The "Two-Step" Isomeric Transition in Te^{121}

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IT was recently shown here that the metastable state of Te^{121} (125–143*d*) decays by a "two-step" isomeric transition, where one step corresponds to an energy of ~50 kev and the other to an energy of ~225 kev.[1] The order in which these steps take place could not be decided in the previous work. The transitions were found to follow each other within a mean time shorter than the resolving time of the coincidence circuit used (0.8×10^{-6} sec.). Using the method of "delayed coincidences" and a circuit with a smaller resolving time (0.45×10^{-6} sec.), we have been able to establish the order in which these transitions take place, as well as the half-life time of the lower excited state. A short-lived metastable state, following β-decay of Hf^{181} into Ta^{181*} (22 μsec.), was first studied by de Benedetti and McGowan[2] with the help of delayed coincidences.

Our experimental procedure, which permits the measurement of half-life times which are of the same order of magnitude as the uncertainty in the "firing time" of a Geiger counter, was the following: The 50-kev transition was detected through the Te *K* x-ray emitted when it is internally converted, and the 225-kev transition through the unconverted γ-ray. The x-rays were identified with the help of critical absorbers and the γ-rays by Pb absorbers. The pulse from either the x-ray or the γ-ray Geiger counter could be delayed by a known time interval with the help of a delay line. The resolving time of the coincidence circuit, as determined from chance coincidences, was found to be 0.45×10^{-6} sec. This is approximately one-half of the mean width of the curve obtained for the delayed coincidences when UX_2 β-rays were sent through both counters. These measurements served to calibrate the arrangement for "zero time delay" (Curve 1, Fig. 1). The curve for the $x-\gamma$ delayed coincidences (curve 2) shows a definite shift relative to the UX_2 calibration curve indicating that the 50-kev transition preceeds the 225-kev transition. The tail of the right part of curve 2 follows approximately an exponential curve corresponding to a half-life time of $(5\pm2)\times10^{-8}$ sec. for the excited state of Te^{121} of 225-kev energy.

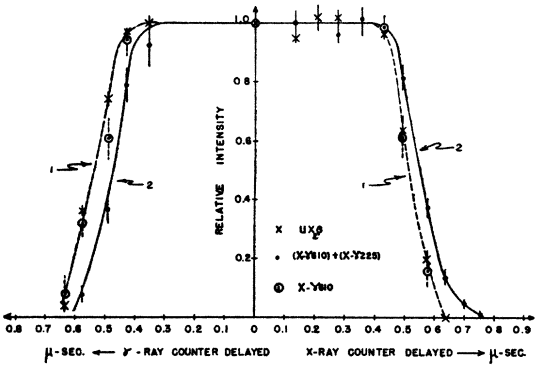

FIG. 1. Delayed coincidences.

The ground state of Te^{121} (16–17*d*) decays by *K*-electron capture to Sb^{121} which is usually left in an excited state of 610-kev energy. With the 225-kev γ-rays practically removed by a Pb absorber, $\frac{1}{16}$" thick, delayed coincidences between the 610-kev γ-rays and Sb *K* x-rays were studied. No delay between these γ-rays and the x-rays could be detected (see Fig. 1). From this we can conclude that the lifetime of the excited state of Sb^{121} is $<2\times10^{-8}$ sec.

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[1] S. B. Burson, P. T. Bittencourt, R. B. Duffield, and M. Goldhaber, Phys. Rev. **70**, 566 (1946).
[2] S. de Benedetti and F. K. McGowan, Phys. Rev. **70**, 569 (1946).

The Microwave Spectrum of Ammonia

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RECENTLY a number of excellent determinations have been made of the fine structure of the inversion band of ammonia at $\nu=0.8$ cm^{-1}. The experiments were performed independently by Bleaney and Penrose,[1] by Townes,[2] and by Good[3] and are all in substantial agreement. Approximately 30 lines were observed and these were fit by a formula containing the rotational quantum numbers J and K. The formula given by Good contains a power series up through the quartic terms but it will be sufficient for our purpose to include only the quadratic terms. Experimentally,

$$\nu/hc=0.79347-0.005048(J^2+J)+0.007040K^2.$$

The splitting of the next higher pair of ammonia levels was determined from infra-red measurements by Sheng, Barker, and Dennison.[4] For these excited levels, they found,

$$\nu/hc=35.9-0.17(J^2+J)+0.23K^2.$$

The existence of the terms in J^2+J and in K^2 were attributed by S., B., and D. to the influence of centrifugal forces which effectively produce a slight change in the potential hill separating the two minima and hence affect the splitting of the levels. A theory was developed which, for the first excited states, gave the very satisfactory result,

$$-0.162(J^2+J)+0.222K^2.$$

The splitting of the ground states was also calculated and it was found that the coefficients of J^2+J and of K^2 were so small as to be virtually unobservable in the infra-red. The wonderful dispersion now attainable in the microwave region makes the influence of these terms easily measurable. The numerical agreement between the observations and the predictions of S., B., and D. was, however, poor. We have reexamined the problems and have found that numerical errors had been made in evaluating the formulas, particularly for the ground state levels.