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Abstract

Full Text

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PHYSICS

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CONVERSION SPECTRA OF SOME NEUTRON-DEFICIENT ISOTOPES OF Tb

In the present work we have studied the conversion spectra of neutron-deficient Tb isotopes produced in the reaction $Ta + p$ (660 MeV). The preparations and measurement conditions were analogous to those described in ^(1, 2). Decay curves constructed from measurements of the heights of the conversion peaks with time showed that the Tb preparation contains several isotopes. Below we give the results obtained for each of the observed activities.

1. $T_{1/2} = 8 \pm 1$ hr. Conversion electrons were observed only for two transitions, $E_{\gamma} = 123$ and 977 keV (see Fig. 1, Table 1). One of the Tb^{154} isomers has $T_{1/2} = 7.5$ hr ⁽³⁾. In addition, a 123-keV level is known in Gd^{154} . We therefore assigned this activity to Tb^{154} . However, we did not observe other transitions to Gd^{154} , known from the decay of Eu^{154} .
2. $T_{1/2} = 18 \pm 1$ hr. Sixteen nuclear transitions were observed in the energy interval from 109 to 1050 keV (see Fig. 1, Table 1), as well as a complex β^+ -spectrum with $E_{gr} = 2.8$ MeV (see Fig. 1, Table 2). Tb^{154} has a half-life close to this, $T_{1/2} = 17.5$ hr, and a β^+ -spectrum with $E_{gr} = 2.6$ MeV ^(3, 4). However, the E_{γ} values of our transitions differ from those for Gd^{154} , known from the decay of Eu^{154} . Among other Tb isotopes, Tb^{152} has a similar value $T_{1/2} = 19 \pm 1$ hr ⁽⁵⁾ (A is uncertain). In our Tb preparation the daughter Gd^{151} , whose radiation we investigated in another work ⁽¹⁾, was found. Thus, the 18-hour activity observed by us may be assigned to Tb^{154} or Tb^{151} , either wholly or in part.
3. $T_{1/2} = 2.3 \pm 0.3$ days. Eight nuclear transitions were observed in the energy interval from ~ 100 to 250 keV (see Fig. 2, Table 1). Up to the present time no Tb isotopes decaying with such a period had been known. The new activity apparently belongs to Tb^{153} . Indeed, among the daughter products in our preparation we observed Gd^{153} . Tb isotopes with $A = 158; 157; 156; 155; 154; 152; 149; 147$ and 145 may be excluded from consideration, since they themselves or their daughter products have

half-lives or γ -spectra incompatible with our data. However, generally speaking, Tb^{148} , Tb^{150} , and, to some extent, Tb^{151} cannot be excluded from consideration, since it has not been identified quite reliably.

4. $T_{1/2} = 5 \pm 1$ days. The nuclear transitions assigned by us to the 5-day period apparently belong to two isotopes: Tb^{155} and Tb^{156} .

To Tb^{155} we assigned 14 transitions (Fig. 2, Table 1), coinciding in energy with some of the 19 known transitions ⁽⁶⁾. In the level scheme of Gd^{155} proposed in ^(6, 7), 11 of the transitions observed by us are placed (the same as in ⁽⁶⁾). To Tb^{156} we assigned the transitions $E_\gamma = 89$ and 199 keV (Fig. 2, Table 1), known from the decay of Eu^{156} ⁽⁸⁾.

5. $T_{1/2} = 10; 120$ and 200 days. The activities identified from 30 conversion lines with the indicated periods belong to daughter products, respectively Gd^{149} , Gd^{151} , and Gd^{153} , which we studied earlier ⁽¹⁾.

[Figure 1]

Fig. 1. Conversion spectrum of Tb with $T_{1/2} = 18$ h (solid black peaks) and $T_{1/2} = 8$ h (shaded peaks). Peaks corresponding to activities with a larger value of $T_{1/2}$ are not shaded; some of them are unresolved from the peaks K -109, K -180, K -250 and from part of the others. The spectrum is reduced to one time. At upper right is shown the β^+ -spectrum of the 18-hour activity Tb^{154} and the Curie plot.

Table 1

Interpretation of the conversion spectrum of Tb

E_γ , keV	K/K_0	K/L	E_γ , keV	K/K_0	K/L
$T = 18 \pm 1$ h; $A =$ 154, 151 (?)	$T = 18 \pm 1$ h; $A =$ 154, 151 (?)	$T = 18 \pm 1$ h; $A =$ 154, 151 (?)	$T = 5 \pm 1$ days; $A = 155$	$T = 5 \pm 1$ days; $A = 155$	$T = 5 \pm 1$ days; $A = 155$
109 ± 1	> 5	> 4	19 ± 1	—	—
180 ± 1	1.1 ± 0.2	6.2 ± 0.6	26 ± 1	—	—
191 ± 1	0.27 ± 0.03	6.9 ± 0.7	60 ± 1	—	—
250 ± 1	1.2 ± 0.1	6.3 ± 0.6	87 ± 1	> 4.5	> 3
271 ± 1	0.31 ± 0.03	4.1 ± 0.4	(101 ± 1)	< 1	—
287 ± 1	1.00	5.2 ± 0.5	105 ± 1	> 4	—
343 ± 1	1.2 ± 0.1	3.6 ± 0.3	149 ± 1	2.1 ± 0.2	5.6 ± 0.5
410 ± 2	$0.060 \pm$ 0.006	(~ 6)	$160\}$	2.1 ± 0.2	4.9 ± 0.3
416 ± 2	$0.029 \pm$ 0.003	(~ 6)	$161\}$		
426 ± 2	0.06 ± 0.01	~ 3	163 ± 1	2.6 ± 0.2	5.3 ± 0.5
431 ± 2	0.38 ± 0.03	~ 6	180 ± 1	3.4 ± 0.4	5.3 ± 0.6

E_γ , keV	K/K_0	K/L	E_γ , keV	K/K_0	K/L
442 ± 2	0.15 ± 0.02	~ 7	(182 ± 2)	—	—
477 ± 2	0.14 ± 0.02	~ 5	262 ± 2	1.00	6.6 ± 0.7
589 ± 2	0.27 ± 0.03	6.0 ± 0.7	340 ± 2	0.14 ± 0.02	—
616 ± 2	0.95 ± 0.06	6.0 ± 0.3	$T =$	$T =$	$T =$
			2.3 ± 0.3	2.3 ± 0.3	2.3 ± 0.3
			days;	days;	days;
			$A = 153$	$A = 153$	$A = 153$
1050 ± 5	$0.023 \pm$ 0.003	3	88 ± 1	> 3	—
$T = 8 \pm 1$	$T = 8 \pm 1$	$T = 8 \pm 1$	(100 ± 1)	> 3	—
h; $A = 154$	h; $A = 154$	h; $A = 154$			
123 ± 1	1	~ 3	110 ± 1	18 ± 2	~ 3
977 ± 5	$0.030 \pm$ 0.003	—	171 ± 1	1.6 ± 0.2	—
$T = 5 \pm 1$	$T = 5 \pm 1$	$T = 5 \pm 1$	174 ± 1	1.00	4.8 ± 0.8
days;	days;	days;			
$A = 156$	$A = 156$	$A = 156$			
89 ± 1	> 10	~ 1	195 ± 1	0.64 ± 0.07	~ 7
199 ± 1	1.0	~ 3	(210 ± 1)	4.2 ± 0.4	7.7 ± 0.7
			(247 ± 2)	1.3 ± 0.2	greater

Fig. 2. Conversion spectrum of Tb with $T_{1/2} = 2.3$ days (solid black peaks) and $T_{1/2} = 5$ days. This spectrum remains after the decay of the 18-hour activity. Lines of the daughter products Tb–Gd¹⁴⁹, Gd¹⁵¹, and Gd¹⁵³ become noticeable after the decay of the activities indicated above. At upper right are shown: **a**–decay curve of the Tb isotope with $T_{1/2} = 2.3 \pm 0.3$ days; **b**–its possible decay scheme.

They could not have been present as impurities, since the strong lines of other Gd isotopes were absent.

Table 2

β^+ -spectrum of Tb¹⁵⁴

E_{gr} , MeV	β_i^+/β_0^+	β^+/K_{capt}
β_0 2.80 ± 0.05	1.00	
β_1 1.65 ± 0.08	0.25	0.9 ± 0.2
β_2 0.75 ± 0.10	0.15	

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CITED LITERATURE

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