^{178}Hf(^{3}He,d), ^{178}Hf(α,t) 2006Bu19

History			
Type	Author	Citation	Literature Cutoff Date
Full Evaluation	Coral M. Baglin	NDS 110, 265 (2009)	15-Nov-2008

E(^{3}He)=32 MeV, Eα=30 MeV; 89.14% enriched target; Enge split-pole spectrograph (FWHM=15-20 keV for (α,t), 20-25 keV for (^{3}He,d)), photographic emulsions; measured σ(E,θ) for (^{3}He,d) At 10 angles (7.5° −50°), σ(E) for (α,t) At two angles; DWBA analysis of $\sigma(\theta)$; deduced L, spectroscopic strengths.

^{179}Ta Levels

E(level)[†]	J$^{\pi}$[‡]	L[#]	S[@]	Comments
0[&] *1*	7/2^{+}	4	0.47	E(level): from (α,t). S: 0.38 from (^{3}He,d); 0.46 (calculated; Coriolis mixed). dσ/dΩ(μb/sr)=12 *2* At 30° for (^{3}He,d), 29 *4* At 60° for (α,t).
32[a] *2*				dσ/dΩ(μb/sr)=4 *1* At 30° for (^{3}He,d),≈2 At 60° for (α,t).
131[&] *1*				other E: 135 *2* In (α,t). dσ/dΩ(μb/sr)=5 *1* At 22.5° for (^{3}He,d), 2 *1* At 60° for (α,t).
180[a] *1*	11/2^{-}	5	0.69	S: 0.75 from (^{3}He,d); 1.01 (calculated; Coriolis mixed), 0.79 (calculated; unmixed). dσ/dΩ(μb/sr)=22 *3* At 30° for (^{3}He,d), 50 *3* At 60° for (α,t).
238.6	5/2^{+}	2	0.76	E(level): rounded value from Adopted Levels. S: 0.78 from (^{3}He,d); 0.75 (calculated). configuration: 5/2[402]. dσ/dΩ(μb/sr)=192 *7* At 30° for (^{3}He,d), 89 *5* At 60° for (α,t).
527[c] *1*	3/2^{+}	(2)	0.06	S: 0.08 from (^{3}He,d); 0.11 (calculated). dσ/dΩ(μb/sr)=22 *3* At 30° for (^{3}He,d), 6 *1* At 60° for (α,t).
629[d] *1*	5/2^{-}	3	0.24	S: 0.44 from (^{3}He,d); 0.25 (calculated; Coriolis mixed). dσ/dΩ(μb/sr)=77 *4* At 30° for (^{3}He,d), 30 *2* At 60° for (α,t).
673[d] *1*	9/2^{-}	5	1.14	E(level): from (α,t); E=679 *1* for multiplet In (^{3}He,d). L,S: L=1 and 5 for multiplet In (^{3}He,d). Two levels are resolved In (α,t) and the (^{3}He,d)/(α,t) cross section ratio indicates that the L=5 component belongs with the 673 level. it is possible that the 5/2,1/2[411] state contributes to this multiplet also but its calculated structure factor (0.04) is very much smaller than that for the 9/2,1/2[541] state. S: 1.6 from (^{3}He,d); 1.03 (calculated; Coriolis mixed). dσ/dΩ(μb/sr)=82 *5* At 30° for multiplet In (^{3}He,d), 60 *4* At 60° for (α,t).
≈680[d]	1/2^{-}	1	0.09	E(level): from (α,t); E=679 *1* for multiplet In (^{3}He,d). L: see comment on 673 level. S: 0.07 from (^{3}He,d); 0.03 (calculated). dσ/dΩ(μb/sr)=82 *5* At 30° for multiplet In (^{3}He,d), 12 *2* At 60° for (α,t).
855[d] *1*	3/2^{-}	1	0.03	S: 0.10 from (^{3}He,d); 0.07 (calculated; Coriolis mixed). dσ/dΩ(μb/sr)=58 *4* At 30° for (^{3}He,d), 4 *1* At 60° for (α,t).
891 *2*		2,3		dσ/dΩ(μb/sr)=15 *2* At 30° for (^{3}He,d),≈2 At 60° for (α,t).
994 *1*		2,3		dσ/dΩ(μb/sr)=35 *3* At 30° for (^{3}He,d), 16 *2* At 60° for (α,t).
1064 *1*		0		dσ/dΩ(μb/sr)=103 *5* At 30° for (^{3}He,d), 10 *1* At 60° for (α,t).
1122 *1*		2,3		other E: 1125 *1* In (α,t). dσ/dΩ(μb/sr)=60 *4* At 30° for (^{3}He,d), 9 *1* At 60° for (α,t).
1177 *1*		2,3		dσ/dΩ(μb/sr)=34 *4* At 30° for (^{3}He,d), 8 *1* At 60° for (α,t).
1231 *2*				dσ/dΩ(μb/sr)=13 *3* At 30° for (^{3}He,d), 5 *1* At 60° for (α,t).
1335 *1*		2		dσ/dΩ(μb/sr)=84 *5* At 30° for (^{3}He,d), 18 *2* At 60° for (α,t).
1396 *2*				E(level): mean value from (^{3}He,d) and (α,t). dσ/dΩ(μb/sr)=16 *4* At 30° for (^{3}He,d), 9 *1* At 60° for (α,t).
1420[b] *1*	3/2^{-}	1	0.15	S: 0.38 from (^{3}He,d); 0.20 (calculated; Coriolis mixed). dσ/dΩ(μb/sr)=240 *8* At 30° for (^{3}He,d), 14 *2* At 60° for (α,t).
1464 *4*		0		unweighted average of 1461 *1* In (^{3}He,d) and 1468 *2* In (α,t).

Continued on next page (footnotes at end of table)

^{178}Hf(^{3}He,d), ^{178}Hf(α,t) 2006Bu19 (continued)

^{179}Ta Levels (continued)

E(level)[†]	Jπ[‡]	L[#]	S[@]	Comments
				dσ/dΩ(μb/sr)=53 *5* At 30° for (^{3}He,d), 14 *2* At 60° for (α,t).
1494[b] *2*	1/2⁻	1	0.11	E(level): mean value from (^{3}He,d) and (α,t). S: 0.06 from (^{3}He,d); 0.02 (calculated; Coriolis mixed). dσ/dΩ(μb/sr)=42 *5* At 30° for (^{3}He,d), 10 *1* At 60° for (α,t).
1524[b] *1*	7/2⁻	3	0.37	other E: 1528 *2* In (α,t). S: 0.24 from (^{3}He,d); 0.41 (calculated; Coriolis mixed). dσ/dΩ(μb/sr)=114 *6* At 30° for (^{3}He,d), 38 *3* At 60° for (α,t).
1555 *1*		3		dσ/dΩ(μb/sr)=50 *5* At 30° for (^{3}He,d), 9 *1* At 60° for (α,t).
1665 *2*				E(level): from (α,t); not observed In (^{3}He,d). dσ/dΩ(μb/sr)≤12 At 30° for (^{3}He,d), 4 *1* At 60° for (α,t).
1874 *3*				dσ/dΩ(μb/sr)=45 *4* At 30° for (^{3}He,d), 6 *1* At 60° for (α,t).
1938 *3*				dσ/dΩ(μb/sr)=47 *5* At 30° for (^{3}He,d), 5 *1* At 60° for (α,t).
1995 *3*				dσ/dΩ(μb/sr)=21 *3* At 30° for (^{3}He,d), 5 *1* At 60° for (α,t).
2142 *5*				E(level): average of 2137 *3* In (^{3}He,d) and 2146 *3* In (α,t). dσ/dΩ(μb/sr)=63 *5* At 30° for (^{3}He,d), 3 *1* At 60° for (α,t).
2272 *2*				E(level): from (α,t). dσ/dΩ(μb/sr)≤6 At 30° for (^{3}He,d), 7 *1* At 60° for (α,t).

[†] Measured relative to E(238.6 level). uncertainties shown are statistical only; there exists an additional calibration uncertainty of≤1 keV for E≤1 MeV and up to 10 keV for E≈2500. The data shown are from (^{3}He,d), except As noted.

[‡] Authors′ values, based on L (from $\sigma(\theta)$ and (^{3}He,d)/(α,t) cross section ratios) and comparison of calculated and experimental structure factors.

[#] From DWBA analysis of $\sigma(\theta)$.

[@] Nuclear structure factor (=dσ/dΩ(exp)/2N dσ/dΩ(DWBA) where N is normalization factor). from (α,t); values from (^{3}He,d) are given In comments.

[&] Band(A): 7/2[404] band.

[a] Band(B): 9/2[514] band.

[b] Band(C): 1/2[530] band. Cross sections for the J=1/2, 3/2 and 7/2 members match the expected fingerprint for this configuration.

[c] Band(D): 1/2[411] band.

[d] Band(E): 1/2[541] band. Cross sections for the J=1/2, 3/2, 5/2 and 9/2 members match the expected fingerprint for this configuration.

^{178}Hf(^{3}He,d), ^{178}Hf(α,t) 2006Bu19

Band(C): 1/2[530] band

7/2$^-$ 1524

1/2$^-$ 1494

3/2$^-$ 1420

Band(E): 1/2[541] band

3/2$^-$ 855

1/2$^-$ ≈680

9/2$^-$ 673

5/2$^-$ 629

Band(D): 1/2[411] band

3/2$^+$ 527

Band(B): 9/2[514] band

11/2$^-$ 180

Band(A): 7/2[404] band

131

32

7/2$^+$ 0

$^{179}_{73}Ta_{106}$