EXACT MEASUREMENT OF THE RATIOS OF INTERNAL-CONVERSION COEFFICIENTS OF 411.7-kev GAMMA QUANTA IN Hg^{198}

V. M. KEL' MAN and R. Ya. METSKHVARISHVILI

Leningrad Physico-Technical Institute

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The following internal conversion coefficient ratios have been obtained for 411.8-kev gamma rays in the shells and subshells of Hg^{198}: $K/L = 2.69 \pm 0.02$; $L_I : L_{II} : L_{III} = 1 : (1.05 \pm 0.02) : (0.45 \pm 0.01)$; $L : M : N : O = 1 : (0.252 \pm 0.0045) : (0.077 \pm 0.004) : (0.018 \pm 0.002)$. Within the accuracy of the measurements, the experimental ratios agree with the theoretical ones presented in the tables by Sliv and Band.

IT has been established by various means that the 411.8-kev gamma rays emitted by the excited nuclei Hg^{198} represent E2 electric quadrupole radiation.[1-3] A precision measurement of the conversion coefficients of these rays is therefore of particular interest to the verification of the high-accuracy theoretical calculations of the conversion coefficient now in progress.

The experimental accuracy can be increased substantially by determining not the absolute values of the conversion coefficients, but their ratios. The conversion-coefficient ratios can be measured with any beta spectrometer of sufficient resolution. If the conversion lines are fully separated, the measurement accuracy increases with the closeness of the spacing of the investigated lines, owing to the reduced values of the various necessary corrections. Since we had at our disposal a magnetic-prism beta spectrometer of high resolution (instrument line half-width 0.04% at a source width of 1 mm),[4,5] capable of separating the internal-conversion lines of the foregoing gamma rays on the L sub-shells and on the M, N, and O shells of Hg^{198}, we undertook the measurement of the ratios of the corresponding conversion coefficients. The measurement of the K/L ratio, which does not require high instrument resolution, was made with a double-focusing beta spectrometer, described by Bobykin and Novik,[6] with a resolution of 0.3%. In both cases, the source was a gold film 1.3 × 10 mm, deposited by cathode spattering on an aluminum backing and then activated with neutrons. The thickness of the gold film was 0.34 mg/cm^2. The aluminum backing was 8 μ thick. The internal conversion lines on the L subshells and M, N, and O shells, plotted with the high-resolution spectrometer, are shown in Figs. 1 and 2. The same lines and the K line obtained with a double-focusing spectrometer are shown in Fig. 3.

The measurements yielded the following ratio between the conversion coefficients:

$$K/L = 2.69 \pm 0.02;$$

$$L_I : L_{II} : L_{III} = 1 : (1.05 \pm 0.02) : (0.45 \pm 0.01);$$

$$L : M : N : O = 1 : (0.252 \pm 0.004) : (0.077 \pm 0.004) : (0.018 \pm 0.002).$$

The accuracy here represents the probable errors.

The data obtained for the K-shell and the L

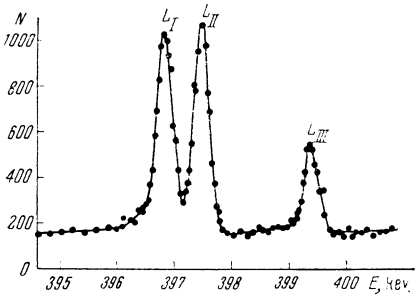

FIG. 1. Internal-conversion lines of 411.8 kev gamma quanta on the L subshells of Hg^{198}.

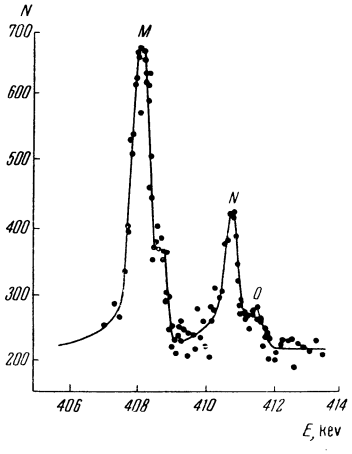

FIG. 2. Internal-conversion lines of 411.8 kev gamma quanta on the M, N, and O shells of Hg^{198}.

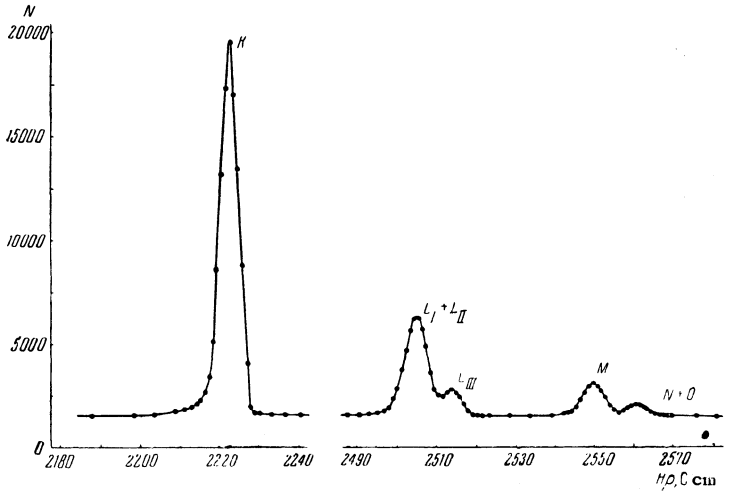

FIG. 3. Internal-conversion lines of the 411.8 kev gamma quanta on the K, L, M, N, and O shells of Hg^{198}, plotted with a double-focusing spectrometer. The only corrections are for decay.

Conversion-coefficient ratios of 4.11.8-kev gamma rays in Hg^{198}

Reference	K/L	$L_I : L_{II} : L_{III}$	L, M, N, O
[1]	2.2±0.8	—	$L/M = 1 : (0.24 \pm 0.17)$
[8]	2.2	—	$L/(M+N) = 1 : 0.25$
[9]	3	—	$L/M = 1:0.3$
[2]	3.1	—	$L/M = 1:0.3$
[3]	2.1±0.5*	(1.00 ± 0.16) : (1.16 ± 0.16) : 0.53*	
Present work	2.69±0.02	1:(1.05 ± 0.02) : (0.45 ± 0.01)	$L : M : N : O = 1 : (0.252 \pm 0.004) : (0.077 \pm 0.004) : (0.018 \pm 0.002)$
Tables[7]	2.72	1:1.09:0.46	

*In these measurements the accuracy is expressed in terms of the maximum error.

sub-shells were compared with the very detailed conversion-coefficient tables, compiled by Sliv and Band[7] with allowance for screening effects and for the finite dimensions of the atomic nucleus. Sufficiently accurate theoretical calculations of the conversion coefficients at the higher levels are still unavailable at present. An interpolation of the energy data listed in the table for Z = 80 yields K/L = 2.72 and $L_I : L_{II} : L_{III} = 1 : 1.09 : 0.46$. Thus, the theoretical and experimental data agree within the limits of experimental error.

The table has been compiled from the most accurate measurements of the conversion coefficients of 411.8-kev gamma quanta in Hg^{198}, made by various investigators. In addition, it lists the theoretical data obtained from the Sliv and Band table. One general conclusion that can be drawn from an analysis of the table is that as the experimental accuracy is increased, the measured conversion-coefficient ratios approach the theoretical ones. This is evidence of the high accuracy of the latter.

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130