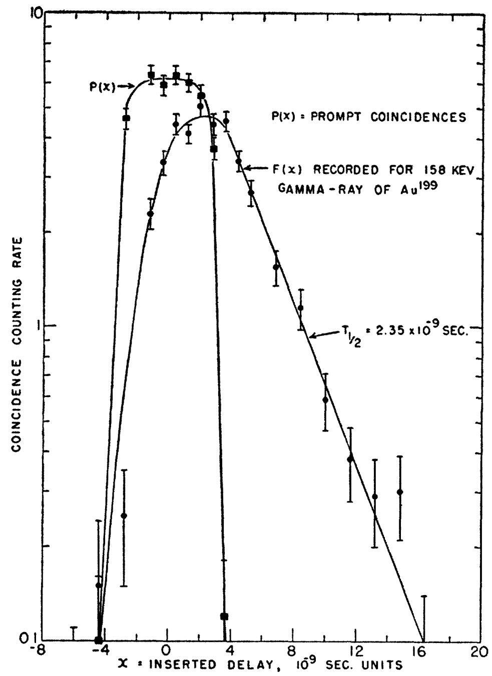

FIG. 1. Delayed resolution curve $F(x)$ showing the half-life of the 158-kev gamma-transition of Hg^{199}, with a prompt resolution curve $P(x)$ for comparison.

$\times 10^{-10}$ second. In view of the extreme shortness of this half-life, the standard deviation should be increased, and we quote for the half-life of the 80-kev excited state of Xe^{131}

$$T_{\frac{1}{2}} = (4.8 \pm 2.0) \times 10^{-10} \text{ second,}$$

consistent with the theoretical expectation for magnetic dipole radiation.[3]

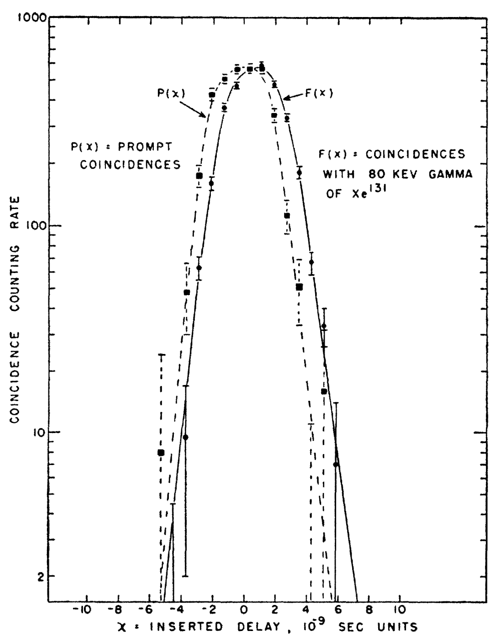

FIG. 2. Delayed resolution curve $F(x)$ for the 80-kev gamma-transition of Xe^{131}, with a prompt resolution curve $P(x)$ for comparison.

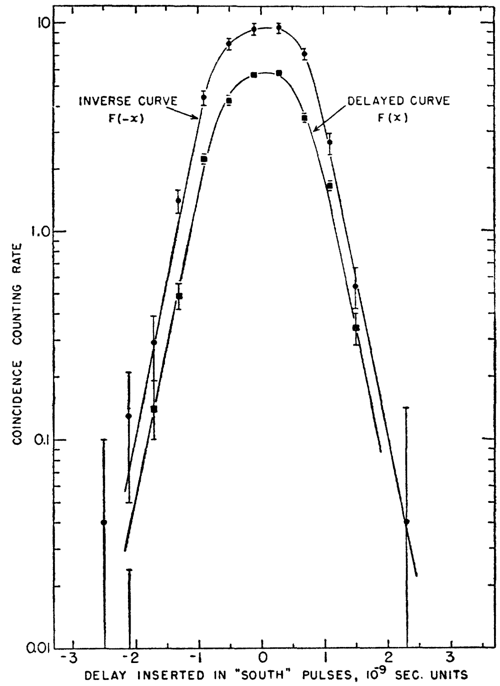

FIG. 3. Delayed resolution curve $F(x)$ and its experimental inverse $F(-x)$ for the 411-kev gamma-transition of Hg^{198}.

For the case of the 411-kev excited state of Hg^{198} the more sensitive "self-comparison" method was used, in which the delayed-coincidence resolution curve is compared with its own inverse. The delayed curve is obtained with the north spectrometer focused on the 328-kev K-conversion line of the 411-kev gamma-ray, and the south spectrometer focused on the beta-continuum just below the line. To obtain the inverse curve, the current in both spectrometers is increased by the same small amount, so that the north spectrometer is on the beta-continuum just above the line, and the south is on the line. Spurious shifts in the resolution curves are canceled by this procedure, and the true effect is doubled. The results are shown in Fig. 3, the centroid analysis yielding $T_{\frac{1}{2}} = (1.0 \pm 1.7) \times 10^{-11}$ second. This result means that the half-life of the 411-kev state is less than, say, 3×10^{-11} second; Moon,[4] however, has shown by a resonant nuclear scattering experiment that it is not much less than a few times 10^{-11} second. The combination of the two results means that the half-life is near 10^{-11} second, consistent with the theoretical expectation for electric quadrupole radiation.[3]

Similar self-comparison experiments have established upper limits of 10^{-10} second for the half-lives of the F-line of ThB and the 364-kev gamma-ray of Xe^{131}, and 2×10^{-10} second for the 207-kev gamma-ray of Hg^{199}. The apparatus and procedure of these measurements are described more fully elsewhere.[5]

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[3] V. F. Weisskopf and J. Blatt, chapter from forthcoming book, *Nuclear Theory*, privately circulated.
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Cross-Over Transition in Te^{123}

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THE disintegration scheme[1] of Te^{123} (100 days) consists of an 88.5-kev gamma-ray followed by a 159-kev line. The shell model predicts an $s_{\frac{1}{2}}$ ground state with $d_{\frac{3}{2}}$ and $h_{11/2}$ as the first

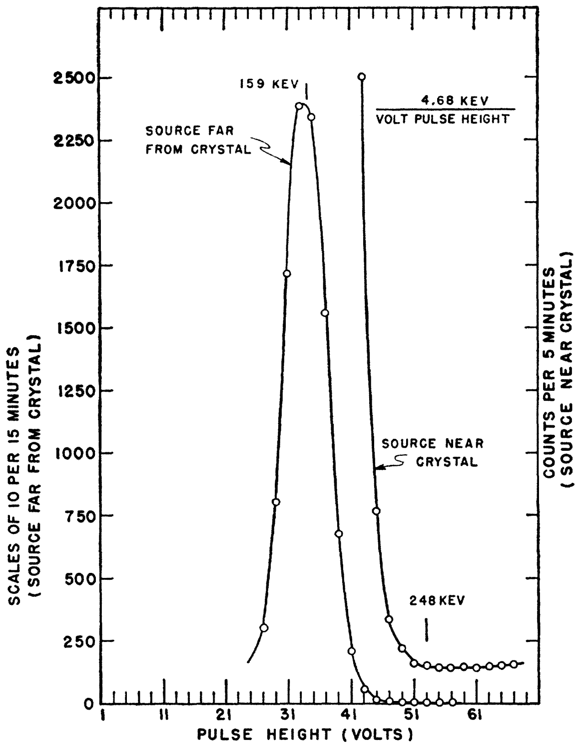

FIG. 1. Pulse-height distribution from Te^{123}.

excited states. If the order of levels is $s_{\frac{1}{2}}$, $d_{\frac{3}{2}}$, $h_{11/2}$, then the 88.5-kev line is due to an $M4$ transition and the 159-kev line is due to an $M1$ transition. The cross-over, i.e., $h_{11/2}-s_{\frac{1}{2}}$ (248 kev) is an $E5$ transition. The validity[2,3] of this level assignment has been demonstrated previously. The Weisskopf[4,5] theory predicts that the cross-over ratio, i.e., $\lambda(E5)/\lambda(M4)$ is equal to 7×10^{-2}. The present experiment was performed to check this value.

A sample of highly enriched Te^{122} was irradiated in the Argonne heavy water-moderated reactor. The gamma-rays emitted were then examined with a NaI crystal and photomultiplier. The pulses were analyzed with a 20-channel pulse-height discriminator. The source was first placed so that the counting rate at 159 kev could be determined accurately. The source was then moved as close to the crystal as possible so that the discriminator still gave reliable results and the counting rate at the cross-over energy was as high as possible. The results were then normalized.

The pulse-height distributions corrected for background are shown in Fig. 1. The normalization factor is 7.7. It may be seen that there is no evidence of a peak at 248 kev. The counting rates at 51, 53, and 55 volts are nearly the same. The difference in rate between 53 and 51 or 55 volts is 0 ± 3 scales of ten. However, it is possible to set a very conservative upper limit on the value of the cross-over ratio from the observed data.

If the experimental counting rate at 53 volts were 3 standard deviations above its observed value, then one would say that the cross-over had been observed. If one uses this value for the counting rate at the cross-over energy, then a very high upper limit is found for the cross-over. The experimental intensity ratio has to be corrected for absorption in the NaI, in the source and in the aluminum cap which surrounds the crystal. In addition, the intensities must be corrected for internal conversion. The tables[6] of Rose, *et al.* were used to find α_K and the theoretical K/L ratios[2] were used to find α_L. The total α was assumed to be $\alpha_K+\alpha_L$.

The result of the above analysis is that the cross-over ratio has a very conservative upper limit of 0.5 percent.

One possible reason for a value that is well below the 7 percent predicted by Weisskopf is that the theory is based on a single proton model. In the case of Te^{123}, an odd N nucleus, the theory may not be very good because of the lack of electric charge. Other examples[3] of this disagreement for odd N nuclei are found in the lifetimes of the $E3$ transitions. In addition, there may be effects due to cancellation of wave functions in the matrix element which could also give a smaller ratio.

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[6] Rose, Goertzel, and Perry, Oak Ridge National Laboratory Report No. 1023 (1951).

Two-Step Isomeric Transition in Ba^{133m} (39 hr)

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IN the 5th neutron shell, it has been observed that the isomers of low neutron number decay in two steps, namely, from an $h_{11/2}$ state to a $d_{\frac{3}{2}}$ state and from there to an $s_{\frac{1}{2}}$ ground state. If the energy differences of the $d_{\frac{3}{2}}$ levels from the $h_{11/2}$ levels are plotted as a function of neutron number, the curves for constant Z break between Te^{125}, Te^{127}, and also between Xe^{129} and Xe^{131}.[1] These breaks appear to be associated with the "rise" of the $s_{\frac{1}{2}}$ levels above the $d_{\frac{3}{2}}$ levels. A similar though small break has been observed between Ba^{133} and Ba^{135}.[2] This suggests that Ba^{133} might possess an $s_{\frac{1}{2}}$ ground state.

Other considerations lead to the same hypothesis: The ground state of Ba^{133} is known to decay to Cs^{133} by K-capture with a long half-life, $\sim$10 years.[3] The ground state of Cs^{133}, from spin measurement and nuclear shell theory, is $g_{7/2}$. Cs^{133} also has an 81-kev excited state which, from the beta-decay of 5.7-day Xe^{133} and from the conversion coefficient of the 81-kev γ-ray, can be characterized as $d_{\frac{5}{2}}$. If the ground state of Ba^{133}, therefore, were $d_{\frac{3}{2}}$, it would decay to the 81-kev excited state of Cs^{133} by an allowed transition which, it can be estimated, would have a half-life $\lesssim$10 days. It is therefore likely that the long-life of the Ba^{133} ground state is associated with an $s_{\frac{1}{2}}$ character of this state.

We therefore searched for a low energy $d_{\frac{3}{2}}\rightarrow s_{\frac{1}{2}}$ transition in Ba^{133m} following the 275.5-kev $h_{11/2}\rightarrow d_{\frac{3}{2}}$ transition. Such a low energy transition might have been overlooked in previous investigations. A source of 39-hr Ba^{133} was obtained by separating barium from $CsNO_3$ which had been bombarded by 15-Mev deuterons. The essentially carrier-free Ba source was placed outside the Be window of an argon-filled proportional counter and the counting rate was measured as a function of the bias voltage of a single channel pulse-height analyzer. A typical curve is shown in Fig. 1. Apart from the strong Ba K x-ray peak, arising from the conversion of the 275.5-kev γ-ray, the figure shows a peak due to a

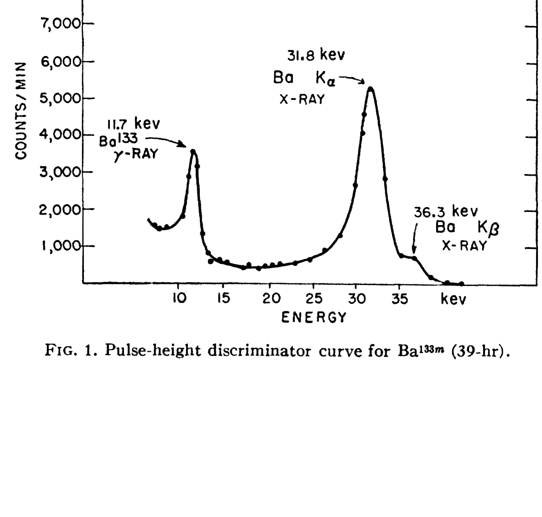

FIG. 1. Pulse-height discriminator curve for Ba^{133m} (39-hr).