^{232}Th(d,t) 2008Bu14

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh, Jagdish K. Tuli, and Edgardo Browne	NDS 185, 560 (2022)	31-Aug-2022

2008Bu14: E(d)=17 MeV. Measured triton spectra with an Enge split-pole magnetic spectrograph at 15 angles from 5° to 60° at McMaster University tandem accelerator facility. FWHM=5.5-6.5 keV. DWBA analysis and Nilsson configurations. Coriolis mixing calculations.

Others: 1977Wi07.

Some of the comments given here are from an e-mail reply from D.G. Burke to the compiler of the XUNDL dataset on June 30, 2008, including some additional $\sigma(\theta)$ plots provided in the e-mail communication.

Others:

1977Wi07 (from the same group as 1970Bo31): E(d)=17 MeV. Measured triton spectra from 20° to 130° in 5° step using Enge split-pole magnetic spectrograph at the University of Rochester tandem van de Graaff accelerator. FWHM=13 keV. High-resolution spectra were recorded at 40° and 80° with FWHM=6-8 keV. Total of 35 levels, with measured cross sections listed at 40° and 80°. Nilsson configurations were proposed for the low-lying levels. DWBA and CCBA analysis.

1972Gr19: E(d)=12.1, 13.1 MeV. Measured triton spectra at 60°, 90°, and 125° using broad-range magnetic spectrograph at Niels Bohr Insitute tandem accelerator laboratory. FWHM=10 keV. Total of 54 levels reported, and measured cross sections listed at 60°, 90° and 120° at E(d)=12.1 MeV, and for 90° and 125° at 13.1 MeV. Comparison of measured and theoretical cross sections for nine Nilsson model configurations assigned for 27 observed levels, however, several assignments are not supported in the work of 2008Bu14.

1972Er03 (also 1970Er04): E(d)=8-12 MeV in 1972Er03. Measured triton spectra and yields for eight levels up to 557 keV using Enge split-pole spectrograph at ANL. In 1970Er04, 27 levels up to 1398 keV are reported from (d,p) and (d,t) studies.

1970Bo31: E(d)=17 MeV. Measured triton spectra at 60° using Enge split-pole magnetic spectrograph at the University of Rochester tandem van de Graaff accelerator. Total of 25 levels, with measured cross sections listed and Nilsson configurations for the low-lying levels. Measured cross sections listed at 60°.

^{231}Th Levels

Additional information 1.

E(level)[†]	J$^\pi$[‡]	L[‡]	S[#]	Comments
0.3[@] *4*	5/2$^+$	2	0.0036 *4*	E(level): most likely the g.s. dσ/dΩ=4 μb/sr *1*. E(level): 0, 5/2, ν5/2[633] (1977Wi07, 1972Gr19). E(level): 0, spectroscopic factor=0.00087 *18*, 5/2$^+$, ν5/2[633] (1972Er03).
42.1[@] *3*	7/2$^+$	4	0.129 *6*	dσ/dΩ=47 μb/sr *5*. E(level): 42 *3*, 7/2, ν5/2[633] (1977Wi07); 42, 7/2, ν5/2[633] (1972Gr19). E(level): 42, spectroscopic factor=0.027 *4*, 7/2$^+$, ν5/2[633] (1972Er03). E(level): 40 *2*, L=4, spectroscopic factor=0.15, 7/2, ν5/2[633] (1970Bo31).
96.4[@] *4*	9/2$^+$	4	0.073 *5*	dσ/dΩ=26 μb/sr *4*. E(level): 98 *3*, 9/2, ν5/2[633] (1977Wi07); 96, 9/2, ν5/2[633] (1972Gr19). E(level): 98 *1*, spectroscopic factor=0.0082 *12*, 9/2$^+$, ν5/2[633] (1972Er03). E(level): 97 *2*, L=4, spectroscopic factor=0.07, 9/2, ν5/2[633] (1970Bo31).
162.7[@] *3*	11/2$^+$	6	0.95 *7*	dσ/dΩ=42 μb/sr *5*. E(level): 164 *3*, 11/2, ν5/2[633] (1977Wi07); 162, 11/2, ν5/2[633] (1972Gr19). E(level): 164 *1*, spectroscopic factor=0.108 *14*, 11/2$^+$, ν5/2[633] (1972Er03). E(level): 163 *2*, L=6, spectroscopic factor=0.97, 11/2, ν5/2[633] (1970Bo31).
186.4[&] *8*	5/2$^-$		≤0.006	dσ/dΩ=6 μb/sr *2*. E(level): 183, 5/2, 5/2[752] (1972Gr19).
206.1[&] *6*	(7/2$^-$)		≤0.001	dσ/dΩ=1 μb/sr *1*.
221.5[a] *4*	3/2$^+$	[2]	0.0081 *6*	dσ/dΩ=11 2.

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^{232}Th(d,t) 2008Bu14 (continued)

^{231}Th Levels (continued)

E(level)[†]	Jπ[‡]	L[‡]	S[#]	Comments
				L: uncertain assignment due to poor L=2 DWBA fit of σ(θ) distribution. E(level): 223 *10* (1977Wi07). E(level): 228 *3*, 3/2, ν3/2[631] (1970Er04).
235.8[&] *3*	9/2⁻			Obscured group.
240.8[a] *3*	5/2⁺	2	0.174 *5*	dσ/dΩ=290 μb/sr *14*. E(level): 240 *5*, 5/2, ν3/2[631] (1977Wi07); 242, 5/2, ν3/2[631] or 1/2, 1/2[631] (1972Gr19). E(level): 242.6 *10*, spectroscopic factor=0.072 *8*, 5/2⁺, ν3/2[631] (1972Er03). E(level): 244 *2*, spectroscopic factor=0.34, 5/2, ν3/2[631] (1970Bo31).
247.7[b] *3*	1/2⁺	0	0.027 *1*	dσ/dΩ=70 μb/sr *14*.
272.4[b] *3*	3/2⁺	2	0.135 *5*	dσ/dΩ=155 μb/sr *7*. E(level): 274 *4*, 1/2,3/2, ν1/2[631] (1977Wi07); 271, 3/2, ν1/2[631] or 7/2, ν3/2[631] (1972Gr19). E(level): 272 *3*, doublet, 1/2,3/2, ν1/2[631] (1970Er04). E(level): 275 *4*, spectroscopic factor=0.17, 1/2,3/2, ν3/2[631] (1970Bo31).
279.8 *8*	7/2⁺&(11/2⁻)	(4+5)		E(level): doublet. dσ/dΩ=80 μb/sr *7* for doublet. L: possible fit with L=4+5. E(level): 280, 11/2, ν5/2[752] (1972Gr19).
301.6[g] *3*	5/2⁺	(2)	0.0047 *5*	dσ/dΩ=6 μb/sr *2*. E(level): 299 *10* (1977Wi07).
317.4[b] *4*	5/2⁺	2	0.039 *2*	dσ/dΩ=38 μb/sr *10*.
325.2[a] *3*	9/2⁺	4	1.30 *4*	dσ/dΩ=376 μb/sr *10*. E(level): 324 *3*, 9/2, ν3/2[631] (1977Wi07); 322, 9/2, ν3/2[631] (1972Gr19). E(level): 324 *2*, spectroscopic factor=0.196 *16*, 9/2⁺, ν3/2[631] (1972Er03). E(level): 325 *2*, L=4, spectroscopic factor=1.69, 9/2, ν3/2[631] (1970Bo31).
333[&] *3*	(13/2⁻)			dσ/dΩ≤15 μb/sr.
352.0[b] *4*	7/2⁺		≤0.04	L: L=2 fits better than L=4 in σ(θ) distribution. dσ/dΩ=10 μb/sr *2*. E(level): 347 *10* (1977Wi07); 348 (1972Gr19).
378.3[g] *5*	(7/2⁺)		≤0.034	L: L=1 fits better than L=4 in σ(θ) distribution. dσ/dΩ=8 μb/sr *2*. E(level): 376, 11/2, ν3/2[631] (1972Gr19).
402.0[&] *3*	15/2⁻	7	3.7 *3*	E(level),L: may have an admixture of L=6, 11/2⁺ member of ν3/2[631] band. dσ/dΩ=60 μb/sr *5*. E(level): 400 *4*, 15/2, ν5/2[752] (1977Wi07); 400, 15/2, ν5/2[752] (1972Gr19). E(level): 402 *2*, L=7, spectroscopic factor=3.94, 15/2, ν5/2[752] (1970Bo31).
447.4[g] *7*	(9/2⁺)	[4]	≤0.01	dσ/dΩ≤3 μb/sr. E(level): 445, 9/2, 1/2[631] (1972Gr19).
466.5 *3*		(1)	0.0096 *6*	dσ/dΩ=18 μb/sr *3*. E(level): 467 *10* (1977Wi07); 462 (1972Gr19); 487 (1972Gr19).
533.9[g] *8*	(11/2⁺,11/2⁻)	(6,7)	0.15 *3*	L: σ(θ) distribution not shown in authors′ Fig. 3, very weak peak, possibly mixed L=6 and 7 for two known levels near this energy. ν7/2[743], J^π=11/2⁻ configuration is also possible if doublet. dσ/dΩ=4 μb/sr *1*.
554.6[c]	1/2⁻	1	0.62 *2*	E(level): energy used for calibration. dσ/dΩ=1.080 mb/sr *22*. E(level): 555 *4*, 1/2, ν1/2[501] (1977Wi07); 551, 1/2, ν1/2[501] (1972Gr19). E(level): 557 *1*, spectroscopic factor=0.409 *35*, 1/2⁻, ν1/2[501] (1972Er03). E(level): 558 *2*, spectroscopic factor=0.94, 1/2, ν1/2[501] (1970Bo31).
579.2[d] *4*	(9/2⁺)	(4)	0.043 *3*	dσ/dΩ=20 μb/sr *3*. E(level): 582 *3* (1970Er04); 577 (1972Gr19).
590.8	3/2⁻	1	0.049 *2*	E(level): authors take from literature (ENSDF-2013). The ν3/2[761] assignment

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^{232}Th(d,t) 2008Bu14 (continued)

^{231}Th Levels (continued)

E(level)[†]	Jπ[‡]	L[‡]	S[#]	Comments
				in ENSDF-2013 update is inconsistent with the measured strength. The quasiparticle+phonon model calculations predict ≈0.6% admixture of ν3/2[501] whereas observed strength gives 3.5% admixture. dσ/dΩ=74 μb/sr *8*, multiplet. E(level): 590, 3/2, ν3/2[501] (1972Gr19).
594.8[c]	5/2⁻&(3/2⁻)	3+1	0.27 *4*	S: for L=3; S=0.040 *9* for L=1. E(level): multiplet. dσ/dΩ=257 μb/sr *20* for doublet. E(level): 592 *5*, 3/2,5/2, ν1/2[501] (1977Wi07). E(level): 595 *3* (1970Er04). E(level): 594 *3*, spectroscopic factor=0.33, 3/2,5/2, ν1/2[501] (1970Bo31).
619.5 *2*	3/2⁻	1	0.077 *3*	dσ/dΩ=125 μb/sr *9*. E(level): 619 *4* (1977Wi07); 622 *2* (1970Er04); 621 *2* (1970Bo31); 615, 5/2, ν1/2[501] (1972Gr19).
629.0 *3*	(5/2)⁻	(3)	0.046 *4*	dσ/dΩ=22 μb/sr *5*. E(level): 628 *6* (1977Wi07); 624 (1972Gr19).
646.6 *4*		3	0.083 *4*	dσ/dΩ=58 μb/sr *6*. E(level): 646 *4* (1977Wi07); 647 *2* (1970Er04); 647 *2* (1970Bo31); 642, 7/2, ν1/2[640] (1972Gr19).
658 *2*				dσ/dΩ≤5 μb/sr.
684.7 *3*		1(+3)	0.067 *6*	E(level),Jπ: possible doublet with Jπ=(1/2⁻,3/2⁻) and (5/2⁻,7/2⁻). S: for L=1; S=0.05 *2* for L=3. dσ/dΩ=117 μb/sr *7*. E(level): 684 *4* (1977Wi07); 686 *2* (1970Er04); 686 *2* (1970Bo31); 681, 5/2, ν1/2[640] (1972Gr19).
709.4 *4*	3/2⁺	2	0.013 *1*	dσ/dΩ=14 μb/sr *3*. E(level): 706, 7/2, ν1/2[501] (1972Gr19).
718.0 *4*	3/2⁻&(7/2)⁻	1+3	0.0074 *2*	E(level): doublet. S: for L=1; S=0.021 *8* for L=3. dσ/dΩ=27 μb/sr *5*. E(level): 716 *10* (1977Wi07); 718 *2* (1970Er04); 715 (1972Gr19).
750.0 *3*		3	0.023 *2*	dσ/dΩ=15 μb/sr *3*. E(level): 744, 11/2, ν1/2[640] (1972Gr19).
769.9 *6*		(6)	0.59 *6*	dσ/dΩ=19 μb/sr *3*. E(level): 764 (1972Gr19).
793.4 *5*	1/2⁺			dσ/dΩ=4 μb/sr *1*.
806.6 *7*	3/2⁺			dσ/dΩ≤10 μb/sr.
812.3[f] *2*	5/2⁻	3(+1)	0.74 *2*	E(level): possible doublet. S: for L=3. S=0.61 *4* for L=3 and 0.027 *6* for L=1 if L=3+1. Jπ: 15/2 suggested as member of ν1/2[770] band in 1987Wh01, deduced from energies of other members of this band is not supported by σ(θ) distribution in (d,t) and σ(^{3}He,α)/σ(d,t) ratio which is consistent with L=3 rather than L=7 required by J=[15/2] (2008Bu14). dσ/dΩ=403 μb/sr *13*. E(level): 811, 5/2, ν5/2[503] (1977Wi07); 808, 5/2, ν5/2[503] (1972Gr19). E(level): 815 *2* (1970Er04); 816 *2* (1970Bo31).
≈833	(1/2)⁻			E(level),Jπ: could be mixed with a known 3/2⁺ level at 839.3. dσ/dΩ=7 μb/sr *2*. E(level): 832 (1972Gr19).
841.42 *5*		1	0.013 *1*	L: from Table 1 of 2008Bu14, σ(θ) distribution not shown in authors′ Fig. 3. The distribution plot was made available to the compiler of the XUNDL dataset in e-mail reply by D.G. Burke on June 30, 2008. dσ/dΩ=18 μb/sr *3*. E(level): 838 *10* (1977Wi07).
854.5 *4*		4,5		dσ/dΩ=14 μb/sr *3*. E(level): 853 *15* (1977Wi07); 849, 3/2, ν3/2[642] (1972Gr19).

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^{232}Th(d,t) 2008Bu14 (continued)

^{231}Th Levels (continued)

E(level)[†]	Jπ[‡]	L[‡]	S[#]	Comments
868.6 3	1/2+	0	0.055 3	dσ/dΩ=0.16 mb/sr 4. E(level): 869 3/2, ν3/2[501] (1972Gr19).
875.4[e] 3	3/2−	1	0.44 2	dσ/dΩ=0.70 mb/sr 4. E(level): 875 4, 3/2, ν3/2[501] (1977Wi07). E(level): 877 2 (1970Er04); 876 2, L=3, spectroscopic factor=2.25, ν5/2[503] (1970Bo31).
889.9 2	(5/2)+	2	0.19 1	Possible member of ν1/2[640] and/or ν1/2[651] bands. dσ/dΩ=0.21 mb/sr 4. E(level): 890 12 (1977Wi07); 892 2 (1970Er04); 885, 5/2, ν3/2[642] (1972Gr19).
914.2[e] 6	5/2−	3	0.083 5	dσ/dΩ=42 μb/sr 5. E(level): 915 5 (1977Wi07); 915 2 (1970Er04); 914 2 (1970Bo31); 908, 5/2, ν3/2[501] (1972Gr19).
930.6 5		(2)	0.022 2	dσ/dΩ=18 μb/sr 3. E(level): 935 2 (1970Er04); 925, 7/2, ν3/2[642] (1972Gr19).
944.2 6				dσ/dΩ≤2 μb/sr.
958.0 7	3/2+			dσ/dΩ=10 μb/sr 2. E(level): 952 (1972Gr19).
966.0 6		2	0.025 2	E(level): 964 in Fig. 3, but 966.0 is the correct value. dσ/dΩ=30 μb/sr 5. E(level): 966 6 (1977Wi07); 965, 7/2, ν3/2[501] (1972Gr19).
974.4 7				dσ/dΩ=20 μb/sr 5. E(level): 973 3 (1970Bo31).
990.5 7				dσ/dΩ=12 μb/sr 2. E(level): 984 (1972Gr19).
1003.0 6	3/2+	(1+2)	0.019 4	E(level): possible doublet. S: for L=1; S=0.013 5 for L=2. dσ/dΩ=50 μb/sr 5. E(level): 999, 9/2, 3/2[642] (1972Gr19).
1011.5 9				dσ/dΩ=22 μb/sr 3. E(level): 1003 10 (1977Wi07); 1008 2 (1970Er04); 1011 3 (1970Bo31).
1021.7 6	3/2−	1	0.037 2	dσ/dΩ=55 μb/sr 5. E(level): 1021 10 (1977Wi07); 1026 2 (1970Er04); 1027 2 (1970Bo31); 1016 (1972Gr19).
1032.9 6	1/2+	0	0.015 1	dσ/dΩ=36 μb/sr 4. E(level): 1034 10 (1977Wi07); 1028 (1972Gr19).
1053 1	(3/2+)			dσ/dΩ=4 μb/sr 2.
1076.5 7	(3/2−)			dσ/dΩ≤5 μb/sr. E(level): 1076 (1972Gr19).
1081.6 6	(3/2+)	2	0.068 3	dσ/dΩ=66 μb/sr 6. E(level): 1086 2 (1970Er04); 1084 2 (1970Bo31).
1091.8 7		(2)	0.015 1	dσ/dΩ=10 μb/sr 3. E(level): 1095 (1972Gr19).
1103.0 6	3/2−	1	0.013 1	dσ/dΩ=21 μb/sr 3. E(level): 1107 3 (1970Er04).
1115.4 6				dσ/dΩ=15 μb/sr 3.
1126.0 6		2	0.018 1	dσ/dΩ=23 μb/sr 3. E(level): 1128 3 (1970Er04); 1120 (1972Gr19).
1154.0 7				dσ/dΩ=5 μb/sr 2.
1159.3 7				dσ/dΩ≤5 μb/sr.
1171.2 6	3/2−	1	0.013 1	dσ/dΩ=24 μb/sr 4. E(level): 1174 (1972Gr19).
1181.2 6		1	0.017 1	dσ/dΩ=29 μb/sr 4.
1187.0 7				dσ/dΩ=11 μb/sr 3.
1200.8 7		1	0.010 1	dσ/dΩ=17 μb/sr 3.
1220.2 7				dσ/dΩ=11 μb/sr 3.
1235 2				dσ/dΩ=13 μb/sr 3.
1262 3				dσ/dΩ≤5 μb/sr.

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^{232}Th(d,t) 2008Bu14 (continued)

^{231}Th Levels (continued)

E(level)†	L‡	S#	Comments
1273 *1*	2	0.018 *1*	dσ/dΩ=24 μb/sr *4*. E(level): 1275 *3* (1970Er04).
1292 *2*			dσ/dΩ=10 μb/sr *2*.
1300 *2*			dσ/dΩ=7 μb/sr *2*.
1323 *2*			dσ/dΩ≤5 μb/sr.
1327 *2*			dσ/dΩ=8 μb/sr *3*.
1345.7 *11*			dσ/dΩ=7 μb/sr *3*. E(level): 1347 (1972Gr19).
1352.8 *11*	1	0.015 *1*	dσ/dΩ=16 μb/sr *3*. E(level): 1350 *8* (1977Wi07).
1372 *2*			dσ/dΩ=7 μb/sr *3*.
1393 *1*	1	0.093 *3*	dσ/dΩ=125 μb/sr *8*. E(level): 1391 *10* (1977Wi07); 1398 *3* (1970Er04); 1399 *2* (1970Bo31); 1386 (1972Gr19).
1405.6 *10*	1	0.037 *2*	dσ/dΩ=55 μb/sr *5*. E(level): 1404 *14* (1977Wi07); 1401 (1972Gr19).
1430.6 *11*			dσ/dΩ=25 μb/sr *10*. E(level): 1429 (1972Gr19).
1437.2 *10*	2	0.18 *1*	dσ/dΩ=178 μb/sr *11*. E(level): 1434 *6* (1977Wi07); 1441 *2* (1970Bo31); 1443 (1972Gr19).
1452 *1*			dσ/dΩ=30 μb/sr *10*. E(level): 1448 *10* (1977Wi07).
1458 *2*			dσ/dΩ≤10 μb/sr. E(level): 1458 (1972Gr19).
1464 *1*	1,(2)	0.019 *1*	L: from Table 1 of 2008Bu14, σ(θ) distribution not shown in authors′ Fig. 3. The distribution plot was made available to the compiler of the XUNDL dataset in e-mail reply by D.G. Burke on June 30, 2008. E(level): possible doublet. S: for L=1. dσ/dΩ=40 μb/sr *10*. E(level): 1464 *10* (1977Wi07).
1476 *2*			dσ/dΩ≤8 μb/sr.
1487.4 *11*	1	0.030 *2*	L: from Table 1 of 2008Bu14, σ(θ) distribution not shown in authors′ Fig. 3. The distribution plot was made available to the compiler of the XUNDL dataset in e-mail reply by D.G. Burke on June 30, 2008. dσ/dΩ=50 μb/sr *5*. E(level): 1487 *8* (1977Wi07); 1481 (1972Gr19).
1494.3 *11*			dσ/dΩ=16 μb/sr *4*. E(level): 1492 *2* (1970Bo31).
1523 *2*			dσ/dΩ=10 μb/sr *3*.
1533 *2*			dσ/dΩ=13 μb/sr *3*.
1542 *2*			dσ/dΩ=15 μb/sr *5*.
1572 *1*	(3)	0.11 *1*	dσ/dΩ=103 μb/sr *9*. E(level): 1577 *3* (1970Bo31); 1564 (1972Gr19).
1585 *1*	1	0.067 *3*	dσ/dΩ=75 μb/sr *6*. E(level): 1586 *4* (1970Bo31); 1576 (1972Gr19).
1601 *1*	1	0.036 *2*	dσ/dΩ=52 μb/sr *5*.
1608 *1*			dσ/dΩ=17 μb/sr *3*. E(level): 1613 (1972Gr19).
1619.5 *10*	1	0.044 *2*	dσ/dΩ=60 μb/sr *5*.
1627 *2*			dσ/dΩ=28 μb/sr *5*.
1648 *1*			dσ/dΩ=48 μb/sr *5*. E(level): 1643 (1972Gr19).
1654 *1*			dσ/dΩ=33 μb/sr *5*.
1666 *2*			dσ/dΩ=50 μb/sr *10*.
1678 *2*			dσ/dΩ=50 μb/sr *10*.
1696 *1*			dσ/dΩ=34 μb/sr *8*.
1708 *1*	1	0.082 *4*	dσ/dΩ=78 μb/sr *10*.

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^{232}Th(d,t) 2008Bu14 (continued)

^{231}Th Levels (continued)

E(level)[†]	Comments
	E(level): 1710 *3* (1970Bo31).
1714 *1*	$d\sigma/d\Omega$=32 μb/sr *10*.

[†] The energy given by 2008Bu14 represents the average of values obtained from spectra at all the angles where the peak was observed. The 554.6 keV peak was used for normalization purposes since the ground state was populated weakly. The quoted uncertainty includes the estimated calibration uncertainty.

[‡] From 2008Bu14, based on DWBA analysis and band structures. 'Fingerprint' method of comparison of experimental spectroscopic strengths or cross sections for members of a rotational band with those perturbed (and unperturbed) predicted by Coriolis calculations has been used by 2008Bu14 to assign levels as rotational members of a band based on a single-particle Nilsson configuration.

[#] Spectroscopic strength from 2008Bu14. Additional uncertainty from choice of optical parameters is 20%.

[@] Band(A): ν5/2[633].

[&] Band(B): ν5/2[752].

[a] Band(C): ν3/2[631].

[b] Band(D): ν1/2[631].

[c] Band(E): ν1/2[501].

[d] Band(F): ν7/2[624].

[e] Band(G): ν3/2[501]. From comparison of measured cross sections with predicted values, the members of this band contain significant admixtures of octupole vibration based on 3/2[631] intrinsic configuration.

[f] Band(H): ν5/2[503].

[g] Band(I): ν5/2[622].

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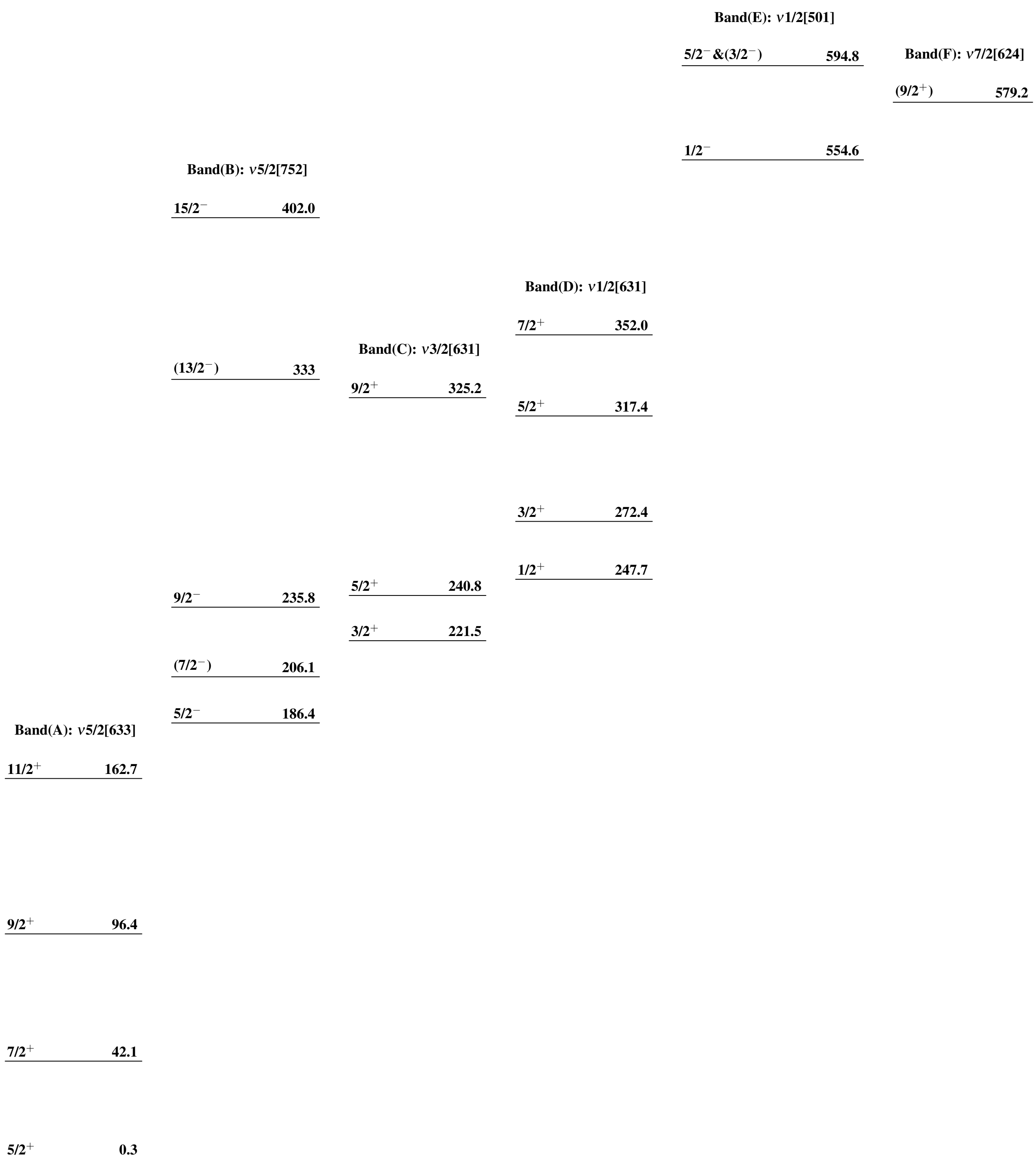

$^{231}_{90}Th_{141}$

^{232}Th(d,t) 2008Bu14 (continued)