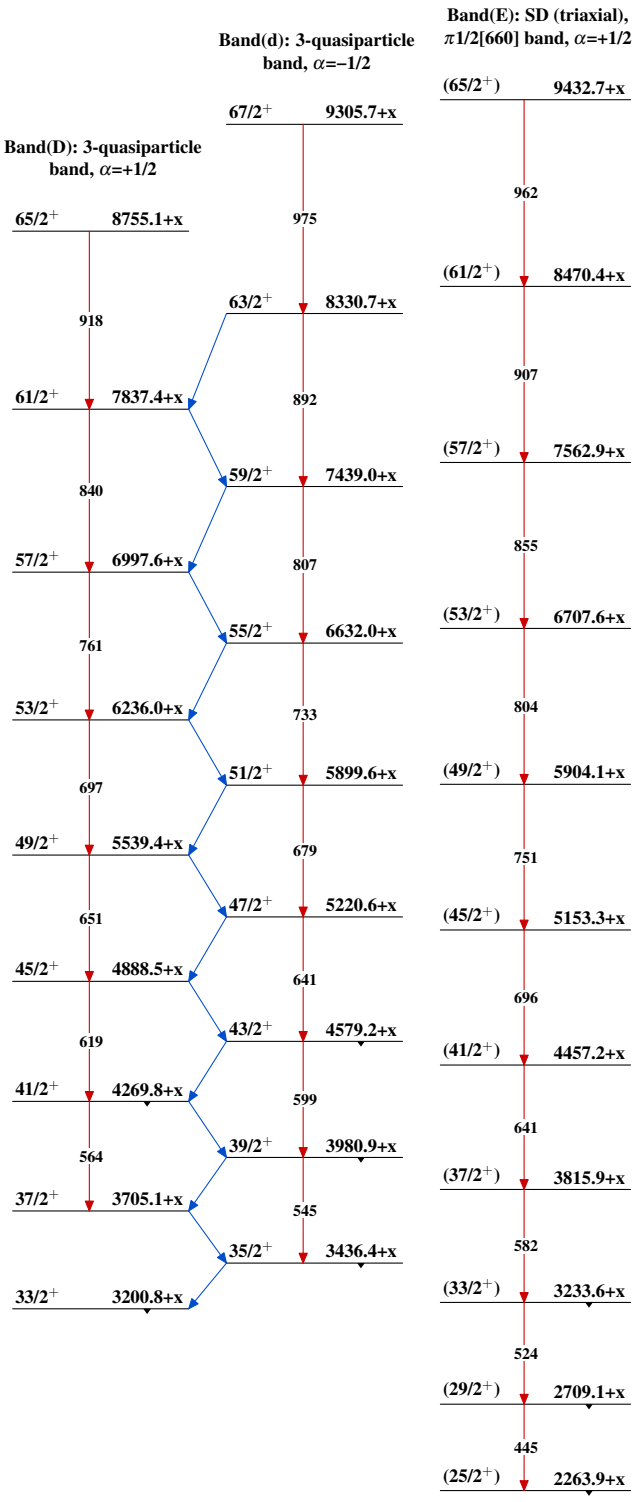
$^{165}_{71}Lu_{94}$

^{138}Ba(^{31}P,4nγ) 1995Sc39



$^{165}_{71}Lu_{94}$

^{138}Ba(^{31}P,4nγ) 1995Sc39 (continued)



$^{165}_{71}Lu_{94}$