^{166}Er(d,p) 1969Tj01,1979Ja23,1968Ha10

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Balraj Singh and Jun Chen	NDS 191,1 (2023)	22-Aug-2023

1969Tj01: E(d)=12.1 MeV from Niels Bohr Institute FN tandem accelerator. Carbon backed, enriched ^{166}Er target of ≈40 μg/cm^2 thickness on ≈40 μg/cm^2 carbon backing. Measured proton spectra and absolute cross sections at θ=60°, 90°, 125° using a magnetic spectrometer with FWHM≈12 keV, and with analyzed particles recorded on photographic plates. Energy uncertainties were assumed to be 3 keV below 1 MeV and 5 keV above 1 MeV excitation as stated in 1967Tj01, and cross section uncertainties of 15-20% as in 1966Bu16. A total of 45 levels up to 1912 keV were reported with absolute cross sections. Nilsson configurations and J^π values were assigned on the basis of 'fingerprint method' of comparison of experimental and theoretical cross sections, the latter using DWBA calculations.

1979Ja23 (experiment at the same laboratory as 1969Tj01 and two authors are the same on two papers): E(d)=12.08 MeV from Niels Bohr institute Tandem accelerator. Measured proton spectra and $\sigma(\theta)$ for 12 angles from 25° to 150° for 17 levels from 79 keV to 1440 keV using a magnetic spectrograph or solid-state detectors, and deduced L-transfers through DWBA analysis of $\sigma(\theta)$ data.

1968Ha10: E(d)≈12.0 MeV from Florida State University Tandem accelerator. Targets: ≈200-1000 μg/cm^2, 72% enriched ^{166}Er deposited on ≈40 μg/cm^2 carbon backing. Measured proton spectra and $\sigma(\theta)$ at 35°, 45°, 60° and 65° using 60-cm Browne-Buechner type magnetic spectrometer with resolution of 0.08%. A total of 79 levels were reported up to 2656 keV, with relative energy uncertainties of 3 keV up to 1749 keV, with absolute uncertainties of 10 keV up to 1749 keV and 15 keV for higher energy levels. J^π values and Nilsson configuration assignments were deduced using 'Fingerprint' method of comparison of measured differential cross sections with theoretical cross sections using DWBA. Cross sections were also measured for levels up to 1913 keV at E(d)=12.5 MeV and for 45°.

Other:

1963Is01: E(d)=15 MeV from University of Pittsburgh cyclotron. Target=natural erbium of 8.6 mg/cm^2 thickness. Measured proton spectra and $\sigma(\theta)$ at 9° to 90° using a magnetic analyzer with photographic plates. FWHM=80 keV. Nine levels were reported up to 700 keV and Nilsson configuration assignments were made. Levels 0, 78 and 172 keV were assigned as 7/2, 9/2 and 11/2 members of the ν7/2[633] band; 208, 262 and 280 keV as 1/2, 3/2 and 5/2 members of the 1/2[521] band; and 350 and 410 keV as 5/2 and 7/2 members of 5/2[512] band, in good agreement with assignments in later experiments.

^{167}Er Levels

Relative σ values from 1968Ha10 are for E(d)=12.5 MeV and 45°. Absolute values in μb/sr can be obtained by a multiplicative factor of 280. Estimated uncertainties are 60%, but 15% internally.

E(level)[†]	J$^\pi$[‡]	L[#]	C^{2}S[@]	Comments
0[b]	7/2$^+$		≈0.001	Relative σ<0.005 (1968Ha10). dσ/dΩ (μb/sr): ≈1 (60°), ≈0.3 (125°) (1969Tj01).
79[b] *3*	9/2$^+$	4	0.04	dσ/dΩ (μb/sr)=10 (30°), 13 (35°), 20 (40°), 19 (45°), 23 (50°), 19 (60°), 20 (75°), 9 (90°), 9.5 (105°), 8 (125°), 5.3 (150°) (1979Ja23). dσ/dΩ (μb/sr): 19 (60°), 9 (90°), 8 (125°) (1969Tj01). E(level): 78 *10*, relative $\sigma\leq$0.09 (1968Ha10).
176[b] *3*	11/2$^+$			dσ/dΩ (μb/sr): ≈3 (60°), ≈1 (125°) (1969Tj01). E(level): 179 *10*, relative $\sigma\leq$0.008 (1968Ha10).
208[c] *3*	1/2$^-$	1	0.20	dσ/dΩ (μb/sr)=235 (25°), 315 (30°), 300 (35°), 385 (40°), 343 (45°), 338 (50°), 292 (60°), 198 (75°), 149 (90°), 70 (105°), 51 (125°), 21 (150°) (1979Ja23). dσ/dΩ (μb/sr): 292 (60°), 149 (90°), 51 (125°) (1969Tj01). E(level): 208 *10*, relative σ=1.0 (1968Ha10).
262[c] *3*	3/2$^-$		0.01	dσ/dΩ (μb/sr): 5 (60°), 10 (90°), 4 (125°) (1969Tj01). E(level): 262 *10*, relative σ=0.15 (1968Ha10).
280[c] *3*	5/2$^-$	3	0.12	dσ/dΩ (μb/sr)=33 (25°), 53 (30°), 66 (35°), 70 (40°), 67 (45°), 64 (50°), 63 (60°), 48 (75°), 38 (90°), 26 (105°), 18 (125°), 16 (150°) (1979Ja23). dσ/dΩ (μb/sr): 63 (60°), 38 (90°), 18 (125°) (1969Tj01). E(level): 280 *10*, relative σ=0.065 (1968Ha10).

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^{166}Er(d,p) 1969Tj01,1979Ja23,1968Ha10 (continued)

^{167}Er Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	L[#]	C^{2}S[@]	Comments
295[b] *3*	13/2$^+$	6	0.96	dσ/dΩ (μb/sr)=6 (25°), 8 (35°), 11.5 (40°), 16 (45°), 22 (50°), 27 (60°), 30 (75°), 42 (90°), 31 (105°), 34 (125°), 25 (150°) (1979Ja23). dσ/dΩ (μb/sr): 27 (60°), 42 (90°), 34 (125°) (1969Tj01). E(level): 300 *10*, relative σ=0.025 (1968Ha10).
347[d] *3*	5/2$^-$		0.03	dσ/dΩ (μb/sr)=5 (25°), 9 (30°), 11 (35°), 9.4 (40°), 10.8 (45°), 12 (50°), 13 (60°), 6.4 (75°), 2.5 (105°), 3 (125°) (1979Ja23). dσ/dΩ (μb/sr): 13 (60°), 3 (125°) (1969Tj01). E(level): 350 *10*, relative σ=0.08 (1968Ha10).
413[c] *3*	7/2$^-$	3	0.26	dσ/dΩ (μb/sr)=51 (25°), 100 (30°), 114 (35°), 134 (40°), 131 (45°), 143 (50°), 125 (60°), 111 (75°), 84 (90°), 60 (105°), 37 (125°), 24 (150°) (1979Ja23). dσ/dΩ (μb/sr): 125 (60°), 84 (90°), 37 (125°) (1969Tj01). E(level): 416 *10*, relative σ=0.45 (1968Ha10).
430[d] *3*	7/2$^-$	3	0.61	dσ/dΩ (μb/sr)=84 (25°), 229 (30°), 286 (35°), 327 (40°), 188 (45°), 320 (50°), 304 (60°), 250 (75°), 260 (90°), 150 (105°), 112 (125°), 60 (150°) (1979Ja23). dσ/dΩ (μb/sr): 304 (60°), 260 (90°), 112 (125°) (1969Tj01). E(level): 429 *10*, relative σ=0.84 (1968Ha10).
535[d] *3*	9/2$^-$		0.18	dσ/dΩ (μb/sr): 15 (60°), 11 (90°), 8 (125°) (1969Tj01). E(level): 538 *10*, relative σ=0.087 (1968Ha10).
573[e] *3*	5/2$^+$			dσ/dΩ (μb/sr): 20 (60°), 6 (90°), 2 (125°) (1969Tj01). E(level): 573 *10*, relative σ=0.069 (1968Ha10).
598 *3*				dσ/dΩ (μb/sr): 9 (60°), 3 (90°), 1 (125°) (1969Tj01). E(level): 595 *10*, relative σ≤0.023 (1968Ha10).
644[c] *3*	11/2$^-$		0.14	dσ/dΩ (μb/sr): 6 (60°), 7 (90°), 5 (125°) (1969Tj01). E(level): 654 *10*, relative σ≤0.15(1968Ha10).
665[f] *3*	11/2$^-$&5/2$^-$		0.18	dσ/dΩ (μb/sr): 11 (60°), 10 (90°), 11 (125°) (1969Tj01). E(level): 674 *10*, relative σ=0.046 (1968Ha10). E(level),J$^{\pi}$: includes 11/2$^-$, 5/2[512] and 5/2$^-$, 5/2[523] states. C^{2}S: for 11/2$^-$, 5/2[512] state.
711[e] *3*	9/2$^+$			dσ/dΩ (μb/sr): 7 (60°), 7 (90°), 2 (125°) (1969Tj01).
750[g] *3*	3/2$^-$	1		dσ/dΩ (μb/sr)=43 (25°), 40 (30°), 44 (35°), 53 (40°), 44 (45°), 42 (50°), 42 (60°), 22 (75°), 34 (90°), 14 (105°), 11 (125°), 5 (150°) (1979Ja23). dσ/dΩ (μb/sr): 42 (60°), 34 (90°), 11 (125°) (1969Tj01). E(level): 750 *10*, relative σ=0.11 (1968Ha10).
767[&] *10*				Relative σ=0.027 (1968Ha10).
802[h] *3*	3/2$^-$	1	0.35	dσ/dΩ (μb/sr)=235 (25°), 238 (30°), 320 (35°), 380 (40°), 385 (45°), 335 (50°), 255 (60°), 190 (75°), 136 (90°), 70 (105°), 67 (125°), 25 (150°) (1979Ja23). dσ/dΩ (μb/sr): 255 (60°), ≈136 (90°), 67 (125°) (1969Tj01). E(level): 803 *10*, relative σ=1.66 (1968Ha10).
854[h] *3*	5/2$^-$		0.48	dσ/dΩ (μb/sr)=49 (25°), 62 (30°), 82 (35°), 77 (40°), 82 (45°), 76 (50°), 73 (60°), 62 (75°), 80 (90°), 25 (105°), 33 (125°), 6 (150°) (1979Ja23). dσ/dΩ (μb/sr): 73 (60°), ≈80 (90°), 33 (125°) (1969Tj01). E(level): 852 *10*, relative σ=0.47 (1968Ha10).
894[g] *3*	7/2$^-$	3		dσ/dΩ (μb/sr)=27 (25°), 60 (30°), 70 (35°), 78 (40°), 71 (45°), 67 (50°), 70 (60°), 61 (75°), 53 (90°), 31 (105°), 23 (125°), 13.6 (150°) (1979Ja23). dσ/dΩ (μb/sr): 70 (60°), ≈77 (90°), 23 (125°) (1969Tj01). E(level): 896 *10*, relative σ=0.45 (1968Ha10).
927[&] *10*				Relative σ=0.035 (1968Ha10).
941[h] *3*	7/2$^-$		0.17	dσ/dΩ (μb/sr)=13 (25°), 10 (30°), 39 (35°), 13 (40°), 23 (45°), 22 (50°), 20 (60°), 22 (75°), 27 (90°), 9 (105°), 13 (125°) (1979Ja23). dσ/dΩ (μb/sr): 20 (60°), 27 (90°), 13 (125°) (1969Tj01). E(level): 940 *10*, relative σ=0.066 (1968Ha10).
953[&] *10*				Relative σ=0.045 (1968Ha10).
972?[a] *10*				Relative σ=0.003 (1968Ha10).

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^{166}Er(d,p) 1969Tj01,1979Ja23,1968Ha10 (continued)

^{167}Er Levels (continued)

E(level)[†]	Jπ[‡]	L[#]	C²S[@]	Comments
990?[a] *10*				Relative σ=0.024 (1968Ha10).
1033?[a] *10*				Relative σ<0.01 (1968Ha10), probably an impurity.
1049[i] *5*	11/2⁻			dσ/dΩ (μb/sr): 5 (60°) (1969Tj01). E(level): 1056 *10*, relative σ=0.056 (1968Ha10).
1084[j] *5*	3/2⁺	2		dσ/dΩ (μb/sr)=30 (30°), 35 (35°), 25 (45°), 38 (50°), 21 (60°), 14 (75°), 15 (90°), 9 (125°), 10 (150°) (1979Ja23). dσ/dΩ (μb/sr): 21 (60°), 15 (90°), 9 (125°) (1969Tj01).
1132[k] *5*	1/2⁺	0		dσ/dΩ (μb/sr)=210 (25°), 143 (30°), 167 (35°), 148 (40°), 96 (45°), 90 (50°), 73 (60°), 64 (75°), 39 (90°), 31 (105°), 18 (125°), 12 (150°) (1979Ja23). dσ/dΩ (μb/sr): 46 (60°), 39 (90°), 18 (125°) (1969Tj01). E(level): 1138 *10*, relative σ=0.34 (1968Ha10).
1173 *5*				dσ/dΩ (μb/sr)=105 (25°), 150 (30°), 134 (35°), 200 (40°), 130 (45°), 171 (50°), 84 (60°), 70 (75°), 77 (90°), 75 (105°), 36 (125°), 34 (150°) (1979Ja23). dσ/dΩ (μb/sr): 84 (60°), 77 (90°), 36 (125°) (1969Tj01). E(level): 1173 *10*, relative σ=0.59 (1968Ha10).
1227?[a] *10*				Relative σ=0.12 (1968Ha10).
1247 *5*				dσ/dΩ (μb/sr): 11 (60°), 11 (90°), 4 (125°) (1969Tj01). E(level): 1255 *10*, relative σ=0.12 at 60° (1968Ha10).
1280 *5*				dσ/dΩ (μb/sr): 27 (60°), 26 (90°), 19 (125°) (1969Tj01). E(level): 1283 *10*, relative σ=0.22 (1968Ha10).
1309[&] *10*				Relative σ=0.054 (1968Ha10).
1332 *5*				dσ/dΩ (μb/sr): 2 (60°), 3 (90°), 2 (125°) (1969Tj01). E(level): 1330 *10*, relative σ=0.094 (1968Ha10).
1384[l] *5*	3/2⁻	1	0.08	dσ/dΩ (μb/sr)=91 (30°), 77 (35°), 97 (40°), 100 (45°), 114 (50°), 123 (60°), 78 (75°), 67 (90°), 37 (105°), 28 (125°), 19 (150°) (1979Ja23). dσ/dΩ (μb/sr): 123 (60°), 67 (90°), 28 (125°) (1969Tj01). E(level): 1385 *10*, relative σ=0.88 (1968Ha10).
1408 *5*				dσ/dΩ (μb/sr): 5 (60°), 10 (90°), 5 (125°) (1969Tj01).
1440[l] *5*	5/2⁻	3	0.39	dσ/dΩ (μb/sr)=15 (25°), 88 (30°), 109 (35°), 155 (40°), 148 (45°), 150 (50°), 156 (60°), 127 (75°), 121 (90°), 84 (105°), 65 (125°), 33 (150°) (1979Ja23). dσ/dΩ (μb/sr): 156 (60°), 121 (90°), 65 (125°) (1969Tj01). E(level): 1443 *10*, relative σ=0.98 (1968Ha10).
1526[l] *5*	7/2⁻		0.23	dσ/dΩ (μb/sr): 70 (60°), 74 (90°), 45 (125°) (1969Tj01). E(level): 1526 *10*, relative σ=0.49 (1968Ha10).
1548 *5*				dσ/dΩ (μb/sr): 76 (60°), 49 (90°), 17 (125°) (1969Tj01). E(level): 1546 *10*, relative σ=0.52 (1968Ha10).
1596 *5*				dσ/dΩ (μb/sr): 88 (60°), 53 (90°), 29 (125°) (1969Tj01). E(level): 1595 *10*, relative σ=0.59 (1968Ha10).
1629[l] *5*	9/2⁻		0.29	dσ/dΩ (μb/sr): 32 (60°), 14 (90°), 5 (125°) (1969Tj01). E(level): 1631 *10*, relative σ=0.26 (1968Ha10).
1645 *5*				dσ/dΩ (μb/sr): 27 (60°), 15 (90°), 14 (125°) (1969Tj01).
1684 *5*				dσ/dΩ (μb/sr): 126 (60°), 71 (90°), 30 (125°) (1969Tj01). E(level): 1686 *10*, relative σ=0.88 (1968Ha10).
1718 *5*				dσ/dΩ (μb/sr): 268 (60°), 178 (90°), 80 (125°) (1969Tj01). E(level): 1720 *10*, relative σ=1.56 (1968Ha10).
1747 *5*				dσ/dΩ (μb/sr): 202 (60°), 126 (90°), 60 (125°) (1969Tj01). E(level): 1749 *10*, relative σ=1.45 (1968Ha10).
1779 *5*				dσ/dΩ (μb/sr): 15 (60°), 13 (90°), 7 (125°) (1969Tj01).
1800 *5*				dσ/dΩ (μb/sr): 15 (60°), 15 (90°), 6 (125°) (1969Tj01). E(level): 1800 *10*, relative σ=0.14 (1968Ha10).
1815 *5*				dσ/dΩ (μb/sr): 34 (60°), 24 (90°), 13 (125°) (1969Tj01).
1842 *5*				dσ/dΩ (μb/sr): 30 (60°), 28 (90°), 15 (125°) (1969Tj01).
1865 *5*				dσ/dΩ (μb/sr): 222 (60°), 122 (90°), 60 (125°) (1969Tj01). E(level): 1867 *10*, relative σ=1.75 (1968Ha10).
1912 *5*				dσ/dΩ (μb/sr): 194 (60°), 98 (90°), 48 (125°) (1969Tj01).

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^{166}Er(d,p) 1969Tj01,1979Ja23,1968Ha10 (continued)

^{167}Er Levels (continued)

E(level)†	Comments
	E(level): 1913 *10*, relative σ=1.58 (1968Ha10).
1961& *15*	
1976& *15*	
1995& *15*	
2016& *15*	
2050& *15*	
2067& *15*	
2113& *15*	
2129& *15*	
2138& *15*	
2156& *15*	
2169& *15*	
2190& *15*	
2201& *15*	
2225& *15*	
2238& *15*	
2249& *15*	
2269& *15*	
2319& *15*	
2336& *15*	
2361& *15*	
2384& *15*	
2408& *15*	
2422& *15*	
2447& *15*	
2462& *15*	
2489& *15*	
2518& *15*	
2530& *15*	
2552& *15*	
2562& *15*	
2576& *15*	
2610& *15*	
2633& *15*	
2656& *15*	

† From 1969Tj01 unless otherwise indicated.
‡ From combined analysis of the relative populations of band members, absolute cross sections, and angular distributions in ^{166}Er(d,p) and ^{168}Er(d,t) (authors′ values).
# From DWBA analysis of angular distributions (1979Ja23).
@ dσ/dΩ(exp)/dσ/dΩ(DWBA) (relative) from Tables 16-20 in 1969Tj01.
& Level from 1968Ha10 only.
a Tentative level from 1968Ha10 only, not listed in the Adopted Levels as it could be from impurities since target enrichment was

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^{166}Er(d,p) 1969Tj01,1979Ja23,1968Ha10 (continued)

^{167}Er Levels (continued)

only 72%, with contribution from other erbium isotopes.

[b] Band(A): $\nu 7/2[633]$.

[c] Band(B): $\nu 1/2[521]$.

[d] Band(C): $\nu 5/2[512]$.

[e] Band(D): $3/2^+$ γ-vibrational band.

[f] Band(E): $\nu 5/2[523]$.

[g] Band(F): $\nu 3/2[521]$.

[h] Band(G): $\nu 1/2[510]$.

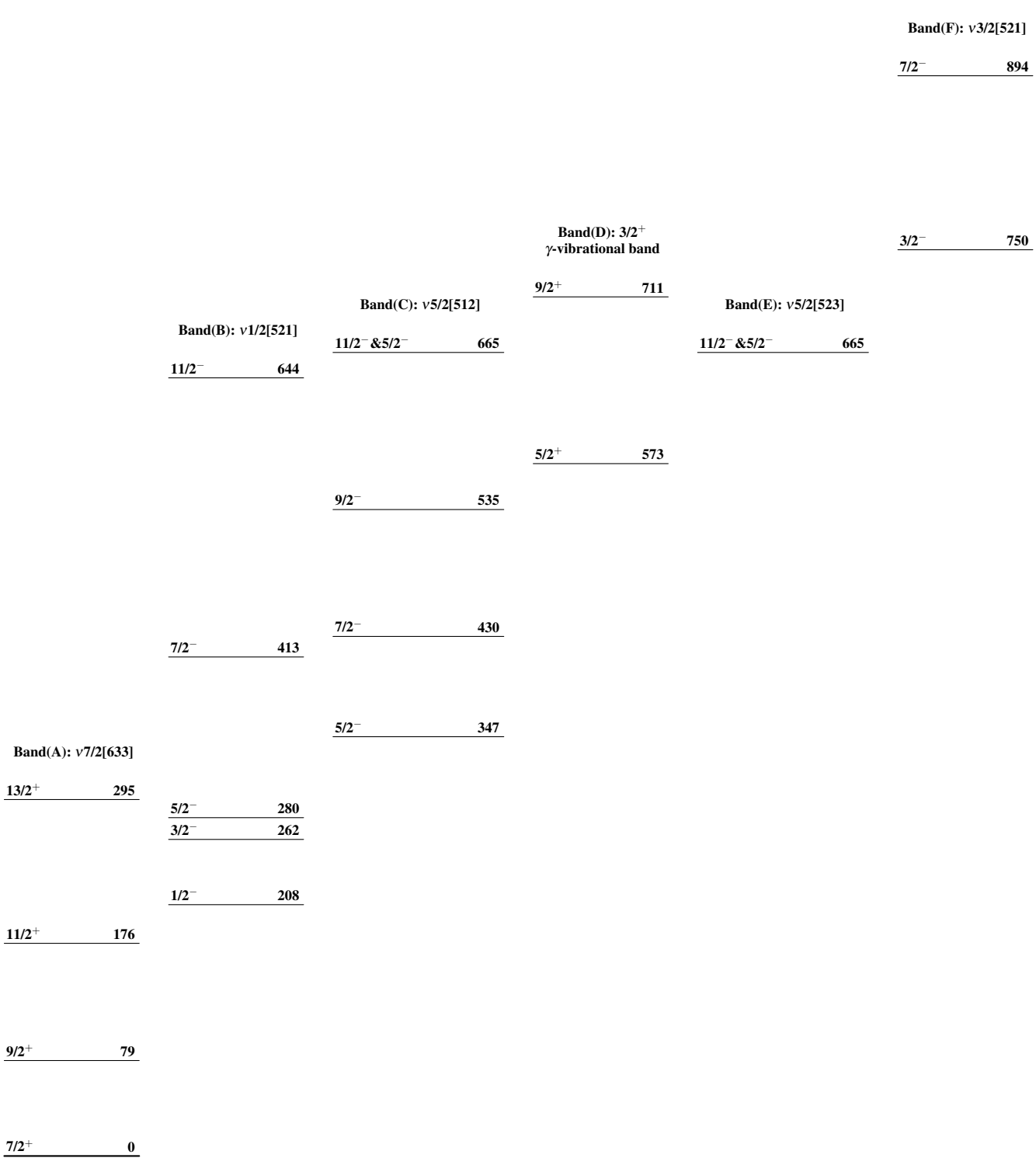
[i] Band(H): $\nu 11/2[505]$.

[j] Band(I): $\nu 3/2[402]$.

[k] Band(J): $\nu 1/2[400]$.

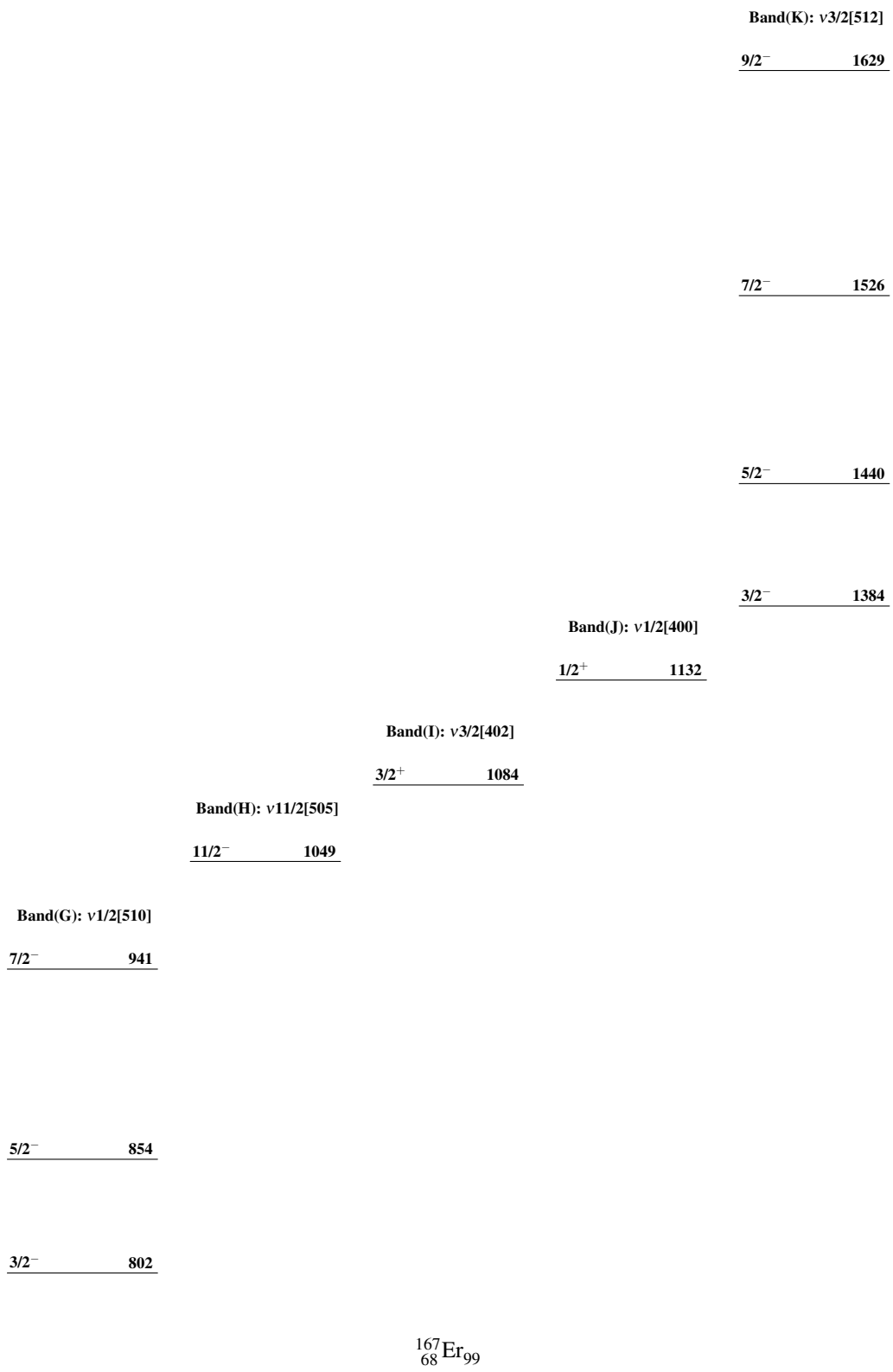
[l] Band(K): $\nu 3/2[512]$.

^{166}Er(d,p) 1969Tj01,1979Ja23,1968Ha10



$^{167}_{68}Er_{99}$

^{166}Er(d,p) 1969Tj01,1979Ja23,1968Ha10 (continued)



$^{167}_{68}Er_{99}$