# AN ESTIMATE OF ISOMERIC TRANSITION ENERGY IN THE DECAY OF $^{234M}$Pa

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Isomeric $E3$-transition in the decay of $^{234m}$Pa ($T_{1/2}$ = 1.17 min.) proceeds between $0^-$ and $3^+$ states with main configurations p1/2$^-$ [530] n1/2$^+$ [631] and p1/2$^-$ [530] n7/2$^-$[743]. Authors [1] establish limit (<10 keV) of its energy, authors [2] determined its energy as $E$ = 2.6±0.3 keV, but this value has to be confirmed.

For different values of supposed isomeric transition energy in the range 25 eV — 10 keV the values $T_{1/2}(\gamma)$ were calculated using known $T_{1/2}$, isomeric branching (0.16 ± 0.04)% and internal conversion coefficients which were determined by extrapolation of theoretical values [3]. The values $T_{1/2}(\gamma)$ are shown in the column 3 of the Table below. For the same energies theoretical $T_{1/2}(\gamma)$ values were calculated using Weiskopf formula and these are shown in the column 4. The ratio of γ-probabilities calculated by both methods defines the values of hindrance factor $F$ shown in the last column. These factors $F$ could be compared with value $F$ = 36 ± 5 for isomeric transition in $^{237}$Pu which proceeds between the same neutron configurations as in $^{234}$Pa. For lower energies (less than 10 eV) transition would be enhanced, for higher energies (more than 25 eV) it would be strongly forbidden both cases being unreasonable. So it could be concluded that the energy discussed is 10–30 eV.

| $E_\gamma$, eV | Conversion coefficient, α [3] | $T_{1/2}(\gamma)$ = α ·$T_{1/2}$/0.16%, sec. | $T_{1/2}(\gamma)$, sec. (theory) | $F_{hindr.}$= $T_{1/2}(\gamma)/T_{1/2}(\gamma)$ (theor.) |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 25 | $9.1 \cdot 10^{22}$ $(P_3+P_4+P_5+Q)^*$ | $4.0 \cdot 10^{27}$ | $6.0 \cdot 10^{25}$ | 67 |
| 50 | $4.1 \cdot 10^{21}(P_\Sigma+Q)$ | $1.8 \cdot 10^{26}$ | $4.7 \cdot 10^{23}$ | 380 |
| 120 | $1.6 \cdot 10^{19}(O+P+Q)$ | $6.6 \cdot 10^{23}$ | $1.0 \cdot 10^{21}$ | 660 |
| 1400 | $4.6 \cdot 10^{12}(N+O+P+Q)$ | $2.0 \cdot 10^{17}$ | $3.6 \cdot 10^{13}$ | $5.6 \cdot 10^3$ |
| 2600 | $3.3 \cdot 10^{11}(N+O+P+Q)$ | $1.4 \cdot 10^{16}$ | $4.6 \cdot 10^{12}$ | $3.0 \cdot 10^4$ |

*The binding energies of electrons in Pa atom are as follows (in eV): 43 ($P_1$), 27($P_2$), 17($P_3$), 4.6($P_4$) and 5.6 ($P_5$) [4].

For testing of the method described the hindrance factor of isomeric transition in $^{235}$U was estimated. This transition proceeds between the same neutron configurations n1/2$^+$ [631] and n7/2$^-$[743] as in $^{237}$Pu and in $^{234}$Pa. At the value $\alpha = 2.5 \cdot 10^{20}$ $F_{hindr.}$ = 20 and is not far from $^{237}$Pu case. Still for $^{234}$Pa one should have in mind that $F$-factors in odd-odd and in odd nuclei could be different even for the same type of transitions.

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