INTENSITY OF NONRADIATIVE TRANSITIONS IN Ta *AND* Pu^{239} *MESIC ATOMS*

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The 2p—1s mesic x-ray transitions in Ta, Pb, and Pu^{239} have been investigated with a scintillation spectrometer. The fraction of nonradiative 2p—1s transitions in Ta and Pu^{239} has been determined by comparing the intensity of radiative transitions per μ^- meson stopped in Ta, Pu^{239}, and Pb.

THE present work is a continuation of intensity measurements of nonradiative transitions in a number of heavy elements[1] carried out by means of a scintillation γ spectrometer.

We have investigated the mesic x-ray spectra and have determined the ratio of intensities of the 2p—1s transitions in Ta and Pu^{239} relative to Pb. In the measurements with Pu the experimental geometry was somewhat changed from that used in the previous work (Fig. 1). The change was due to the large background in the γ-spectrometer counter from the natural radioactivity of Pu^{239}.

The γ-ray detector was a scintillation counter with a NaI(Tl) crystal 70 mm in diameter and 45 mm thick. The crystal was arranged so that its background rate was the same when used with equivalent targets of Pu^{239}, Pb, and Cd. The γ-spectrometer counter utilized a type FÉU-13 photomultiplier which has satisfactory stability at an average current of up to several milliamperes.

It was established by preliminary measurements that with radiation loading of the γ detector by the Pu activity the γ-ray spectrum from the 2p—1s transitions in Pb is displaced toward the hard region by 3—5% (E_γ = 6.02 MeV). This shift should not introduce appreciable error into the experimental results, since the loading of the γ counter was approximately the same in the measurements with the different targets and the γ rays have nearly the same energy. The effect of the Pu^{239} γ radiation on the monitor which recorded the number of μ-meson stoppings in the target was negligibly small and amounted to less than 1%.

The plutonium target had dimensions of 50 × 50 mm and a thickness of 5 g/cm². Nine plates of Pu^{239} were wrapped in aluminum foil of

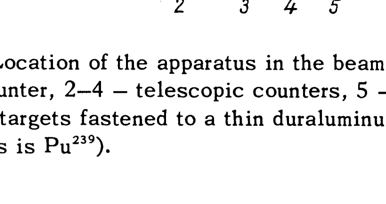

FIG. 1. Location of the apparatus in the beam: 1 – gas Cerenkov counter, 2–4 – telescopic counters, 5 – NaI(Tl) crystal, 6 – targets fastened to a thin duraluminum sheet (one of the targets is Pu^{239}).

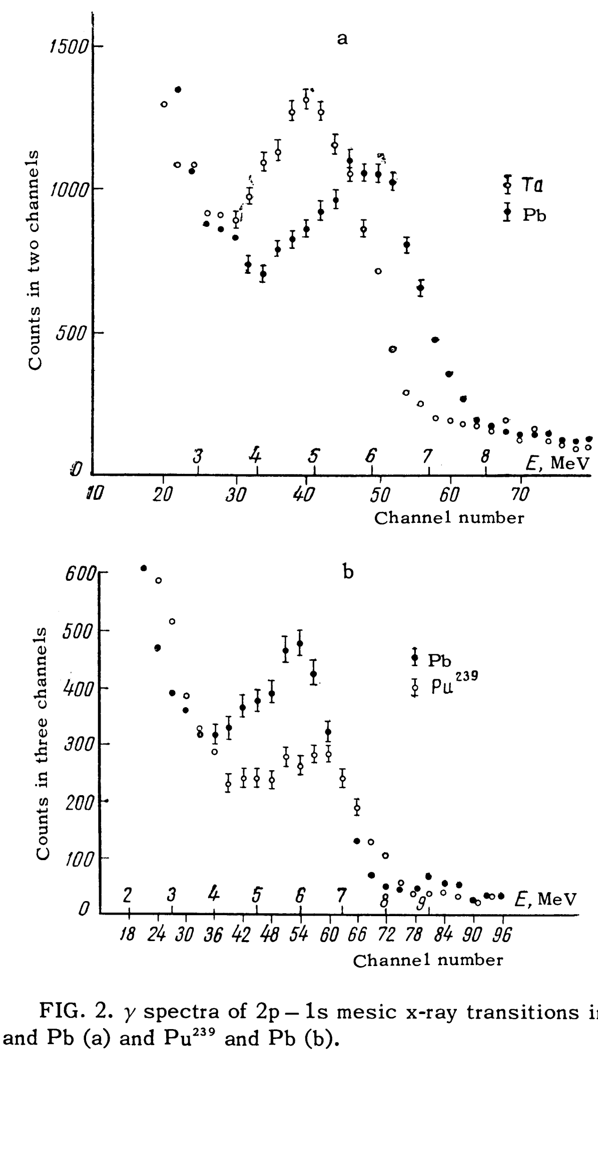

FIG. 2. γ spectra of 2p – 1s mesic x-ray transitions in Ta and Pb (a) and Pu^{239} and Pb (b).

Element	Number of radiative 2p – 1s transitions	Fraction of nonradiative 2p – 1s transitions
Pb	1	
Ta	1±0.08*	0±0.08*
Pu^{239}	0.59±0.06	0.41±0.06

*A correction has been made for the solid angle.

total thickness 1.9 g/cm². The fraction of nonradiative 2p—1s transitions was determined by comparison of the γ spectra obtained with lead and with the materials being studied. The contribution of γ rays from 3d—2p transitions in the spectral region studied was taken into account. For this purpose we used the elements Br, Mo, and Cd, in which the energies of the 2p—1s transitions are close to the corresponding 3d—2p transition energies in Ta, Pb, and Pu^{239}. In each measurement the targets were equivalent in ionization loss. In the Pu^{239} measurements all of the targets were wrapped in aluminum foil of thickness 1.9 g/cm².

Under the experimental conditions used, the center of the Ta target was 6 mm closer to the γ-ray detector than the center of the Pb target. Therefore the γ-ray yield from the 2p—1s transition in μ^--mesic atoms must be decreased by 10% in comparison with Pb. The γ spectra are shown in Fig. 2; the experimental results are listed in the table.

The results obtained are consistent with the theoretical assumptions of Zaretskiĭ and Novikov.[2]

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[1] Balats, Kondrat'ev, Landsberg, Lebedev, Obukhov, and Pontecorvo, JETP **38**, 1715 (1960); **39**, 1168 (1960). Soviet Phys. JETP **11**, 1239 (1960); **12**, 813 (1961).

[2] D. F. Zaretskiĭ and V. M. Novikov, JETP **41**, 214 (1961), Soviet Phys. JETP **14**, 157 (1962).

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