LIFETIMES OF THE 118-kev AND 139-kev LEVELS OF Tm^{169} MEASURED BY A NEW METHOD

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The lifetimes of two rotational states in Tm^{169} have been measured by a new method which is a variation on ideas suggested by Devons[1] and Gerholm.[2] With this method it is possible to measure lifetimes in the region 10^{-11}-10^{-10} sec of levels situated between two low-energy highly converted γ transitions.

Description of the method.—A thin source is placed between two long lens β-spectrometers (see Fig. 1) which are tuned to the respective energies of the conversion electrons resulting from the cascade. Immediately after leaving the source the electrons are alternatingly accelerated and decelerated in high-frequency electric fields produced in re-entrant microwave cavities placed on both sides of the source. If this energy modulation is larger than the resolution of the spectrometer, the combination of microwave resonator plus spectrometer works a periodic shutter which transmits electrons to the detector only during short time intervals when the modulating field is zero. The two cavities are fed from the same oscillator—a CW magnetron of 80 w at 2450 Mc/sec—and the time delay between the opening of the two "shutters" can be changed by introducing a phase shift between the two modulating fields. This phase shift is measured on an interferometer. The coincidence rate is recorded as a function of the phase shift. In order to be able to determine the lifetime of the level from this curve it is necessary to know the response of the instrument to prompt radiation. The "prompt curve" is obtained by repeating the same measurement (coincidence rate as function of phase shift) with a modulating field of the same amplitude but of much lower frequency. As long as the modulating period T is very large compared with the mean life τ this response is independent of T. In the actual experiment a modulation frequency of 50 cps was used. Instead of modulating the energy of the conversion electrons the currents through the spectrometer coils were modulated.

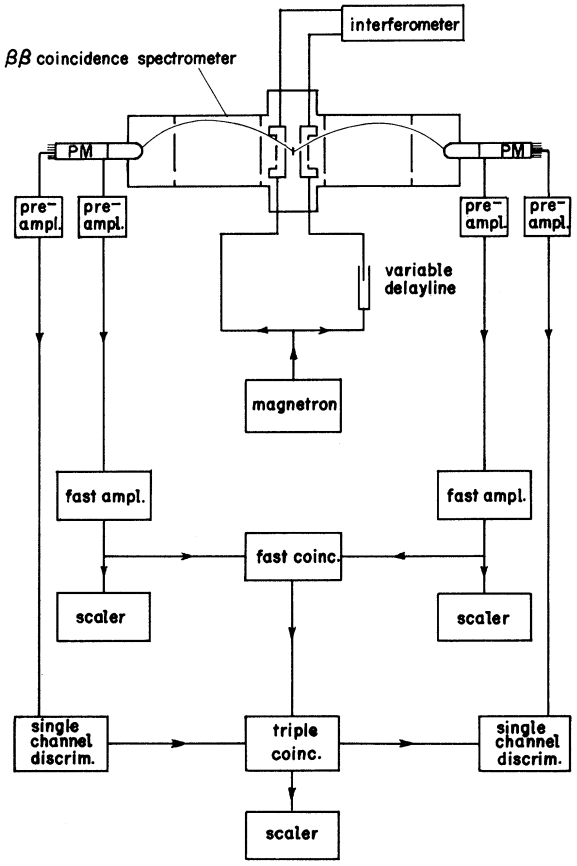

FIG. 1. Schematic diagram of the apparatus.

Measurements.—The excited levels in Tm^{169} were reached from Yb^{169}. The source was prepared by depositing Yb^{168} on an aluminium foil (150 $\mu g/cm^2$) in the mass separator of the Institute for Theoretical Physics in Copenhagen.[3] The sample was then irradiated for 3 weeks in a neutron flux of $1.5\times10^{13} n/cm^2$ sec. The sources were approximately 1 mm in diameter and 50μC strong. For measurements on the 118-kev level the spectrometers were tuned to the K-conversion lines of the 198-kev and 110-kev transitions. In the case of the 139-kev level coincidences between the 177-K and the 131-K electrons were registered. In all cases the amplitude of the modulation was about 4% of the electron energy. The ratio of true to random coincidences was better than 20:1. The spectrometers had a momentum resolution of 1% (full width at half height). The experimental points can be seen in Fig. 2. The "prompt curve" was obtained with a 50-cps modulation and the delayed curve with 2450-Mc/sec. The modulation depths were adjusted to be equal in the two measurements. By folding different lifetimes τ into the experimental prompt

curve, delayed curves can be calculated. In the case of rf modulation the absolute phase is not known and in Fig. 2 it has been chosen so as to give the best agreement between the experimental points and the calculated curves. No normalization of the ordinate is necessary because both the "prompt" and the delayed coincidences are measured for the same level and under the same experimental conditions. The values of lifetimes that give the best fit are $T_{1/2} = (6.2 \pm 1.0) \times 10^{-11}$ sec and $T_{1/2} = (2.9 \pm 0.7) \times 10^{-10}$ sec for the 118-kev and the 139-kev level, respectively. Using the branching ratios and conversion coefficients given by Hatch et al.,[4] one gets 1.2 and 1.8 for the relative reduced transition probabilities $B(E2)$ of the 118-kev and 131-kev transitions, respectively.

In earlier measurements the mean lifetime of the 97-kev level in Pt^{195} was determined to be about 2×10^{-10} sec. The experiment was made with a carrier-free sample of Au^{195} deposited by electrolysis.

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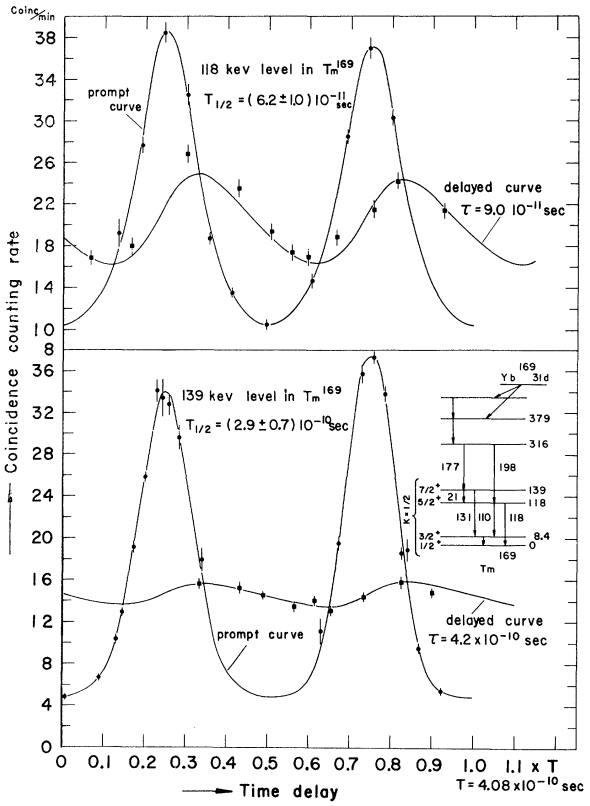

FIG. 2. Coincidence counting rate as a function of time delay (zero point arbitrary) for "prompt" and delayed coincidences.

[1]S. Devons (private communication).

[2]T. R. Gerholm, Arkiv Fysik 11, 55 (1956).

[3]We are greatly indebted to Dr. O. Skilbreit and Professor A. Bohr for their help and cooperation.

[4]E. N. Hatch et al., Phys. Rev. 104, 745 (1956).

BETA-SPECTROMETRIC STUDY OF THE ANGULAR DISTRIBUTION OF THE K-, L-, AND $M+N+\ldots$-SHELL PHOTOELECTRONS FROM URANIUM

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As an extension of previous work[1] we have investigated the longitudinal angular dependence (or Θ dependence) of the K, L, and $M+N+\ldots$ shells by a beta-spectrometric study of the photoelectrons ejected from a thin uranium converter (2.19 ± 0.02 mg U/cm^2) by the action of unpolarized gamma radiation ($h\nu = 412$, 662, and 1332 kev). The experimental arrangement is similar to that used earlier by Hultberg and Novakov[1] and a detailed description is given by Hultberg.[2] Full definitions of all symbols used here are given in reference 2.

The uranium foil of 14.6-mm diameter was placed at the ordinary source position in the double focusing β-ray spectrometer. A special construction permitted the cylindrical gamma-ray source (2×2 mm) to be rotated around the foil center, in the plane of the central electron orbit in the spectrometer. The source-converter distance was $a = 30$ mm. The angle between the direction of incidence of the gamma-rays and the direction of emission of the photoelectrons is described by the symbol Θ (see Fig. 2 in reference 2). For a specific value of the relative angle Θ, the photoline spectrum of the K, L, and $M+N+\ldots$ lines was recorded in the ordinary way. An illustration is given in Fig. 1, where K, L, and $M+N+\ldots$ photolines are shown at the energy