NUCLEAR EXCITATION OF Ag^{107} BY X-RAYS

利用X-射線對銀原子核的激勵

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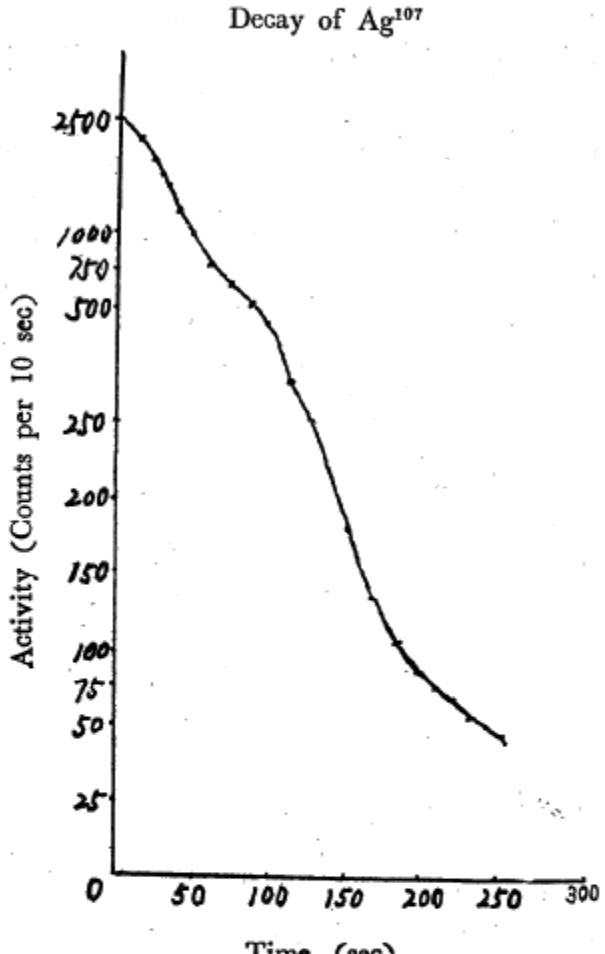
謝 振 權

I. Introduction

The X-ray excitation of the isomeric state of silver was first abserved by Collins and Feldmeier. Further work showed that, similar to indium, one could obtain, from an X-ray excitation curve, two activation levels, at 0.85 Mav and 1.25 Mev. wiedenbeck repeated these experiments and was able to analyze the resulting X-ray excitation curve into evidence for some six activation levels at 1.18, 1.59, 1.95, 2.32, 2.76, and 3.13 Mav. All of there experiements used ordinary silver 107.

The original investigation of Alvarez, Helmholz, and Nelson of the University of California established the metastable state in silver by a study of the decay of cadmium but did not identify the isotope. Helmholz showed that in order to account for the presence of two internally converted gamma-rays, it was necessary to postulate that isotopes of silver had metastable states of approximately 40 sec htlf-life, Bradt, etal., measured the half-life and associated disintegrations schemes and silver, not knowing the isotopic assignment until Helmholz identified the parent cadmium isotopic, the 94-kev gamma-ray of half-life 44.3 sec was assigned to Ag^{107}.

With the availability of the separated isotopic of silver, it became desirable to determine directly the half-life and to obtain the X-ray exictation curve.



(Fig. 1.)

II. Experimental Procedure

(*A*) *Irradiation*

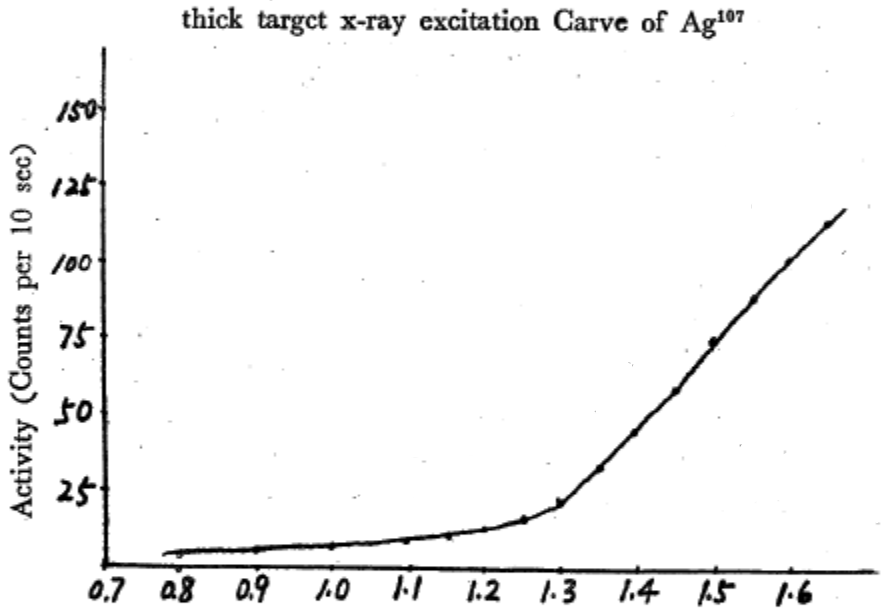
The separated isotopic of silver were obtained as chloride, and metallic foils were prepared by electroplating on platinum disks 7/8″ in diameter. The isotopic proportions and the foil thicknesses were as follows. These thicknesses were greater than the range of the conversion electrons to be detected.

The X-rays were produced with the electrostatic generator by stopping a well-collimated beam of monoergic electrons in a thick (1/16″) gold target, as in previous experiments, the current was monitored by a Brown recording potentio-

meter, and the voltage was measured and stabilized by a null-type generating voltmeter and associated control circuits. The voltage calibration was based on the photo-disintegration thresholds of beryllium and deuterium as measured by Mobley and Lanbenstein.

(*B*) *Counting*

The activities encountered in this experiment were low owing to the following facts.



(Fig. 2.)

(1) Small cross section. This necessitated large electron beam currents (250μ amp average).

(2) Short half-life. This required a minimum delay between the end of the irradiation and the beginning of the counting. This delay was reduced to considerably less than one half-life.

(3) Law energy conversion electrons. Since the absorption of thin (1.5 mg/cm^2) windows in traceable and similar counters was found to be prohibitive, it was necessary to place the irradiated foil within the counter itself. Silver-cathods, argon-ether filled counters, after irradiation by the intense X-ray beam,

had a high counting rate due to increased photosensitivity. The counting rate could be reduced by hight shielding. Nevertheless, light-tight counters thus irradiated showed a spurious activity which persisted after the silver activity had decayed. Evacuated silver-cathode counters were irradiated and filled, immediately after irradiation, with a non-irradiated gas mixture, these, too, exhibited a small activity having a half-life greater than 10 times that of the metastable silver. A 0.1 mg/cm^2 coating of zapon lacquer on the silver reduced, but did not obliterate, this spurious activity. Finally, a nuclear Instrument Corporation "Q-gass" flow counter was used. This was modified so that the sample holder was flushed with Q-gass before the sample was introduced into the counting volume. This reduced the waiting period for reliable counting from about 200 to about 10 sec. The total delay time between the end of the irradiation and the beginning of the counting was kept constant at 25 sec. The use of the flow counter confirmed the belief that many surfaces emit low energy "delayed" electrons for periods verying from 30 sec to several minutes. The "delayed" electrons and the increased photosensitivity have been observed by other workers under different circumstances. Of the substances examined for these "delayed" electrons, zapon lacquer is an emitter, whereas collodion and Lucite are practicably nonemitters. Consequently the silver foils were mounted on Lucite diskes, for handling purposes, and were coated with 0.2 mg/cm^2 collodion films.

III. Results

(*A*) *Half-lives*

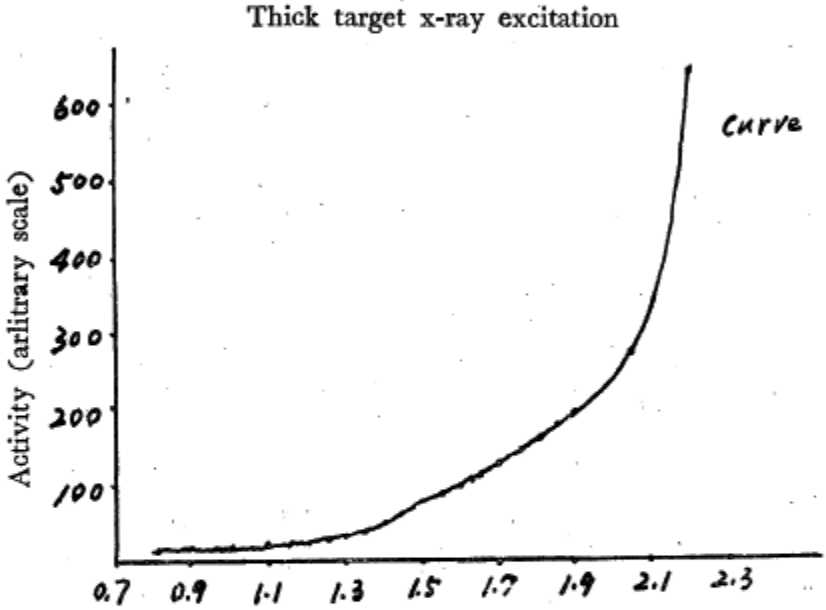
Irradiations were made at 2.6 Mev with a 200 μ Amp beam current, and initial activities of about 100 counts/sec resulted. Data were obtained by photographing the scaler and clock every five seconds over a period of about 250 sec. Statistical errors were reduced by adding corresponding points from separate decay curves. The decay curves for Ag^{107} shown in Fig. 1. The half-life of Ag^{107} is 44.0 ± 1.0 sec, measured half-lives of 44.3 ± 0.2 sec, and Helmholz assigned these to Ag^{107}. The direct measurements obtained in this experiment verify this assignment.

(*B*) *Excitation Curves*

The thick target X-ray excitation curve is obtained by platting the norma-

lized activity as a function of the electron bean energy. Since the activity has a short half-life, the varying target current was weighted exponentially from the end of the irradiation period. Thus, all activities were normalized to infinite irradiation with constant current.

For each isotope, several irradiations were made at each voltage, and the activities were averaged to reduce the statistical error.



(Fig. 3.)

Figure 2 show the lower energy portion of the excitation curve for Ag^{107}, the threshold in thecase is below 800 Kev, although the data do not permit accuret location, the breaks in the curve indicate an activation level in Ag^{107} at 1.285 ± 0.018 Mev. Figure 3 show excitation curve over the entire energy range investigated and emphasizes the 75 Kev difference between the corresponding level in the nuclei, in considering the close similarity between the nuclei in other respects, it is to be expected that such a small difference between the energy levels exists, the approximate over-all crose section at 1.4 Mev is of the order of $10^{-34}cm^2$ for isotope. In Fig. 2 and 3, to convert activity to over-all cross section, multiply the ordinates by $4 \times 10^{-36}cm^2$.

These excitation curves agree with the early work of Feldmeier in this labora-

tory but are contrary to that of Widenbeck. This experiment is further confirmation that, as had been previously discussed, one cannot obtain more than a few energy levels by X-ray excitation.

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