# The 521 keV Beta Transition in $^{182}$Ta Decay.

K. S. ROW and D. L. SASTRY

*The Laboratories for Nuclear Research, Andhra University - Waltair*

(ricevuto il 2 Gennaio 1969)

**Summary.** — The beta-gamma directional correlation of the 521-67 keV cascade in $^{182}$Ta decay was measured to investigate the higher-order effects. The observed correlation function at $\bar{E}_\beta = 450$ keV is found to be isotropic and is given by $W_{\beta\text{-}\gamma}(\theta)$ (at $\bar{E}_\beta = 450$ keV) $= 1 + (0.025 \pm \pm 0.031)P_2(\cos\theta)$. The $A_{22}$ coefficient indicates no higher-order contributions to the 521 keV allowed but hindered beta transition of $^{182}$Ta.

Tantalum-182 is a highly deformed nucleus and its ground state is characterized by $3^-$. The beta-decay modes of $^{182}$Ta and the resulting gamma-rays from $^{182}$W have been fairly well investigated and established [1,2] (decay scheme: ref. [1]). The 521 (keV) betas with intensity $(65 \pm 10)$ form the main component that proceeds from the $3^-$ ground state of $^{182}$Ta with a $\log ft$ value of 8.1. According to the studies [3,4] made before 1964, the emission of 521 keV betas of $^{182}$Ta leaves the resulting daughter nucleus $^{182}$W at an excitation of 1222 keV characterized by $2^+$. This requires the beta transition to be of nonunique first forbidden type. However subsequent works [1,2] show from an accurate analysis of beta groups and the following gamma-rays that 521 keV betas from the $3^-$ state of $^{182}$Ta proceed to the 1289 keV $2^-$ state of $^{182}$W according to which the beta transition should be an allowed one. The

[1] P. G. HANSEN, H. L. NIELSEN and K. WILSKY: *Nucl. Phys.*, **54**, 657 (1964).

[2] H. DANIEL, J. HUEFNER, TH. LORENTZ, O. W. B. SCHULTZ and U. GRUBER: *Nucl. Phys.*, **56**, 147 (1964).

[3] J. J. MURRAY, F. BOEHM, P. MARMIER and J. W. M. DUMOND: *Phys. Rev.*, **97**, 1007 (1955).

[4] J. DEMUYNCK, J. VERHEEGHE and B. VAN DER VALDE: *Compt. Rend.*, **244**, 3050 (1957).

interesting feature of this beta transition is its allowed nature with a high $\log ft$ value.

When the normal sizes of the allowed matrix elements suffer a reduction due to some nuclear-model effect, the allowed beta transitions will be retarded. If the second-forbidden matrix elements are not at the same time reduced, from beta-decay theory it follows ($^5$) that their contributions to the allowed beta transition manifest finite but small beta-gamma anisotropy. So we have taken up the angular-correlation measurement of the 521 keV ($\beta$)--67 keV ($\gamma$) cascade in the decay of $^{182}$Ta to look into the effects of second-forbidden matrix elements. The anisotropy value also indicates the possible nature of the beta transition.

The $^{182}$Ta source was obtained in liquid form from the Atomic Energy Establishment, Harwell. The source for the present experimentation was prepared by allowing a drop of liquid to evaporate to dryness on a mylar film of thickness 0.6 mg/cm². The experimental arrangement was a fast-slow scintillation assembly ($^6$) operated at $2\tau$ value equal to 10 ns. The beta detection was accomplished by a thin plastic scintillator (NE-102) of $\frac{1}{8}''$ thickness while a $(1 \times 1)$ in NaI(Tl) crystal was used for the 67 keV gamma-ray detection. This particular choice of the detectors and their sizes helped a low gamma-gamma background contribution to the beta-gamma coincidence data. The betas of energy lying between 400 and 500 keV were accepted in a window of 100 keV and the following 67 keV gammas were accepted in a window of 10 keV in order to eliminate the interferences from other cascades. The coincidence data were collected at two angles 180° and 90° and corrected for chance and gamma-gamma background. After normalization of the corrected beta-gamma coincidences to the single beta counts at 180° and 90°, the following angular correlation function in its final form is obtained:

$$W_{\beta\text{-}\gamma}(\theta) \text{ at } \bar{E}_\beta = 450 \text{ keV}, \qquad = 1 + (0.025 \pm 0.031) P_2(\cos\theta).$$

Thus from the experimentally obtained correlation function it is seen that the anisotropy factor is zero within experimental errors. This suggests that whatever mechanism that is responsible for the reduction of allowed matrix elements reduces the second-forbidden matrix elements also, that cause the $3^- \xrightarrow[521 \text{ keV}]{\beta} 2^-$ transition in $^{182}$Ta decay. It can also be concluded that the zero value of anisotropy does not give any indication for the present beta transition to be different from an allowed one.

($^5$) M. MORITA: *Phys. Rev.*, **113**, 1584 (1959); *Progr. Theor. Phys. Suppl.*, No. 26 (1963).

($^6$) W. V. S. RAO, K. S. ROW, D. L. SASTRY and S. JNANANDA: *Proc. Phys. Soc.*, **87**, 917 (1966).

RIASSUNTO (*)

Si è misurata la correlazione direzionale beta-gamma della cascata 521-67 keV nel decadimento del $^{182}$Ta allo scopo di studiare gli effetti d'ordine più elevato. Si trova che la funzione di correlazione osservata per $\overline{E}_\beta = 450$ keV è isotropa ed è data per $\overline{E}_\beta = 450$ keV da $W_{\beta\text{-}\gamma}(\theta) = 1 + (0.025 \pm 0.031)\,P_2(\cos\theta)$. Il coefficiente $A_{22}$ indica che non vi sono contributi d'ordine più elevato alla transizione beta di 521 keV del $^{182}$Ta permessa ma ritardata.

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(*) *Traduzione a cura della Redazione.*

β-переход 521 кэВ при распаде $^{182}$Ta.

**Резюме** (*). — Для исследования эффектов более высоких порядков была измерена корреляция направлений β-γ для каскада 521-67 кэВ при распаде $^{182}$Ta. Обнаружено, что наблюденная корреляционная функция при ($E_\beta^- = 450$ кэВ) является изотропной, а при ($E_\beta^+ = 450$ кэВ) эта функция имеет вид $W_{\beta\text{-}\gamma}(\theta) = 1 + (0.025 \pm 0.031)\,P_2(\cos\theta)$. Коэффициент $A_{22}$ указывает на отсутствие вкладов более высокого порядка в 521 кэВ разрешенный, но затрудненный β-переход для $^{182}$Ta.

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(*) *Переведено редакцией.*