

## DETERMINATION OF CONVERSION COEFFICIENTS FROM THE DECAY OF $Pb^{202m}$ BY MEANS OF A SEMICONDUCTOR DETECTOR

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**Abstract:** New attempts to determine conversion coefficients using semiconductor detectors were made. In this case the 0.422 and 0.787 MeV transitions from the decay of  $Pb^{202m}$  were studied. Conversion coefficients were determined by means of the electron-gamma coincidence method, replacing the conventional magnetic spectrometer by a semiconductor counter. The value of the K conversion coefficient corresponding to the E2 0.422 MeV transition is  $\alpha_K(0.422) = 0.032 \pm 0.002$ . That corresponding to the 0.787 MeV E5 transition is  $\alpha_K(0.787) = 0.008 \pm 0.004$ .

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RADIOACTIVITY  $Pb^{202m, 202}$  [from  $Tl(d, xn)$ ]; measured  $\gamma$ , ce.  
 $Pb^{202m}$ ; measured cc, ce  $\gamma$ -coin. Natural target.

### 1. Introduction

As has been pointed out <sup>1)</sup> conversion coefficients can be determined with the method of electron-gamma coincidences by replacing a magnetic spectrometer by a semi conductor counter. The transitions from the decay of  $Pb^{202m}$  offer the possibility of applying the abovementioned method for determining conversion coefficients.

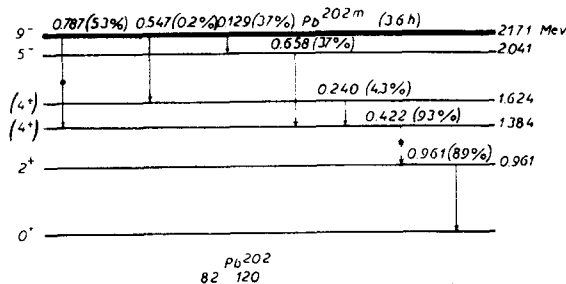


Fig. 1. Excited and isomeric levels corresponding to  $Pb^{202}$ .

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The decay scheme, which is shown in fig. 1, has been studied by many authors <sup>2-8</sup>). Maeder *et al.* <sup>3</sup>) have studied the conversion coefficients corresponding to the 0.422, 0.787 and 0.961 MeV transitions by indirect methods, applying a normalization factor.

McDonnell *et al.* <sup>8</sup>) have measured the conversion coefficients corresponding to the 0.787 MeV transition, by means of the determination of the total intensity, K conversion intensity and K/L ratio. These measurements were performed with a high resolution magnetic beta spectrometer.

In the present work, attempts to measure the conversion coefficient for the 0.422 and 0.787 MeV transitions were made with the already mentioned electron-gamma coincidence method.

## 2. Experimental Procedure

The carrier-free source of  $Pb^{202m}$  was produced by irradiating thallium sulphate with 22 MeV deuterons from the Philips synchrocyclotron of the Argentine AEC.

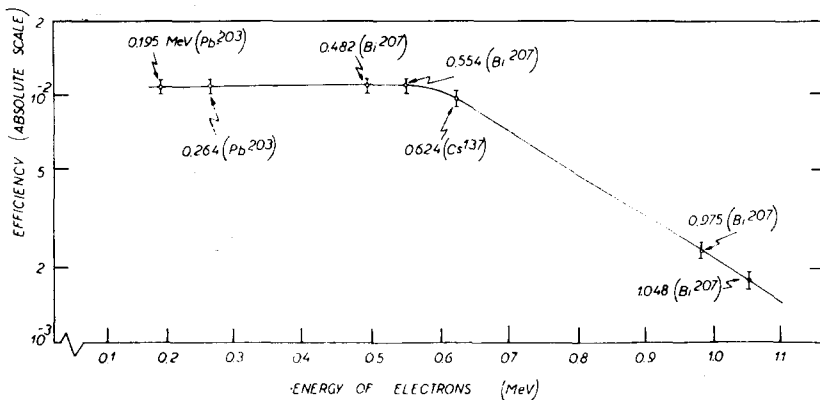


Fig. 2. Absolute efficiency as a function of the energy of impinging electrons, corresponding to the semiconductor counter used in the present work.

TABLE I

Characteristics of the solid state counter used in the present work

Constant	Value
Surface	0.28 cm <sup>2</sup>
Applied voltage	150 V
Charge resistor	20 Megohms
Restivity	3500-3600 Ω-cm
Capacity	7.84 pF
Barrier thickness	380 μm

The chemical separation was performed according to the procedure described elsewhere <sup>9</sup>). A drop of 2 mm diameter was deposited on a 0.9 mg/cm<sup>2</sup> Mylar backing.

The electron-gamma coincidence arrangement described previously<sup>1,10</sup>) was used.

The surface barrier solid state counter was made at the electronics laboratories of the Argentine AEC, according to the conventional procedures<sup>11,12</sup>). An absolute efficiency curve of the counter is plotted in fig. 2 as a function of the electron energy. The characteristics of the counter are described in table 1. The gamma radiation was detected by a conventional NaI(Tl) crystal 5 cm diam.  $\times$  5 cm thick coupled to an RCA-6655A photomultiplier.

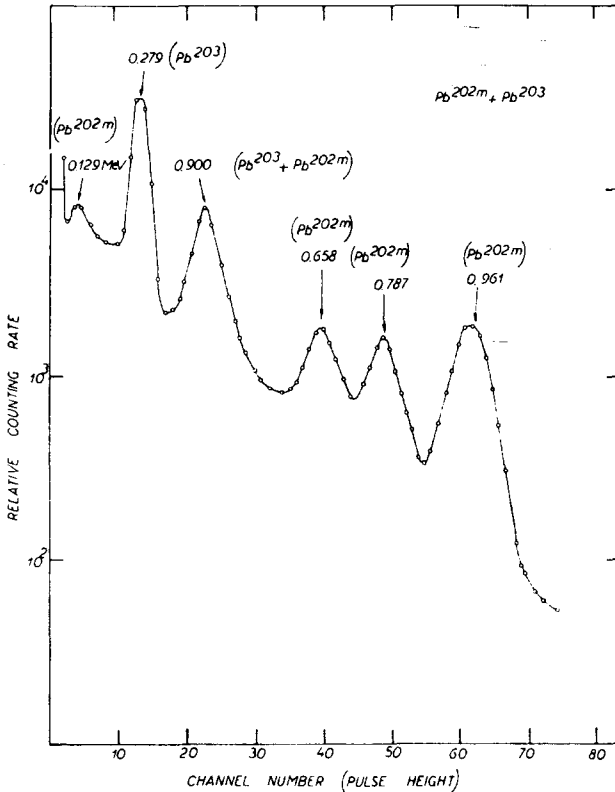


Fig. 3. Gamma spectrum from the decay of the sample ( $\text{Pb}^{202\text{m}}$  and  $\text{Pb}^{203}$ ) recorded with a NaI(Tl) crystal 5 cm diam.  $\times$  5 cm thick.

When bombarding natural thallium with deuterons and waiting for the decay of short activities, it is expected, after chemical separation, to detect radiations only from the disintegration of  $\text{Pb}^{202\text{m}}$  and  $\text{Pb}^{203}$ . The corresponding gamma- and electron-conversion-spectra of the sample are shown in figs. 3 and 4, respectively.

#### 2.1. DETERMINATION OF THE CONVERSION COEFFICIENT CORRESPONDING TO THE E2 0.422 MeV TRANSITION

The 0.787 MeV peak was gated at the single-channel analyser, and the corresponding cascading conversion electron spectrum displayed in a 100-channel PENCO PA-4 analyser.

This experiment was performed with an adjusted delay in the fast gamma branch in order to get 100 % efficiency of the coincidence circuit for the  $\gamma(0.787)$ - $e(0.422)$  cascade. The corresponding electron conversion spectrum is shown in fig. 5. The corresponding value for the K-conversion coefficient is indicated in table 2. The K/L ratio is also quoted.

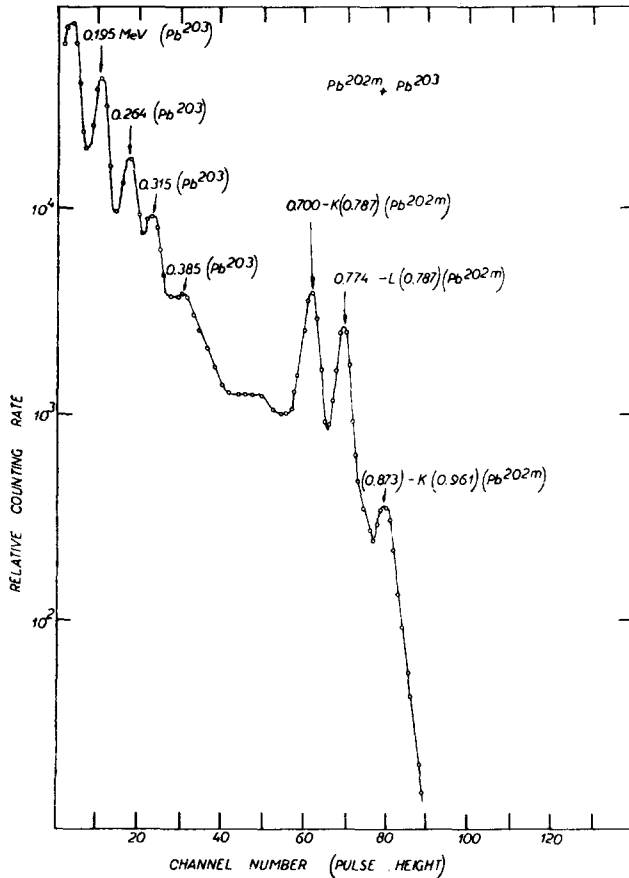


Fig. 4. Electron conversion spectrum from the decay of the sample ( $Pb^{202m}$  and  $Pb^{203}$ ) recorded with the semiconductor counter used in the present work.

## 2.2. DETERMINATION OF THE K CONVERSION COEFFICIENT CORRESPONDING TO THE E5 0.787 MeV TRANSITION

In order to determine the conversion coefficient corresponding to the 0.787 MeV transition, the 0.963 MeV peak was gated at the single-channel analyser. The cascading electron conversion spectrum was recorded in a multichannel analyser. This is shown in fig. 6. Two pairs of K and L conversion electrons appear, one for the 0.422 MeV transition and one for the 0.787 MeV transition. The corresponding value for the conversion coefficient is quoted in table 2. The K/LM ratio is also mentioned.

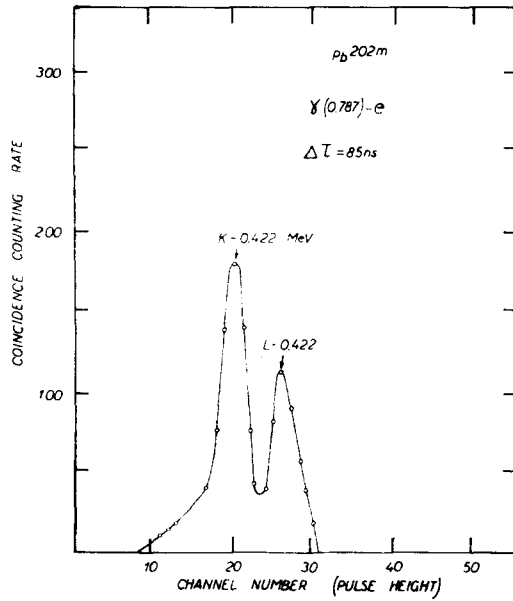


Fig. 5. Electron conversion spectrum in coincidence with the 0.787 MeV gamma ray, in the decay of  $Pb^{202m}$ .

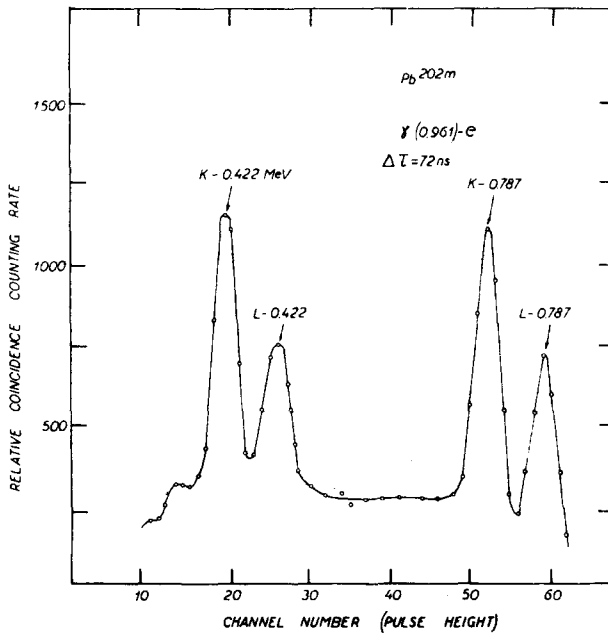


Fig. 6. Electron conversion spectrum in coincidence with the 0.963 MeV gamma ray, in the decay of  $Pb^{202m}$ .

### 3. Discussion

As table 2 shows, the conversion coefficients determined in the present work agree with the theoretical values and with previously measured values.

TABLE 2

Values for the conversion coefficients and K/LM ratios corresponding to the transitions of 0.421 and 0.787 MeV in the decay of  $\text{Pb}^{202m}$  (3.6 h)

Ref.	Transition energy (MeV)	Character	K/LM	$\alpha_K$
<sup>8)</sup>	0.421	E2	$1.9 \pm 0.1$	$0.035 \pm 0.006$
Present work			$1.9 \pm 0.1$	$0.032 \pm 0.002$
Theoretical value				0.030
<sup>8)</sup>	0.787	E5	$1.08 \pm 0.08$	$0.089 \pm 0.013$
<sup>8)</sup>			$1.18 \pm 0.10$	$0.081 \pm 0.014$
			(K/L)	
Present work			$1.13 \pm 0.11$	$0.088 \pm 0.004$
Theoretical value				0.086

For the 0.422 MeV transition there is only one previous indirect measurement of the K conversion coefficient. For the 0.787 MeV, there are two previous measurements, one of them with a high resolution magnetic beta spectrometer <sup>8)</sup>.

These results indicate the perspective offered for beta spectroscopy by semiconductor detectors, as it has been demonstrated that high resolution magnetic beta spectrometers can be replaced successfully by this new kind of counter for measuring conversion coefficients.

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