Low-intensity transition in the decay of ^{175}Hf

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A study of the decay of ^{175}Hf has confirmed the presence of a weak transition in ^{175}Lu. A γ ray was found with an energy of 353.3±0.2 keV and an intensity (relative to 100 for the 343 keV γ ray) of 0.21±0.02.

[RADIOACTIVITY ^{175}Hf [from ^{174}Hf(n,γ)]; measured E_γ, I_γ. Natural target, Ge(Li) detector.]

The γ-ray spectrum of ^{175}Hf, which decays by electron capture to excited states in ^{175}Lu, has been measured most recently by Johansen *et al.*[1] Their results are in general agreement with previous work[2-5] with the exception of one transition at 353 keV which has not been found in any other measurements of the hafnium spectrum. We report here the results of a new study of this spectrum in which the presence of the 353 keV γ ray is confirmed.

A high purity sample of HfO_2 was exposed to thermal neutrons in the Pennsylvania State University nuclear reactor in May, 1972. The activity induced in the sample was allowed to decay for 573 days before any spectroscopy was carried out. This waiting time served the triple function of (1) enhancing by a factor of 40 the activity due to the 70-day ^{175}Hf compared with that of the much more abundant 42-day ^{181}Hf, (2) eliminating any contribution to the spectrum from other isotopes and isomers of hafnium, and (3) eliminating any contribution from most of the contaminants present in the original source.

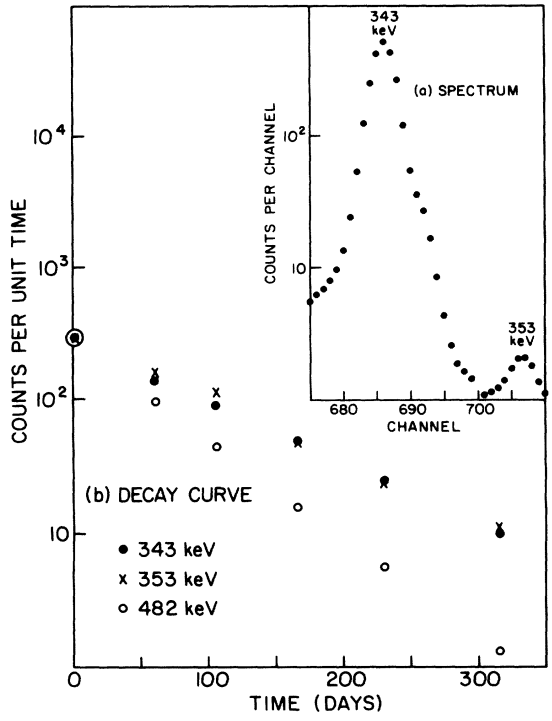

FIG. 1. (a) Spectrum of ^{175}Hf γ rays in the vicinity of 353 keV. (b) Decay curves of γ rays from ^{175}Hf and ^{181}Hf. All counts are shown on an arbitrary scale.

To measure the γ spectrum the source powder was wrapped in aluminum foil, sealed in polyethylene, and mounted in a polystyrene source holder in front of the detector. The detector was a 40 cm^3 Ge(Li) spectrometer with a resolution of 3 keV for the 1333 keV γ ray of ^{60}Co. Six spectra were recorded over a period of 315 days. During this time the intensity of γ rays from ^{175}Hf decays by a factor of 22.6 while the intensity of γ rays from ^{181}Hf decays by a factor of 172. It was easily possible from this to identify the γ rays from each of the two hafnium isotopes as well as those from contaminants in the source. In order to maintain a convenient counting rate, the source-detector distance was gradually reduced as the source decayed, thereby increasing the efficiency of the detection system by a measurable factor.

The results of these measurements clearly reveal the presence of a 353 keV γ ray in ^{175}Hf. The spectrum in this energy region is shown in Fig. 1(a), where the 353 keV γ ray is seen just above the well-established (and most intense) ^{175}Hf γ ray at 343 keV. The decay curves of each of these γ rays are shown in Fig. 1(b) together with the decay curve of the 482 keV γ ray from the shorter-lived ^{181}Hf.

The energy of the weak ^{175}Hf γ ray is found to be 353.3±0.2 keV and its intensity (relative to 100 for the 343 keV γ ray) is found to be 0.21±0.02. Both of these values are in excellent agreement with the results of Johansen *et al.*[1] This γ ray presumably represents, as proposed by Johansen *et al.*,

a transition to the ground state from the $[541]\frac{1}{2}^-$ isomer in ^{175}Lu which has been found at 353.6 keV in recent studies of the ^{176}Yb$(p, 2n)$ reaction.[6,7]

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