Radiations from the Decay of Ag^{102} *

by
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Abstract

The existence of a 15-min activity ascribed to Ag^{102} has been reported by Ames *et al*[1]. We have investigated the beta and gamma radiations emitted from an isotopically enriched (51%) target of Pd^{102} bombarded by 16-Mev protons in the UCLA spiral-ridge cyclotron. Our measurements in a magnetic lens spectrometer indicate that Ag^{102} decays by positron emission with a half-life of 13 ± 0.4 min and with an end-point energy of 2.20 ± 0.08 Mev. The following gamma rays were found to decay with the same half-life: 0.51 Mev (100) (annihilation radiation), 0.55 Mev (70), 0.72 Mev (26), 0.84 Mev (4), 1.26 Mev (8), 1.57 Mev (7), 1.77 Mev (7), 2.07 Mev (weak), 2.79 Mev (weak), and 3.33 Mev (weak). The numbers in the parentheses following the gamma energies indicate the relative intensities, taking the annihilation-radiation intensity as 100. Gamma-gamma coincidence experiments indicate coincidences among the 0.55-, 0.72-, and 0.84-Mev gamma rays and between the 0.72- and 1.26-Mev gamma rays. Further studies on the gamma-gamma and beta-gamma coincidences are in progress.

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1 Ames *et al*, Phys. Rev., 118, 1599 (1961).

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The neutron deficient silver isotopes with mass numbers 102, 103, and 104 have been studied since the early work of Enns (P.R., 56, 872(1939)) by bombarding the natural Pd foil with protons. Ames et al observed a strong 15 ± 2 minute activity following the bombardment of Pd^{102} isotopically enriched to 35 % with the 18.5-Mev protons and thus provided the first direct experimental evidence for the existence of Ag^{102}.

In our experiments, we use the Pd foil of 12 mg/cm^2 thick in the enriched form of Pd^{102} with the percentage of abundance as follows:

Isotope Pd	
102	50.9
104	20.7
105	13.2
106	8.4
108	4.8
110	2.0

In all measurements, the target was bombarded with 16-Mev protons for the period of 10 minutes in order to maximize the production of the (p,n) reaction of Pd^{102} and to minimize the competing background activities.

The positron spectrum emitted from the decay of Ag^{102} was investigated using a magnetic lens spectrometer of 1.6 % resolution. Measurements ranging in energy from 0.43 to 2.50 Mev were made. Half-life analysis was followed in all measurements in order to separate out the long lived competing activities. Since many bombardments were needed, all data had to be normalized to the same source strenth. Our measurements indicate the half-life of Ag^{102} to be 13 ± 0.4 minutes compared to 15 ± 2 minutes as reported by Ames <u>et</u> <u>al</u>. The Kurie plot of the beta spectrum indicates a positron group of allowed shape with the end point energy at 2.20 ± 0.08 Mev (Figure I). Deviation from the straight line in the region with energy below 1 Mev may be due to finite source thickness, but it may indicate the existence of another positron group with the maximum end-point energy at about 1 Mev. This would be in agreement with the existence of the 1.26 Mev gamma ray and will be checked by performing a beta-gamma coincidence experiment. Due to the fact that the gamma ray spectrum is complex (which will be described later), one would expect the beta transition of more than one group.

The gamma ray spectrum was examined by using a 3×3 in NaI(Tl) scintillation counter of 8 % resolution for the 0.66 Mev gamma ray of Cs^{137} and a 400 channel pulse height analyzer. The source, after bombardment, was placed in an axial direction at 1 to 2 feet away from the counter. The analyzor was calibrated with the gamma rays from the decay of Na^{22}(0.51, and 1.28 Mev) and Cl^{34}(1.1, 2.1, and 3.2 Mev). The gamma ray spectrum was followed from two to five hours, and nine gamma rays besides the annihilation radiation was observed to decay with the same half-life (that is with the half-life of about 13 minutes). Figure II shows the gamma ray spectrum of Ag^{102} in the log scale. The numbers in parentheses following the gamma ray energies indicate the relative intensities, taking the intensity of the annihilation radiation as 100. The resolution of the scintillation counter is not high enough to clearly separate the 0.55 Mev gamma ray from the annihilation radiation. The existence of gamma rays with the highest energy at 3.33 Mev is in agreement with the calculations using the result of the empirical mass formula which gives the energy available for the electron capture from the ground state of Ag^{102} as 6.3 Mev.

Gamma-gamma coincidence experiment was performed using two 3 X 3 in NaI(Tl) scintillation counters with the source holder at the pivot point of azimuthal counters. The electronics of the coincidence system was such that a single channel discriminator could be set on any gamma ray peak and the spectrum of gamma rays in coincidence with this peak could be recorded in the multichannel pulse height analyzer. The true coincidence spectrum was stored in the first half of the analyzer memory, and the chance coincidence spectrum in the second half of the analyzer memory. Subtraction of the second half of analyzer memory from the first half gives the net coincidence spectrum. Data were accumulated from many bombardments at each discriminator setting on the gamma ray. Figure III shows the gamma coincidence spectrum. From this figure, we notice that 0.55, 0.72, and 0.84 Mev gamma rays are in coincidence and that 0.72 and 1.26 Mev gamma rays are also in coincidence. The 0.55, 0.72, and 0.84 Mev gamma rays probably represent a cascade from an excited state at 2.11 Mev to the ground state and the 2.07 Mev gamma ray may correspond to the crossover transition. Coincidence between the 0.72 and the 0.84 Mev gamma rays was expected by the existence of the 1.57 Mev gamma ray which presumably represents another crossover transition.

Further studies are under way in an attempt to determine the level scheme of the daughter nucleus Pd^{102} following the decay of Ag^{102}.

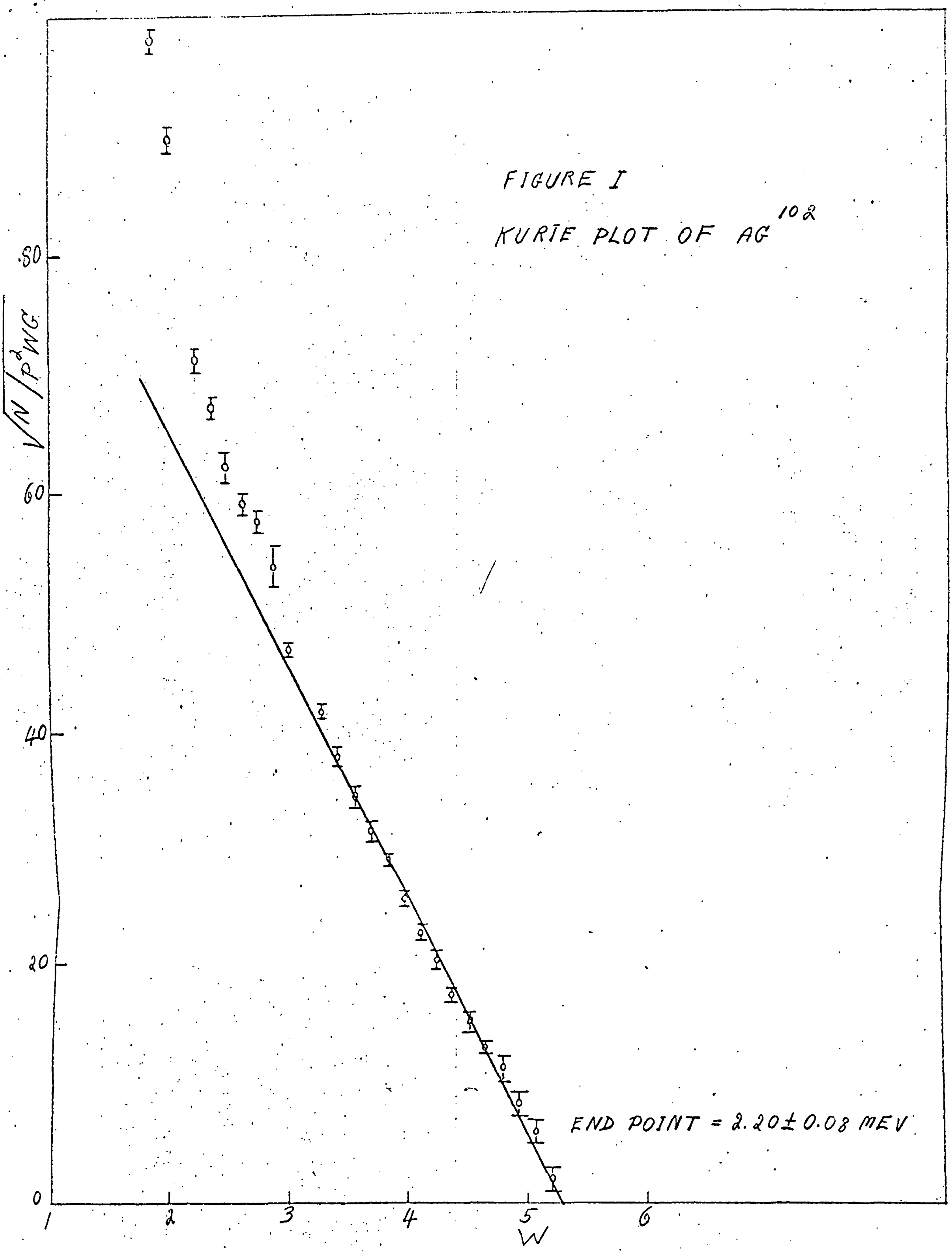

FIGURE I
KURIE PLOT OF AG 102
END POINT = 2.20 ± 0.08 MEV
√N/P²WG
W
80
60
40
20
0
1
2
3
4
5
6

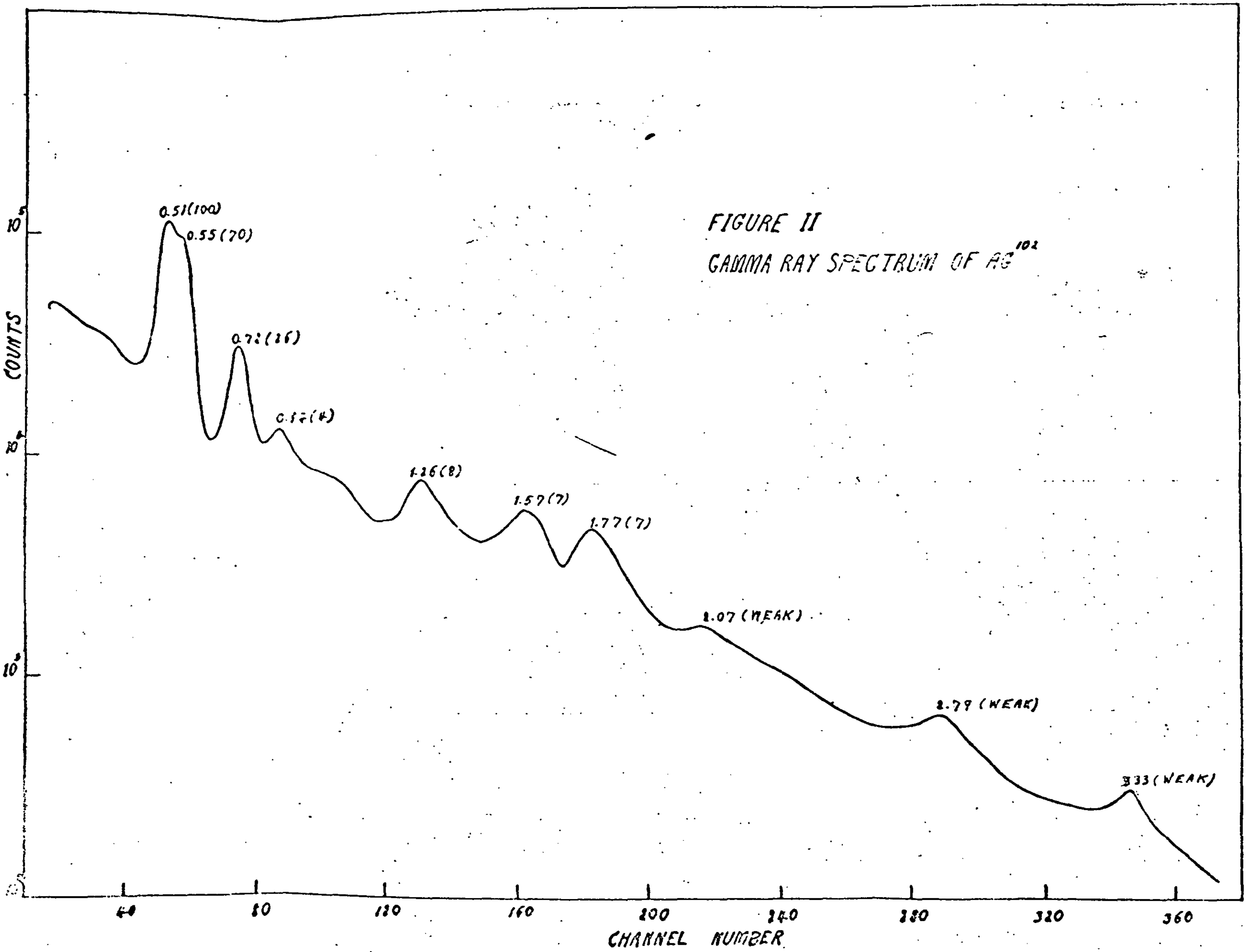

FIGURE II
GAMMA RAY SPECTRUM OF AG^{102}

FIGURE III GAMMA RAY COINCIDENCE SPECTRUM