THE L_1 SUBSHELL FLUORESCENCE YIELD OF Tl (*)

M. I. MARQUES, M. C. MARTINS and J. G. FERREIRA

Laboratory of Physics, Faculty of Science
University of Lisbon, Portugal

(Received 9 July 1980)

ABSTRACT — L_1 fluorescence yield of Tl has been measured by comparing the relative intensities of the K and L_1-X-ray spectra. The experimental result is $\omega_1 = 0.109 \pm 0.016$

1 — INTRODUCTION

Experimental information of atomic fluorescence yields for L_1 subshell, ω_1, is scarce mostly for elements in the atomic number region $Z \geqslant 70$. Particularly, the three experimental values [1, 2, 3] reported for thallium ($Z = 81$) do not agree very well.

The purpose of this note is to find ω_1 for Tl by comparison of the K and L_1 X-ray spectra of this element, which is a different method.

We denote by n_K, n_1, F_K, F_{L_1}, the numbers of primary vacancies in K and L_1 shells respectively and the correspondent number of L X-ray photons; ω_K, ω_1 represent the atomic fluorescence yields of the K and L_1 shells and f_{KL_1} the probability of ionization transfer from the level K to the L_1 level.

The following equations are valid

$$F_K = \omega_K \, n_K \qquad F_{L_1} = \omega_1 \, (n_1 + f_{KL_1} \, n_K)$$

or

$$\omega_1 = \omega_K \, \frac{F_{L_1}}{F_K} \, \frac{1}{(n_1/n_K) + f_{KL_1}} \tag{1}$$

(*) This work has been supported by INIC (Portugal); results presented at the Conference of the Portuguese Physics Society (Porto, April 80).

A result for ω_1 of Tl can be obtained from expression (1) as ω_K, n_1/n_K and f_{KL_1} are well known and F_{L_1}/F_K has been measured in the present work.

2 — EXPERIMENTAL PROCEDURE

K and L X-ray spectra of Tl were obtained, following β^- decay of ^{203}Hg, using a Si(Li) X-ray detector, 10 mm in diameter and 5 mm deep, fitted with a 0.025 mm Be window and having a resolution of 210 eV FWHM at 6.4 keV.

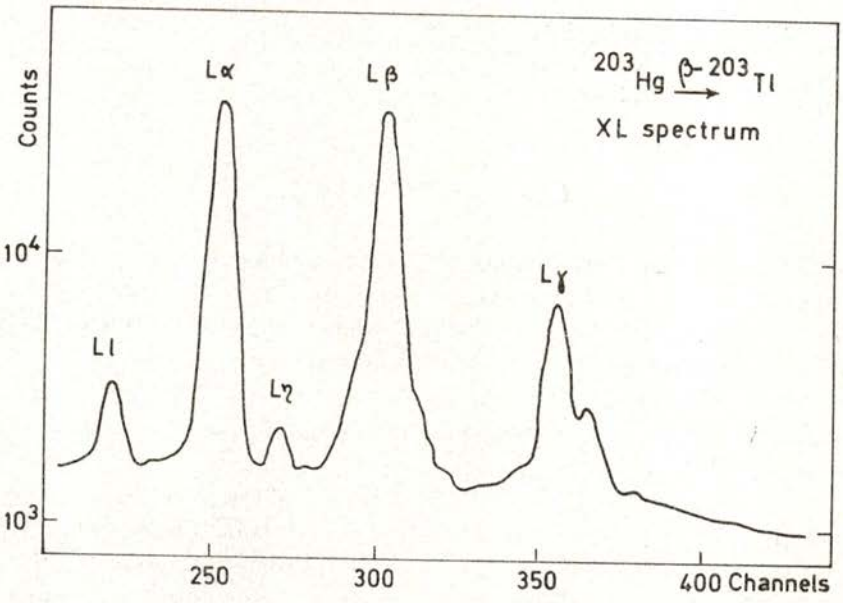

Fig. 1 — L X-ray spectrum of Tl

The source preparation and the method used to obtain the efficiency-absorption curve were previously described [4].

The L_1 X ray spectrum is due to the lines $L\beta_4$, $L\beta_3$, $L\gamma_2$, $L\gamma_3$, $L\gamma_4$ and the contribution of these lines in all the L-X spectrum (Fig. 1) is evaluated by decomposing the $L\gamma$ group in the L_1 and $(L\gamma_2+L\gamma_6+L\gamma_3+L\gamma_4)$ lines. Theoretical L radiative rates of Scofield [5] and experimental values of Salem et al. [6] were used in this

evaluation. Lα of Np (13.9 keV) and γ (14.4 keV) of ^{57}Fe, which have energies very close to Lγ_1 of Tl (14.29) keV were used to obtain the shape of this line.

3 — RESULTS

In table I we present the values of ω_K, f_{KL_1}, and n_1/n_K adopted to determine ω_1 by expression (1); transition rates from Scofield (*a*) and Salem et al. (*b*) were used in evaluating F_{L_1}/F_K

TABLE I

ω_K [7]	f_{KL_1} [8]	n_1/n_K [9]	F_{L_1}/F_K
0.966	0.0190	0.155	0.0217 (*a*) 0.0176 (*b*)

Table II shows our result $\omega_1 = 0.109 \pm 0.016$ together with values obtained in previous experimental work.

TABLE II

Sujkowski et al. [1]	Wood et al. [2]	Auler et al. [3]	Present work
0.11 ± 0.025	0.07 ± 0.02	0.10	0.109 ± 0.016

REFERENCES

[1] Z. SUJKOWSKI and O. MELIN, *Ark. Fys.*, **20**, 193 (1961).

[2] R. E. WOOD, J. M. PALMS and P. V. RAO, *Phys. Rev.*, **187**, 1497 (1969).

[3] L. T. AULER, A. G. DA SILVA and A. G. PINHO, *Rev. Bras. Fis.*, **4**, 29 (1974).

[4] M. I. MARQUES, M. C. MARTINS, J. G. FERREIRA, *J. Phys. B.*, **13**, 41, (1980).

[5] J. M. SCOFIELD, *At. Data and Nucl. Data Tables,* **14**, 121 (1974).

[6] S. I. SALEM, S. L. PANOSSIAN and R. A. KRAUSE, *At. Data and Nucl. Data Tables,* **14**, 91 (1974).

[7] M. O. KRAUSE, *J. Phys. Chem. Ref. Data,* **8**, 307 (1979).

[8] P. V. RAO, M. H. CHEN and B. CRASEMANN, *Phys. Rev.,* **A5**, 997 (1972).

[9] Table of isotopes, ed. C. M. LEDERER and V. S. SHIRLEY, 7th edition (1978).