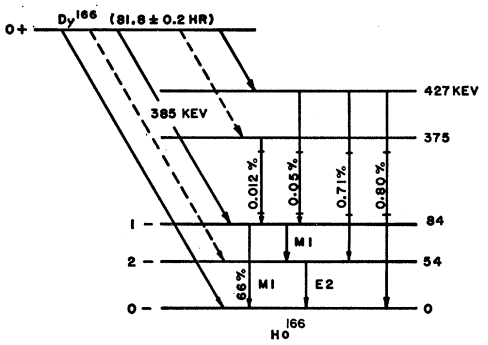

FIG. 7. Proposed decay scheme of Dy^{166}. Percentages are absolute gamma-ray intensities except for the 84 kev transition which includes conversion intensities.

radiations of the following energies: 50, 84, 373, and 427 kev. When scintillation studies were made to find radiations coincident with the 84-kev gamma ray, two additional low intensity radiations of 291 and 343 kev were found to be present. No other γ-γ coincidences were observed although the 373-kev transition is presumably coincident with the 54-kev level transition which was observed in permanent magnet spectrographic studies. The coincidence could not be observed, due to the high electron conversion probability of this low-energy state.

The beta spectrum coincident with the 84-kev radiation was studied using the previously described hollow plastic scintillator. The maximum beta energy leading to this state, was found to be 385±10 kev. The total energy therefore between the Dy^{166} and Ho^{166} ground states is 469±15 kev.

Permanent-magnet studies revealed the presence of two highly converted transitions which could not be seen in the gamma spectrum. Their approximate energies are 30 and 54 kev. The converted 84-kev transition was also present. Relative intensities of the L_1, L_2, and L_3 conversion lines, indicated the following multipolarity changes predominate in these transitions: 30 kev—$M1$, 54 kev—$E2$, and 84 kev—$M1$.

A decay scheme consistent with the data is given in Fig. 7. Except for minor transition intensity differences, the decay scheme is in substantial agreement with that which has recently been reported elsewhere.[5,6]

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New Isotope Indium-106†

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A new isotope, In^{106}, has been produced by proton bombardment of cadmium. Mass and atomic number assignment have been made on the basis of the excitation function and chemical separations, and by using a target enriched in Cd^{106}. Two positron energy end points of this 5.3-min activity have been measured at 4.85 and 3.1 Mev. Gamma rays at 1.65 and 1.85 Mev have been resolved from a complex high-energy spectrum.

IN cadmium targets irradiated with protons from the UCLA cyclotron, a 5.3-min activity emitting high-energy gamma rays has been observed. This activity has been assigned to In^{106} on the basis of the following evidence.

Measurements were made with a $1\frac{1}{2}$- ×2-in. NaI(Tl) scintillation detector coupled to an integral discriminator followed by a scalar. The discriminator was set to accept only pulses corresponding to gamma-ray energies greater than 1.8 Mev. Using this method, two easily separable half-lives were present in the decay of the cadmium target, one of 5.3 min and another of about one hour.

A cadmium foil 6 mg/cm² thick with Cd^{106} enriched from its natural abundance of 1.21 to 77.9% was obtained from Isotopes Division of Oak Ridge National Laboratory. A portion of this enriched foil was superimposed on a natural cadmium foil 10 mg/cm² thick of the same area and bombarded with 14-Mev protons. The yields of the 5.3-min activity from the foils, corrected to the same foil thickness, was found, within experimental error, to be in the same ratio as the isotopic abundance of Cd^{106}. This proved that the target isotope responsible for the activity was Cd^{106}.

A chemical separation of the target into indium, cadmium, and silver fractions showed the 5.3-min activity to be from an isotope of indium.

Measurements on the yield of gamma rays above 1.8 Mev as a function of proton energy indicated the 5.3-min activity to be the result of a p,n reaction and placed an upper limit on its threshold of 8 Mev. With the above information this activity can definitely be assigned to

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In^{106}. Further evidence for the high threshold of the $Cd^{106}(p,n)In^{106}$ reaction is given by recent calculations from a semiempirical atomic mass law.[1] These calculations place this threshold at 6.9 Mev.

A 3- ×3-in. NaI(Tl) crystal having a resolution of 8% for the Cs^{137} gamma ray (0.66 Mev) and a 256-channel pulse height analyzer were used to investigate the gamma-ray spectrum from the decay of the enriched target. The resulting plot of the spectrum proved to be complex, but two gamma rays with the half-life of In^{106} were apparent at 1.65 and 1.85 Mev. There was some evidence for gamma rays at 2.2, 2.7, and 3.2 Mev; the spectrum shape was inconsistent with these, being a 3.2-Mev gamma ray and its escape peaks. The spectrum above 2 Mev is difficult to resolve and seems to indicate that a number of high-energy gamma rays closely spaced in energy are involved in the decay of In^{106}. The high-energy spectrum was quite free from gamma rays of competing activities. Measurements with the $1\frac{1}{2}$- ×2-in. scintillation detector showed that during the first 10 min after bombardment more than 98% of the activity above 1.8 Mev in the enriched target was from In^{106}. This fact was verified by following the decay of the spectrum with the large crystal and pulse height analyzer. Since a 0.63-Mev energy level is known to exist in Cd^{106}, one would expect a gamma ray of this energy to occur in the In^{106} decay. The spectrum below 1.4 Mev contains contributions from gamma rays of other activities present in the target. These gamma rays tend to obscure any low-energy gamma rays from In^{106}.

A beta-gamma coincidence experiment is now being undertaken to aid in the resolution of the In^{106} gamma-ray spectrum.

The positron spectrum emitted by this isotope has been investigated using a magnetic lens spectrometer. The resulting Kurie plot, which is shown in Fig. 1, indicates a resolution into at least three components with endpoints at 4.85, 3.1, and possibly 2.3 Mev. Additional evidence for the endpoint at 3.1 Mev is given by the presence of the 1.65 and 1.85 Mev gamma rays, either of which may correspond to the energy difference between this endpoint and the one at 4.85. The endpoint of the third component, indicated by the dashed line in Fig. 1, is uncertain due to the accumulation of errors from subtraction of the other two components. The fact that the low-energy points lie above the extrapolation of the third component may be due to either the presence of a fourth component or distortion of the spectrum due to source thickness.[2] A beta-gamma coincidence experiment[3] within the spectrometer may be necessary to resolve the uncertainties in this situation. The positron spectrum below 0.4 Mev and the probability of K-electron capture have not yet been investigated.

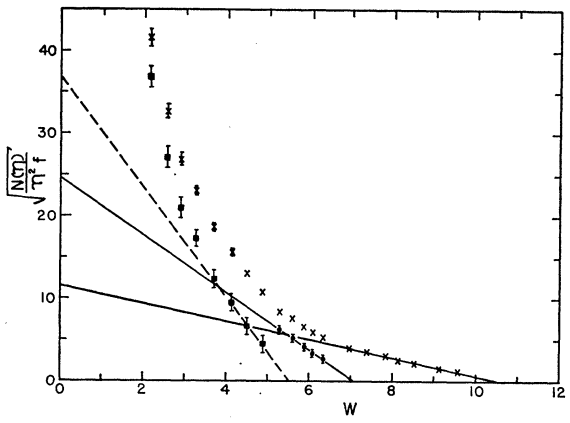

FIG. 1. The Kurie plot for the positron spectrum of In^{106}. Experimental data are indicated by ×, the second component by ●, and the remainder after subtraction of the first two components by ■.

The authors wish to thank Dr. Willard F. Libby for helpful advice on the chemical separations.

[1] P. A. Seeger, Nuclear Phys. **25**, 1 (1960).

[2] A. C. G. Mitchell in *Beta- and Gamma-Ray Spectroscopy*, edited by Kai Siegbahn (North-Holland Publishing Company, Amsterdam, 1955), pp. 241 ff.

[3] See reference 2, pp. 221 ff.