$^{232}\text{Th(d,p)}$ 1972Vo08,1972Gr19

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	B. Singh, J. K. Tuli, E. Browne	NDS 170, 499 (2020)	8-Oct-2020

1972Vo08: E(d)=12 MeV. Measured proton spectra using Enge Split-pole magnetic spectrograph at the tandem van de Graaff accelerator at Argonne. Cross sections were measured at 90°, 135° and 150°. The FWHM is estimated by evaluators as ≈10 keV from authors' spectral Fig. 4. The L values were estimated from ratios of cross sections at 90° and 150° for some of the levels. Note that the experiments reported by 1972Vo08 and 1972Er03 are from the same laboratory, with author J.R. Erskine from Argonne on both the papers.

1972Er03: E(d)=8-12 MeV. Measured proton spectra and excitation functions for eight levels up to 326 keV at 135° using Enge Split-pole magnetic spectrograph at the tandem van de Graaff accelerator at Argonne.

1972Gr19: E(d)=12.0, 13.1 MeV. Measured proton spectra using a broad-range magnetic spectrograph at the tandem accelerator at the Niels Bohr Institute. Cross sections were measured at 60°, 90° and 125°. FWHM=13 keV. Deduced seven band structures with Nilsson orbital assignments.

2014Gu04, 2013Gu27, 2013Gu10, 2012Gu21, 2012Wi03: E(d)=12 MeV, measured continuum γ rays; deduced γ-strength functions and M1 scissors resonance.

Others:

1988Bl03: $^{232}\text{Th(d,pF)}$ E=11.5-14 MeV. Measured fission fragment cross section and $\sigma(\theta)$; deduced triple-humped fission barriers.

1961Ho12: E(d)=10.7 MeV. Measured protons at 119° using a double-focusing magnetic spectrometer at Indiana University cyclotron facility. No resolved levels in ^{233}Th were reported.

Q(d,p)=2567 7 (1972Vo08).

Q(d,p)=2555 10 (1972Gr19).

^{233}Th Levels

Absolute differential cross section data from 1972Vo08 are at 150°, uncertainties are stated by the authors as ≈10% for strong peaks. Ratios of cross sections at 90° and 150° are from 1972Vo08. Detailed cross section data at E=12.0 and 13.1 MeV, and at a total of five angles from 1972Gr19 are also given in comments.

E(level)[†]	J^{π}[‡]	S[#]	Comments
0[f]	1/2+	0.052	S: 0.060 9 (1972Er03). dσ/dΩ=47 μb/sr, dσ(90°)/dσ(150°)=2.8 (1972Vo08). dσ/dΩ=153 μb/sr (60°), 113 μb/sr (90°), 50 μb/sr (125°) for 12.0 MeV; 89 μb/sr (90°), 59 μb/sr (125°) for 13.1 MeV (1972Gr19).
16.1[f] 5	3/2+	0.081	S: 0.129 10 (1972Er03). E(level): 16 (1972Gr19). dσ/dΩ=95 μb/sr, dσ(90°)/dσ(150°)=2.2 (1972Vo08). dσ/dΩ=244 μb/sr (60°), 226 μb/sr (90°), 124 μb/sr (125°) for 12.0 MeV; 163 μb/sr (90°), 87 μb/sr (125°) for 13.1 MeV (1972Gr19).
53.5[f] 5	5/2+	0.0022	S: 0.0031 10 (1972Er03). E(level): 54 (1972Gr19). dσ/dΩ=4 μb/sr, dσ(90°)/dσ(150°)≈2 (1972Vo08). dσ/dΩ=11 μb/sr (60°), 7 μb/sr (90°), 3 μb/sr (125°) for 12.0 MeV; 9 μb/sr (90°), 4 μb/sr (125°) for 13.1 MeV (1972Gr19).
92.5[f] 15	7/2+	0.014	S: 0.033 6 (1972Er03). E(level): 92 (1972Gr19). dσ/dΩ=13 μb/sr, dσ(90°)/dσ(150°)≈2 (1972Vo08). dσ/dΩ=27 μb/sr (90°), 22 μb/sr (125°) for 12.0 MeV; 20 μb/sr (90°), 9 μb/sr (125°) for 13.1 MeV (1972Gr19).
106.9[g] 10	9/2+	0.112	S: 0.155 15 (1972Er03). E(level): 106 (1972Gr19). dσ/dΩ=128 μb/sr, dσ(90°)/dσ(150°)=1.2 (1972Vo08). dσ/dΩ=120μb/sr (60°), 178 μb/sr (90°), 141 μb/sr (125°) for 12.0 MeV; 165 μb/sr (90°), 128

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$^{232}\text{Th(d,p)}$　　1972Vo08,1972Gr19 (continued)

^{233}Th Levels (continued)

E(level)[†]	J[π‡]	S[#]	Comments
			μb/sr (125°) for 13.1 MeV (1972Gr19).
159.0[f] 10	9/2+	0.050	S: 0.060 7 (1972Er03). E(level): 160 (1972Gr19). $d\sigma/d\Omega$=59 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)=1.1 (1972Vo08). $d\sigma/d\Omega$=48 μb/sr (60°), 64 μb/sr (90°), 100 μb/sr (125°) for 12.0 MeV; 88 μb/sr (90°), 60 μb/sr (125°) for 13.1 MeV (1972Gr19).
178[g] 2	11/2+	0.026	E(level): 183 (1972Gr19). $d\sigma/d\Omega$=6 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)≈0.4 (1972Vo08). $d\sigma/d\Omega$=10 μb/sr (90°), 5 μb/sr (125°) for 13.1 MeV (1972Gr19).
220[f] 2	11/2+	0.047	E(level): 216 (1972Gr19). $d\sigma/d\Omega$=11 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)≈0.3 (1972Vo08). $d\sigma/d\Omega$=4 μb/sr (60°), 6 μb/sr (90°), 6 μb/sr (125°) for 12.0 MeV; 9 μb/sr (90°), 14 μb/sr (125°) for 13.1 MeV (1972Gr19).
252.3[h] 5	(15/2−)	(0.181)	S: 0.178 30 (1972Er03). E(level): 252 (1972Gr19). $d\sigma/d\Omega$=30 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)=0.38 (1972Vo08). $d\sigma/d\Omega$=8 μb/sr (60°), 14 μb/sr (90°), 24 μb/sr (125°) for 12.0 MeV; 20 μb/sr (90°), 32 μb/sr (125°) for 13.1 MeV (1972Gr19).
278[i] 2	7/2+	0.011	E(level): 278 (1972Gr19). $d\sigma/d\Omega$=11 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)≈0.5 (1972Vo08). $d\sigma/d\Omega$=8 μb/sr (60°), 5 μb/sr (90°), 7 μb/sr (125°) for 12.0 MeV; 6 μb/sr (90°), 14 μb/sr (125°) for 13.1 MeV (1972Gr19).
297[@ f]	(13/2+)		$d\sigma/d\Omega$=4 μb/sr (90°), 16 μb/sr (125°) for 13.1 MeV (1972Gr19); level unresolved at 12.0 MeV.
326.0[i] 10	9/2+	0.070	S: 0.104 10 (1972Er03). E(level): 322 (1972Gr19). $d\sigma/d\Omega$=87 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)=1.2 (1972Vo08). $d\sigma/d\Omega$=75 μb/sr (60°), 122 μb/sr (90°), 96 μb/sr (125°) for 12.0 MeV; 120 μb/sr (90°), 99 μb/sr (125°) for 13.1 MeV (1972Gr19).
336?[& j] 5	3/2+	0.0035	$d\sigma/d\Omega$=5 μb/sr (1972Vo08).
370.6[j] 10	5/2+	0.0106	E(level): 367 (1972Gr19). $d\sigma/d\Omega$=23 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)=1.6 (1972Vo08). $d\sigma/d\Omega$=40 μb/sr (60°), 49 μb/sr (90°), 25 μb/sr (125°) for 12.0 MeV; 44 μb/sr (90°), 21 μb/sr (125°) for 13.1 MeV (1972Gr19).
388.5[ei] 10	11/2+	(0.040)	E(level): 387 (1972Gr19). $d\sigma/d\Omega$=10 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)≈0.6 for doublet (1972Vo08). $d\sigma/d\Omega$=13 μb/sr (90°), 9 μb/sr (125°) for 13.1 MeV (1972Gr19); level unresolved at 12.0 MeV.
388.5[ek] 10	9/2+	(0.0078)	
410.0[j] 15	(7/2+)		E(level): 408 (1972Gr19). J$^\pi$: Tentative band assignment (1972Vo08). $d\sigma/d\Omega$=19 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)=1.1 (1972Vo08). $d\sigma/d\Omega$=16 μb/sr (60°), 25 μb/sr (90°), 19 μb/sr (125°) for 12.0 MeV; 26 μb/sr (90°), 14 μb/sr (125°) for 13.1 MeV (1972Gr19).
443? 5			E(level): 440 (1972Gr19). $d\sigma/d\Omega$=6 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)≈0.5 (1972Vo08). $d\sigma/d\Omega$=3 μb/sr (90°), 3 μb/sr (125°) for 12.0 MeV; 8 μb/sr (90°), 4 μb/sr (125°) for 13.1 MeV (1972Gr19).
464[& k] 3	11/2+	0.024	$d\sigma/d\Omega$=6 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)≈0.5 (1972Vo08).
480.9[j] 10	9/2+	0.014	E(level): 480 (1972Gr19). $d\sigma/d\Omega$=19 μb/sr, $d\sigma$(90°)/$d\sigma$(150°)=0.66 (1972Vo08). $d\sigma/d\Omega$=11 μb/sr (60°), 19 μb/sr (90°), 12 μb/sr (125°) for 12.0 MeV; 25 μb/sr (90°), 13 μb/sr (125°) for 13.1 MeV (1972Gr19).
510?[@]			$d\sigma/d\Omega$=5 μb/sr (60°) 12.0 MeV; 5 μb/sr (90°), 4 μb/sr (125°) for 13.1 MeV (1972Gr19).

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$${}^{232}\text{Th(d,p)} \quad \textbf{1972Vo08,1972Gr19 (continued)}$$

<u>^{233}Th Levels (continued)</u>

E(level)[†]	J$^{\pi}$[‡]	S[#]	Comments
538[l] 2	(1/2$^-$)	(0.032)	E(level): 537 (1972Gr19). dσ/dΩ=28 μb/sr, dσ(90°)/dσ(150°)=1.7 (1972Vo08). dσ/dΩ=57 μb/sr (60°), 47 μb/sr (90°), 34 μb/sr (125°) for 12.0 MeV; 51 μb/sr (90°), 25 μb/sr (125°) for 13.1 MeV (1972Gr19).
582.0[l] 15	(3/2$^-$)	(0.027)	E(level): 581 (1972Gr19). dσ/dΩ=49 μb/sr, dσ(90°)/dσ(150°)=2.0 (1972Vo08). dσ/dΩ=113 μb/sr (60°), 86 μb/sr (90°), 53 μb/sr (125°) for 12.0 MeV; 107 μb/sr (90°), 37 μb/sr (125°) for 13.1 MeV (1972Gr19).
610.0[&] 15			dσ/dΩ=6 μb/sr, dσ(90°)/dσ(150°)≈1 (1972Vo08).
627.8 20			E(level): 624 (1972Gr19). dσ/dΩ=55 μb/sr, dσ(90°)/dσ(150°)=1.7 (1972Vo08). dσ/dΩ=101 μb/sr (60°), 93 μb/sr (90°), 76 μb/sr (125°) for 12.0 MeV; 126 μb/sr (90°), 52 μb/sr (125°) for 13.1 MeV (1972Gr19).
680.6 10			E(level): 682 (1972Gr19). dσ/dΩ=22 μb/sr, dσ(90°)/dσ(150°)=2.6 (1972Vo08). dσ/dΩ=86 μb/sr (60°), 76 μb/sr (90°), 51 μb/sr (125°) for 12.0 MeV; 83 μb/sr (90°), 50 μb/sr (125°) for 13.1 MeV (1972Gr19).
691.2[&] 15			dσ/dΩ=16 μb/sr, dσ(90°)/dσ(150°)≈1 (1972Vo08).
710.6[&] 15			dσ/dΩ=8 μb/sr, dσ(90°)/dσ(150°)≈0.8 (1972Vo08).
725.8 10			E(level): 722 (1972Gr19). dσ/dΩ=32 μb/sr, dσ(90°)/dσ(150°)=1.6 (1972Vo08). dσ/dΩ=60 μb/sr (60°), 60 μb/sr (90°), 36 μb/sr (125°) for 12.0 MeV; 70 μb/sr (90°), 39 μb/sr (125°) for 13.1 MeV (1972Gr19).
753.4 15			E(level): 748 (1972Gr19). dσ/dΩ=7 μb/sr, dσ(90°)/dσ(150°)≈1 (1972Vo08). dσ/dΩ=6 μb/sr (60°), 6 μb/sr (90°), 5 μb/sr (125°) for 12.0 MeV; 16 μb/sr (90°), 17 μb/sr (125°) for 13.1 MeV (1972Gr19).
766.8 20			E(level): 766 (1972Gr19). dσ/dΩ=16 μb/sr, dσ(90°)/dσ(150°)≈2 (1972Vo08). dσ/dΩ=35 μb/sr (60°), 38 μb/sr (90°), 22 μb/sr (125°) for 12.0 MeV; 25 μb/sr (90°), 20 μb/sr (125°) for 13.1 MeV (1972Gr19).
796 3			E(level): 789 (1972Gr19). dσ/dΩ=8 μb/sr (1972Vo08). dσ/dΩ=3 μb/sr (60°), 9 μb/sr (90°), 5 μb/sr (125°) for 12.0 MeV; 12 μb/sr (90°), 7 μb/sr (125°) for 13.1 MeV (1972Gr19).
812 3			E(level): 810 (1972Gr19). dσ/dΩ=16 μb/sr, dσ(90°)/dσ(150°)≈1 (1972Vo08). dσ/dΩ=32 μb/sr (60°), 33 μb/sr (90°), 20 μb/sr (125°) for 12.0 MeV; 40 μb/sr (90°), 23 μb/sr (125°) for 13.1 MeV (1972Gr19).
846 3			E(level): 843 (1972Gr19). dσ/dΩ≈46 μb/sr (1972Vo08). dσ/dΩ=96 μb/sr (60°), 105 μb/sr (90°), 65 μb/sr (125°) for 12.0 MeV; 115 μb/sr (90°), 71 μb/sr (125°) for 13.1 MeV (1972Gr19).
855?[&] 5			dσ/dΩ≈14 μb/sr (1972Vo08).
873 4			E(level): 868 (1972Gr19). dσ/dΩ=4 μb/sr (1972Vo08). dσ/dΩ=23 μb/sr (90°), 32 μb/sr (125°) for 13.1 MeV (1972Gr19); level unresolved at 12.0 MeV.
887 3			E(level): 886 (1972Gr19). dσ/dΩ=18 μb/sr, dσ(90°)/dσ(150°)≈0.7 (1972Vo08). dσ/dΩ=36 μb/sr (60°), 30 μb/sr (90°), 19 μb/sr (125°) for 12.0 MeV; 22 μb/sr (90°), 46 μb/sr (125°) for 13.1 MeV (1972Gr19).
900[&] 3			dσ/dΩ=11 μb/sr, dσ(90°)/dσ(150°)≈0.5 (1972Vo08).
924 4			E(level): 919 (1972Gr19). dσ/dΩ=12 μb/sr, dσ(90°)/dσ(150°)=2.4 (1972Vo08). dσ/dΩ=27 μb/sr (60°), 24 μb/sr (90°), 24 μb/sr (125°) for 12.0 MeV; 37 μb/sr (90°), 48

^{232}Th(d,p)　　1972Vo08,1972Gr19 (continued)

^{233}Th Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	Comments
		μb/sr (125°) for 13.1 MeV (1972Gr19).
945 *4*		E(level): 944 (1972Gr19).
		dσ/dΩ=6 μb/sr, dσ(90°)/dσ(150°)≈1 (1972Vo08).
		dσ/dΩ=19 μb/sr (60°), 14 μb/sr (90°), 15 μb/sr (125°) for 12.0 MeV; 27 μb/sr (90°), 28 μb/sr (125°) for 13.1 MeV (1972Gr19).
954[&] *4*		dσ/dΩ=6 μb/sr, dσ(90°)/dσ(150°)≈1 (1972Vo08).
973 *4*		E(level): 968 (1972Gr19).
		dσ/dΩ=16 μb/sr, dσ(90°)/dσ(150°)=1.2 (1972Vo08).
		dσ/dΩ=15 μb/sr (60°), 21 μb/sr (90°), 17 μb/sr (125°) for 12.0 MeV; 25 μb/sr (90°), 20 μb/sr (125°) for 13.1 MeV (1972Gr19).
991 *3*		E(level): 988 (1972Gr19).
		dσ/dΩ=20 μb/sr, dσ(90°)/dσ(150°)≈1 (1972Vo08).
		dσ/dΩ=23 μb/sr (60°), 22 μb/sr (90°), 26 μb/sr (125°) for 12.0 MeV; 40 μb/sr (90°), 35 μb/sr (125°) for 13.1 MeV (1972Gr19).
1026 *3*		E(level): 1023 (1972Gr19).
		dσ/dΩ=65 μb/sr, dσ(90°)/dσ(150°)=1.1 (1972Vo08).
		dσ/dΩ=64 μb/sr (60°), 87 μb/sr (90°), 72 μb/sr (125°) for 12.0 MeV; 123 μb/sr (90°), 77 μb/sr (125°) for 13.1 MeV (1972Gr19).
1038[&] *4*		dσ/dΩ=16 μb/sr, dσ(90°)/dσ(150°)≈1.2 (1972Vo08).
1046 *4*		E(level): 1043 (1972Gr19).
		dσ/dΩ=8 μb/sr, dσ(90°)/dσ(150°)≈1.5 (1972Vo08).
		dσ/dΩ=48 μb/sr (60°), 43 μb/sr (90°), 22 μb/sr (125°) for 12.0 MeV; 51 μb/sr (90°), 30 μb/sr (125°) for 13.1 MeV (1972Gr19).
1073 *5*		E(level): 1069 (1972Gr19).
		dσ/dΩ=9 μb/sr, dσ(90°)/dσ(150°)≈1 (1972Vo08).
		dσ/dΩ=21 μb/sr (60°), 58 μb/sr (90°), 11 μb/sr (125°) for 12.0 MeV; 25 μb/sr (90°), 15 μb/sr (125°) for 13.1 MeV (1972Gr19).
1101[m] *3*	(1/2$^+$)	E(level): 1097 (1972Gr19).
		dσ/dΩ=163 μb/sr, dσ(90°)/dσ(150°)=1.5 (1972Vo08).
		dσ/dΩ=207 μb/sr (60°), 357 μb/sr (90°), 190 μb/sr (125°) for 12.0 MeV; 311 μb/sr (90°), 173 μb/sr (125°) for 13.1 MeV (1972Gr19).
1116[&] *5*		dσ/dΩ=16 μb/sr (1972Vo08).
1130[m] *3*	(3/2$^+$)	E(level): 1125 (1972Gr19).
		dσ/dΩ=62 μb/sr, dσ(90°)/dσ(150°)≈0.8 (1972Vo08).
		dσ/dΩ=46 μb/sr (60°), 74 μb/sr (90°), 61 μb/sr (125°) for 12.0 MeV; 109 μb/sr (90°), 58 μb/sr (125°) for 13.1 MeV (1972Gr19).
1152[m] *4*	(5/2$^+$)	E(level): 1150 (1972Gr19).
		dσ/dΩ=89 μb/sr, dσ(90°)/dσ(150°)=1.6 (1972Vo08).
		dσ/dΩ=152 μb/sr (90°), 96 μb/sr (125°) for 12.0 MeV; 215 μb/sr (90°), 81 μb/sr (125°) for 13.1 MeV (1972Gr19).
1164[&] *4*		dσ/dΩ=49 μb/sr, dσ(90°)/dσ(150°)≈1.5 (1972Vo08).
1170?[&] *5*		dσ/dΩ=13 μb/sr (1972Vo08).
1178 *4*		E(level): 1176 (1972Gr19).
		dσ/dΩ=65 μb/sr, dσ(90°)/dσ(150°)≈0.8 (1972Vo08).
		dσ/dΩ=88 μb/sr (90°), 68 μb/sr (125°) for 12.0 MeV; 139 μb/sr (90°), 61 μb/sr (125°) for 13.1 MeV (1972Gr19).
1190[&] *5*		dσ/dΩ=24 μb/sr, dσ(90°)/dσ(150°)≈1.3 (1972Vo08).
1219[m] *5*	(7/2$^+$)	E(level): 1215 (1972Gr19).
		dσ/dΩ=18 μb/sr, dσ(90°)/dσ(150°)≈1 (1972Vo08).
		dσ/dΩ=57 μb/sr (90°), 30 μb/sr (125°) for 12.0 MeV; 50 μb/sr (90°), 33 μb/sr (125°) for 13.1 MeV (1972Gr19).
1236[&] *4*		dσ/dΩ=10 μb/sr, dσ(90°)/dσ(150°)≈1 (1972Vo08).
1258 *4*	[a]	E(level): 1255 (1972Gr19).
		dσ/dΩ=49 μb/sr, dσ(90°)/dσ(150°)=1.8 (1972Vo08).

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^{232}Th(d,p)   1972Vo08,1972Gr19 (continued)

^{233}Th Levels (continued)

E(level)[†]	Comments
	dσ/dΩ=188 μb/sr (90°), 118 μb/sr (125°) for 12.0 MeV; 183 μb/sr (90°), 122 μb/sr (125°) for 13.1 MeV (1972Gr19).
1265[&] 4	dσ/dΩ=52 μb/sr, dσ(90°)/dσ(150°)=1.8 (1972Vo08).
1280[b] 4	E(level): 1279 (1972Gr19).
	dσ/dΩ=48 μb/sr, dσ(90°)/dσ(150°)=2.1 (1972Vo08).
	dσ/dΩ=88 μb/sr (90°), 73 μb/sr (125°) for 12.0 MeV; 103 μb/sr (90°), 70 μb/sr (125°) for 13.1 MeV (1972Gr19).
1290[&] 5	dσ/dΩ=27 μb/sr, dσ(90°)/dσ(150°)=1.5 (1972Vo08).
1302 4	E(level): 1300 (1972Gr19).
	dσ/dΩ=32 μb/sr, dσ(90°)/dσ(150°)=1.8 (1972Vo08).
	dσ/dΩ=79 μb/sr (90°), 28 μb/sr (125°) for 12.0 MeV; 77 μb/sr (90°), 61 μb/sr (125°) for 13.1 MeV (1972Gr19).
1316 5	E(level): 1318 (1972Gr19).
	dσ/dΩ=20 μb/sr (1972Vo08).
	dσ/dΩ=63 μb/sr (90°), 40 μb/sr (125°) for 13.1 MeV (1972Gr19).
1331[c] 4	E(level): 1335 (1972Gr19).
	dσ/dΩ=26 μb/sr, dσ(90°)/dσ(150°)=1.3 (1972Vo08).
	dσ/dΩ=65 μb/sr (90°), 51 μb/sr (125°) for 12.0 MeV; 44 μb/sr (90°), 45 μb/sr (125°) for 13.1 MeV (1972Gr19).
1344[&] 5	dσ/dΩ=15 μb/sr (1972Vo08).
1367 5	E(level): 1362 (1972Gr19).
	dσ/dΩ=12 μb/sr, dσ(90°)/dσ(150°)=1.3 (1972Vo08).
	dσ/dΩ=31 μb/sr (90°), 24 μb/sr (125°) for 13.1 MeV (1972Gr19).
1387 4	E(level): 1382 (1972Gr19).
	dσ/dΩ=26 μb/sr, dσ(90°)/dσ(150°)=1.5 (1972Vo08).
	dσ/dΩ=75 μb/sr (90°), 58 μb/sr (125°) for 13.1 MeV (1972Gr19).
1394[&] 4	dσ/dΩ=24 μb/sr, dσ(90°)/dσ(150°)=1.5 (1972Vo08).
1402[d] 5	E(level): 1398 (1972Gr19).
	dσ/dΩ=18 μb/sr (1972Vo08).
	dσ/dΩ=138 μb/sr (90°) for 12.0 MeV; 49 μb/sr (90°), 29 μb/sr (125°) for 13.1 MeV (1972Gr19).
1430 4	E(level): 1425 (1972Gr19).
	dσ/dΩ=27 μb/sr, dσ(90°)/dσ(150°)=1.3 (1972Vo08).
	dσ/dΩ=54 μb/sr (90°) for 12.0 MeV; 56 μb/sr (90°), 47 μb/sr (125°) for 13.1 MeV (1972Gr19).
1454[@]	dσ/dΩ=40 μb/sr (90°), 28 μb/sr (125°) for 13.1 MeV (1972Gr19).
1480[@]	dσ/dΩ=39 μb/sr (90°) for 12.0 MeV; 36 μb/sr (90°), 36 μb/sr (125°) for 13.1 MeV (1972Gr19).
1546[@]	dσ/dΩ=52 μb/sr (90°) for 12.0 MeV; 42 μb/sr (90°), 36 μb/sr (125°) for 13.1 MeV (1972Gr19).
1580[@]	dσ/dΩ=60 μb/sr (90°) for 12.0 MeV; 72 μb/sr (90°) for 13.1 MeV (1972Gr19).

[†] Values are from 1972Vo08 unless otherwise stated. Energies measured by 1972Vo08 and 1972Gr19 are generally in good agreement. For high-energy levels (E>600), values in 1972Gr19 are generally lower by 3-6 keV. 1972Er03 studied levels with E≤326 keV only; their measured energies are in agreement with those given by 1972Vo08 and 1972Gr19 in this region.

[‡] Assignments were made by 1972Vo08 and 1972Gr19 from absolute cross sections, inferred L-values deduced from ratio of cross sections at 90° and 150°, fingerprint method for rotational bands, and energy systematics.

[#] dσ(exp)/(1.5(2J+1)dσ(DWBA)) from 1972Vo08. Values from 1972Er03 for eight levels up to 326 keV are given under comments. Theoretical spectroscopic factors are given by 1972Vo08 and 1972Er03, while 1972Gr19 compared measured and theoretical cross sections for assigned configurations.

[@] Level reported by 1972Gr19 only.

[&] Level not reported by 1972Gr19.

[a] 9/2$^+$,1/2[620] + (3/2$^+$,3/2[622]) assignment proposed by 1972Gr19.

[b] 5/2$^+$,3/2[622] tentative assignment by 1972Gr19.

[c] 7/2$^+$,3/2[622] tentative assignment by 1972Gr19 for a level observed by them at 1335 keV.

[d] 9/2$^+$,3/2[622] tentative assignment by 1972Gr19 to a level observed by them at 1398 keV.

^{232}**Th(d,p)**   **1972Vo08,1972Gr19** **(continued)**

^{233}Th Levels (continued)

[e] Doublet.
[f] Band(A): ν1/2[631] band.
[g] Band(B): ν5/2[622] band.
[h] Band(C): Possible ν7/2[743] band.
[i] Band(D): ν7/2[624] band.
[j] Band(E): ν3/2[631] band.
[k] Band(F): ν5/2[633] band.
[l] Band(G): Possible ν1/2[501] band.
[m] Band(H): ν1/2[620] band. Assignment from 1972Gr19.

${}^{232}\textbf{Th(d,p)}$ 1972Vo08,1972Gr19

Band(E): $\nu 3/2[631]$ band

$9/2^+$ 480.9   **Band(F): $\nu 5/2[633]$ band**

     $11/2^+$ 464

Band(D): $\nu 7/2[624]$ band $(7/2^+)$ 410.0

$11/2^+$ 388.5 $9/2^+$ 388.5

$5/2^+$ 370.6

$3/2^+$ _ _ _ _ _ 336

$9/2^+$ 326.0

Band(A): $\nu 1/2[631]$ band

$(13/2^+)$ 297

Band(C): Possible $7/2^+$ 278
$\nu 7/2[743]$ band

$(15/2^-)$ 252.3

$11/2^+$ 220

Band(B): $\nu 5/2[622]$ band

$11/2^+$ 178

$9/2^+$ 159.0

$9/2^+$ 106.9

$7/2^+$ 92.5

$5/2^+$ 53.5

$3/2^+$ 16.1

$1/2^+$ 0

${}^{233}_{90}\text{Th}_{143}$

<u>^{232}Th(d,p)   1972Vo08,1972Gr19 (continued)</u>

Band(H): ν1/2[620] band

(7/2$^+$)   **1219**

(5/2$^+$)   **1152**

(3/2$^+$)   **1130**

Band(G): Possible   (1/2$^+$)   **1101**
ν1/2[501] band

(3/2$^-$)   **582.0**

(1/2$^-$)   **538**

$^{233}_{90}\text{Th}_{143}$