

$^{164}\text{Dy}(d,^3\text{He})$ **1976SuZR**

Type	Author	History	Citation	Literature Cutoff Date
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Additional information 1.

1976SuZR (also **1977SuZW**): E= 35 MeV. Measured $\sigma(\theta)$ from 5° to 30° in ten steps. FWHM=35– 45 keV. DWBA predictions. $1/2[411] + \gamma$ bands: in stripping studies on lighter odd-A ^{155}Tb - ^{161}Tb isotopes, the $1/2[411]$ state was found to be fragmented, giving rise to two $K=1/2^+$ bands at ≈ 500 and 1000 . Previous calculations (**1972So12**,**1966Be32**) suggest this fragmentation is due to interaction between the $1/2[411]$ state and $K=2$ γ vibrations built on the $3/2[411]$ and $5/2[413]$ orbitals. However, these calculations were not able to account for detailed spectroscopic properties (level energies and spectroscopic strengths) of these bands observed in the stripping studies.

^{163}Tb Levels

E(level)	J^π	L	S ‡	Comments
0 $\&$	$(3/2)^+$	2	0.08	
57 $\&$ 10	$(5/2)^+$	2	0.68	
122 $\&$ 10	$(7/2^+)^\#$		0.40 $^\#$	
235 $\&$ 10	$(9/2^+)^\#$		0.22 $^\#$	
343 a 10	$(7/2)^-$	3	0.05	
388 d 10	$(5/2^+)$	(2)	0.06	
437 b 10	$(5/2^-)$	(3)	0.09	E(level), J^π : a 422 level in (t,α) is assigned (1992Ga15) as the $9/2^-$ member of the $7/2[523]$ band. The $5/2^-$ member of the $5/2[532]$ band is expected to be much weaker (predicted value <0.01 (1976SuZR)) than reported here. In (t,α) , this level has been assigned as part of a multiplet at 552. The $9/2^-$ member of the $7/2[523]$ band is not reported in $(d,^3\text{He})$. S: not resolved from a strong L=4, 465 level.
465 d 10	$(7/2)^+$	4	1.04	
537 a 10	$(11/2)^-$	5	1.40	
574 b 10	$(7/2^-)$	(3)	0.09	E(level),L, J^π : a 552 doublet in (t,α) is assigned (1992Ga15) as the L=4, $9/2^+$ member of the $5/2[413]$ band and the $5/2^-$ member of the $5/2[532]$ band. The $7/2^-$ member of the $5/2[532]$ band is identified (1992Ga15) at 662 in (t,α) . The $9/2^+$ member of the $5/2[413]$ band is not reported in $(d,^3\text{He})$.
674 f 10	$(3/2^+)\&(1/2^+)$	(2)	0.10	E(level), J^π : doublet consisting mainly of the $3/2^+$ member of the $K^\pi=1/2^+$ band (Configuration= $\pi 1/2[411] + [3/2[411]-Q_{22}, 5/2[413]-Q_{22}]$), and a small fraction of the $1/2^+$ member of this configuration. The $1/2^+$ member of this $K^\pi=1/2^+$ band is not reported in (t,α) . A 662 level (L=3) in (t,α) (1992Ga15) is assigned as the $7/2^-$ member of the $5/2[532]$ band, while a similar assignment is made in $(d,^3\text{He})$ for a level at 574.
709 f 10	$(5/2^+)$	(2)	0.02	E(level): weak peak (as shown in figure 5.2 of 1976SuZR) in the tail of a strong peak. In (t,α) a weak 678 level may correspond to this level.
789 f 10	$(7/2^+)$	(4)	0.13	E(level), J^π : a 771 level in (t,α) is assigned (1992Ga15) as the $9/2^-$ member of the $5/2[532]$ band. The $7/2^+$ member of the $K^\pi=1/2^+$ band (configuration= $\pi 1/2[411] + [3/2[411]-Q_{22}, 5/2[413]-Q_{22}]$) is not reported in (t,α) . The $9/2^-$ member of the $5/2[532]$ is not reported in $(d,^3\text{He})$.
896 b 10	$(11/2)^-$	5	0.75	
994 e 10	$1/2^+\&3/2^+$	2	0.12	E(level), J^π : doublet consisting mainly of the $3/2^+$ member of the $K^\pi=1/2^+$ band (configuration= $\pi 1/2[411] + [3/2[411]-Q_{22}, 5/2[413]-Q_{22}]$), and a small fraction of the $1/2^+$ member. The $1/2^+$ state may be responsible for the shoulder appearing on the low-energy side of the 994 peak.
1066 c 15	$(3/2^-)$	(1)	0.08	E(level), J^π ,L: a 1065 level in (t,α) assigned (1992Ga15) as the L=2, $(5/2)^+$ member of the $K^\pi=1/2^+$ band with configuration= $\pi 1/2[411] + [3/2[411]-Q_{22}, 5/2[413]-Q_{22}]$. The $3/2^-$ member of the $3/2[541]$ band is not reported in (t,α) . The $5/2^+$ member of

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¹⁶⁴Dy(d,³He) 1976SuZR (continued)

¹⁶³Tb Levels (continued)

E(level)	J ^π †	L	S‡	Comments
				the K ^π =1/2 ⁺ band with configuration=π1/2[411] + [3/2[411]-Q ₂₂ , 5/2[413]-Q ₂₂] is reported at 1110 in (d, ³ He).
1110 ^e 15			0.04	L: treated as tentative (by the evaluators) due to possible mixture of light-mass impurities which tend to produce an L=1 pattern also. L: L=2 (J=5/2 ⁺) proposed by 1976SuZR is questionable in view of a very weak peak (figure 5.2 in 1976SuZR) in the tail of a strong peak. E(level),J ^π : an 1112 level in (t,α) assigned (1992Ga15) as the L=4, (7/2) ⁺ of the K ^π =1/2 ⁺ band with configuration=π1/2[411] + [3/2[411]-Q ₂₂ , 5/2[413]-Q ₂₂] The 5/2 ⁺ member of this band is assigned at 1065 in (t,α) (1992Ga15). The 7/2 ⁺ member of this band is assigned at 1184 in (d, ³ He).
1184 ^e 15			0.22	L: L=4 (J=7/2 ⁺) proposed by 1976SuZR is questionable in view of a very weak peak (figure 5.2 in 1976SuZR) in the tail of a strong peak. E(level),J ^π : no assignment is made in (t,α) for an 1186 group (1992Ga15). The 7/2 ⁺ member of the K ^π =1/2 ⁺ band with configuration=π1/2[411] + [3/2[411]-Q ₂₂ , 5/2[413]-Q ₂₂] is assigned at 1110 in (t,α).
1226 ^g 15	(1/2 ⁺)&(7/2 ⁻)	(0+3)	≈0.17,0.10	E(level),J ^π ,S: probable doublet from level-energy predictions and inconsistency of σ(θ) data with any particular L-value. It may consist of the 1/2[420] bandhead and the 7/2 ⁻ member of the 3/2[541] band. Tentative values of S, based on the proposed decomposition, are given. In (t,α) the 7/2 ⁻ member of the 3/2[541] band is associated with an 1818 level (1992Ga15).
1292 ^{@g} 15	(5/2) ⁺	2	0.24 [@]	
1371 ^e 15	(9/2) ⁺		0.12	L,J ^π : no assignment made in (t,α) for a 1351 group (1992Ga15). The 9/2 ⁺ member of the K ^π =1/2 ⁺ band with configuration=π1/2[411] + [3/2[411]-Q ₂₂ , 5/2[413]-Q ₂₂] is not reported in (t,α).
1441 ^{@g} 15	(7/2) ⁺	(4)	0.34 [@]	
1512 15			≈0.04	L: L=2 proposed by 1976SuZR is questionable (evaluators).
1564 [@] 15			[@]	
1818 ^h 15			0.13	L,J ^π : an 1815 level in (t,α) assigned (1992Ga15) as the L=3, (7/2) ⁻ member of the 3/2[541] band. The 3/2[422] band members are not reported in (t,α). The 7/2 ⁻ member of the 3/2[541] band is not reported in (d, ³ He). L: L=2 proposed by 1976SuZR is questionable (evaluators).
1910? 15				
1983 ^h 15	(7/2) ⁺	4	0.89	L,J ^π : a 1982 level in (t,α) assigned (1992Ga15) as the L=5, (11/2) ⁻ member of the 3/2[541] band. The 3/2[422] band members are not reported in (t,α). The 11/2 ⁻ member of the 3/2[541] band is not reported in (d, ³ He).

† From L and comparison with predicted bandhead energies, rotational band spacing, and relative intensity patterns. The L and J assignments for several levels in this work disagree with those from the more recent (t,α) work of 1992Ga15. Comparisons of two studies are given under comments. See adopted J^π's (essentially from (t,α)) in Adopted Levels.

‡ V²C_{j,l}², where V=fullness parameter and the C_{j,l} are the expansion coefficients of the spherical-shell-model states in the deformed-orbital wave function. A general uncertainty of 15% is stated by 1976SuZR, which is probably valid for strong and well resolved peaks only.

Rotational parameter indicates these are the 7/2⁺ and 9/2⁺ members of the 3/2[411] band; however, σ(θ)'s do not indicate a specific L-transfer, and the transition strengths are ≈5 times larger than the expected values. For the 7/2⁺ level this enhancement may be due to the tail of the 5/2⁺ peak, while the enhancement of the 9/2⁺ member may be due, in part, to two-step processes.

@ Doublet. S value is for the dominant member.

& Band(A): π3/2[411] band.

^a Band(B): π7/2[523] band. 9/2⁻ member at ≈430 is expected to be too weakly populated to be observed. Strong Coriolis coupling with the 5/2[532] band is expected.

^b Band(C): π5/2[532] band. 9/2⁻ member at ≈719 is expected to be too weakly populated to be observed. Strong Coriolis

 $^{164}\text{Dy}(\text{d},^3\text{He})$ **1976SuZR (continued)**

 ^{163}Tb Levels (continued)

coupling with the 7/2[523] band is expected.

- ^c Band(D): $\pi 3/2[541]$ band (?). The $11/2^-$ member is predicted at ≈ 1500 . However, $\sigma(\theta)$ for the 1512 and 1564 are not characteristic of $L=5$ and the predicted level strength, including Coriolis coupling is too large. Both the $5/2^-$ and $9/2^-$ members are expected to be weakly populated.
- ^d Band(E): $\pi 5/2[413]$ band. A is smaller than expected suggesting Coriolis coupling. Predicted position of $9/2^+$ member obscured by other transitions of greater intensity.
- ^e Band(F): $K^\pi=1/2^+$ band. Configuration= $\pi 1/2[411] + [3/2[411]-Q_{22}, 5/2[413]-Q_{22}]$ (upper fragment).
- ^f Band(G): $K^\pi=1/2^+$ band. Configuration= $\pi 1/2[411] + [3/2[411]-Q_{22}, 5/2[413]-Q_{22}]$ (lower fragment).
- ^g Band(H): $\pi 1/2[420]$ band. Large decoupling parameter ($a \approx 1$) expected for this band implies that the $3/2$ and $5/2$ members and the $7/2$ and $9/2$ members would be observed as pairs of unresolved levels. The experimental a is consistent with this interpretation as is the A value, assuming the 1226 is a doublet including the $1/2[420]$ bandhead.
- ^h Band(I): $\pi 3/2[422]$ band (?). The tentative level observed at 1910 agrees with the predicted energy for the $5/2^+$ member; however, it does not have the expected strength. The weak $9/2$ member is predicted to lie outside the experimental range. This band is not reported in (t, α) ([1992Ga15](#)).

$^{164}\text{Dy}(d,^3\text{He})$ 1976SuZRBand(D): $\pi 3/2[541]$ band (?) $(1/2^+)$ & $(7/2^-)$ 1226 $(3/2^-)$ 1066Band(C): $\pi 5/2[532]$ band $(11/2^-)$ 896Band(B): $\pi 7/2[523]$ band $(7/2^-)$ 574 $(11/2^-)$ 537 $(5/2^-)$ 437 $(7/2^-)$ 343Band(E): $\pi 5/2[413]$ band $(7/2^+)$ 465 $(5/2^+)$ 388Band(A): $\pi 3/2[411]$ band $(9/2^+)$ 235 $(7/2^+)$ 122 $(5/2^+)$ 57 $(3/2^+)$ 0 $^{163}_{65}\text{Tb}_{98}$

$^{164}\text{Dy}(\text{d},^3\text{He})$ 1976SuZR (continued)

		Band(I): $\pi 3/2[422]$ band
		(?)
		<u>(7/2)⁺ 1983</u>
		<u>1818</u>
		Band(H): $\pi 1/2[420]$ band
		<u>(7/2)⁺ 1441</u>
		<u>1292</u>
		<u>(1/2⁺) & (7/2⁻) 1226</u>
		<u>1184</u>
		<u>1110</u>
		<u>1/2⁺ & 3/2⁺ 994</u>
		Band(G): $K^\pi=1/2^+$ band
		<u>(7/2)⁺ 789</u>
		<u>(5/2)⁺ 709</u>
		<u>(3/2⁺) & (1/2⁺) 674</u>