Identification of Platinum-188†

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An unstable even-even neutron-deficient platinum isotope with a half-life of 10.3±0.4 days has been prepared and assigned a mass number 188. The decay of this isotope results in unstable iridium 188, which in turn decays to a known excited state in stable osmium 188.

INTRODUCTION

THE lightest platinum ($Z=78$) isotope previously reported is stable platinum-190, occurring in nature to the extent of 0.012 percent.[1] In an attempt to prepare and identify lighter platinum radioisotopes, bombardments of metallic iridium foil with 50-Mev protons have been carried out in the Nevis and Harvard University synchrocyclotrons. The iridium foil was stated by the manufacturer[2] to be 99.8+ percent pure, and spectroscopic analysis[3] revealed only the presence of platinum to the extent of 0.1 percent as a heavy element impurity.

SEPARATION PROCEDURES

After bombardment a platinum fraction was chemically isolated by solvent extraction of the platinum as a platinum-tin complex into ethyl acetate from 6*N* hydrochloric acid, the iridium target having been previously dissolved in a fused mixture of KOH and KNO_3.[4] An iridium fraction could be prepared free from radioplatinum by repeated extraction of added inert platinum carrier solution. The method was checked by achieving a satisfactory separation of 3-day Pt^{191} and 4-day Pt^{193m} from 75-day Ir^{192} and 19-hour Ir^{194} formed by 22-Mev deuteron bombardment of natural iridium.

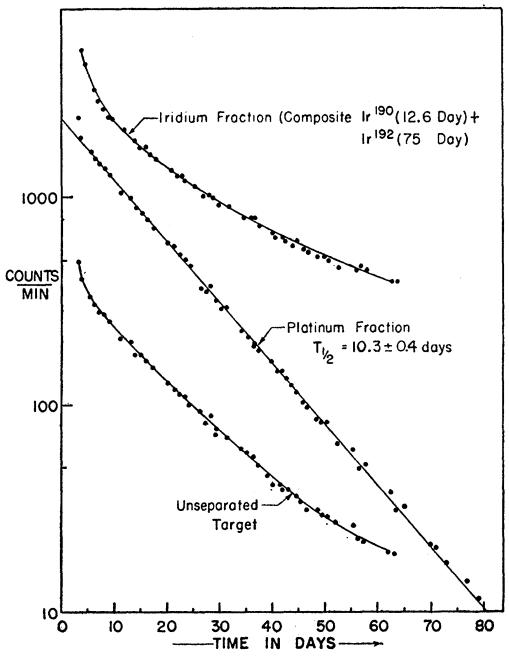

FIG. 1. Gross decay curves of fractions isolated from an iridium target bombarded with 50-Mev protons.

DECAY DATA

A typical decay curve of the platinum and iridium fractions separated from an iridium target after bombardment is shown in Fig. 1. The decay was followed with an Amperex 200C Geiger-Müller counter having an end window 1.4 mg/cm² thick. After 3 days the platinum fraction showed a simple exponential decay with a half-life of 10.3±0.4 days, which was followed for over 70 days. The iridium fraction shows a complex decay curve.

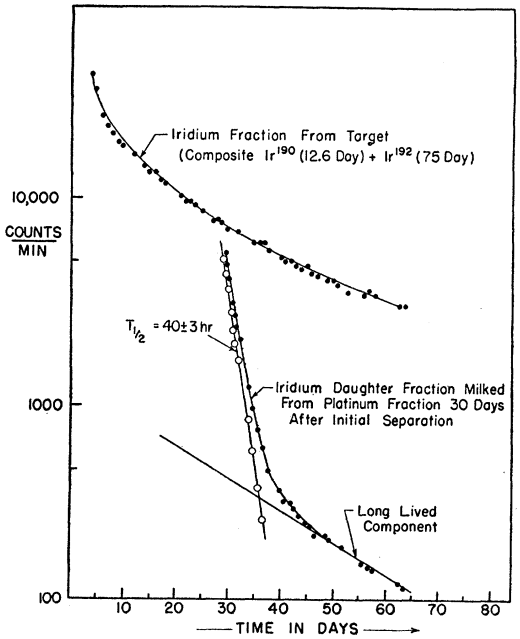

FIG. 2. Gross decay curves of the iridium fraction isolated directly after bombardment from the target (top curve) and the iridium fraction isolated from an aged sample of the 10.3-day platinum (bottom curve).

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[1] W. T. Leland, Phys. Rev. **76**, 992 (1949).

[2] Baker and Company, Inc., Newark, New Jersey.

[3] We are indebted to the spectroscopy division of Brookhaven National Laboratory for performing this analysis.

[4] W. Wayne Meinke, University of California Radiation Laboratory Report UCRL-432 (unpublished).

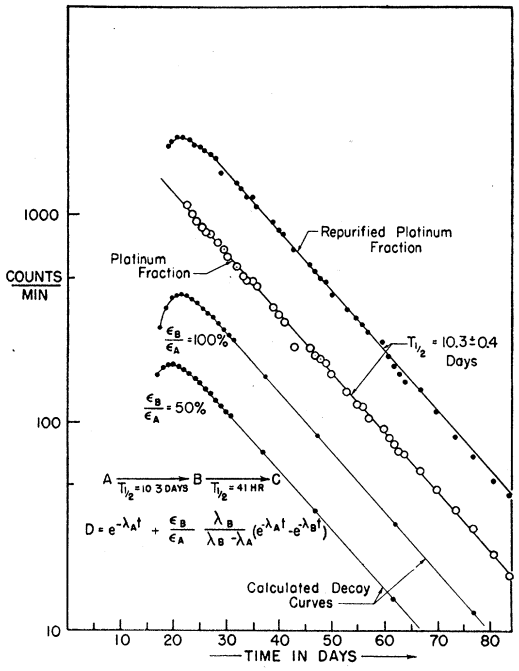

FIG. 3. Gross decay curves of a 10.3-day platinum fraction isolated directly after bombardment and of a repurified sample of the 10.3-day platinum (top 2 curves), for comparison the calculated gross decay curves of a 10.3-day isotope with 41-hour daughter isotope are shown (bottom 2 curves).

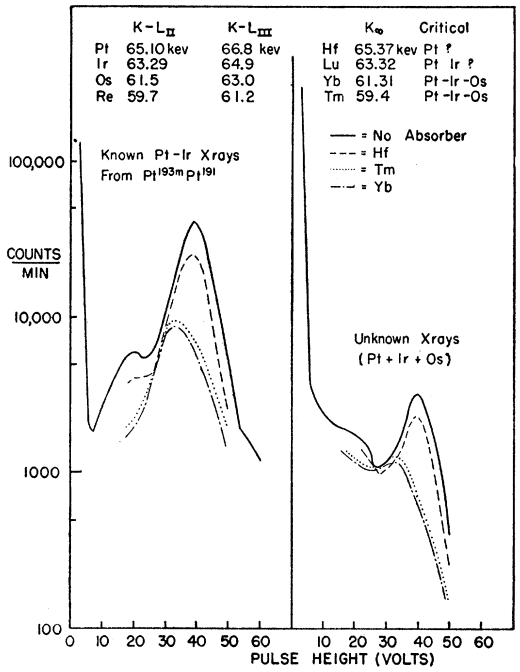

FIG. 4. Comparison of the critical absorption of known platinum and iridium x-rays and the x-rays occurring in the decay of an aged sample of 10.3-day platinum.

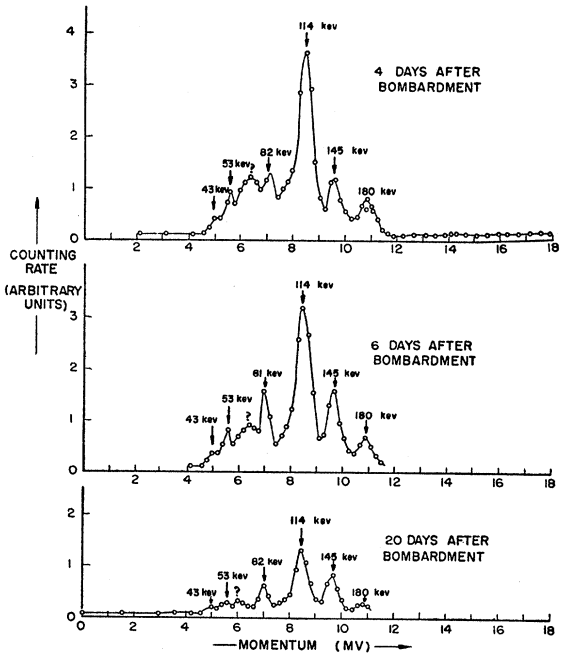

FIG. 5. Conversion electron peaks accompanying the decay of the 10.3-day platinum activity showing the initial increase of the electron lines at 82 and 145 kev.

In order to determine chemically the element to which this half-life was to be assigned, further individual separations of mercury, gold, platinum, iridium, and osmium were undertaken from the platinum fraction 36 days after its initial separation from the target. No activity was found to be present in the mercury, gold, or osmium fractions. However, the iridium and repurified platinum fractions both showed activity. The decay curves of the iridium fractions, isolated directly from the target and isolated from the aged platinum fraction, are shown in Fig. 2. The iridium fraction isolated from the aged platinum fraction shows a decay resolvable into a short-lived component having a half-life of 40±3 hours, and a longer-lived component having a half-life of approximately 10 days. The iridium fraction isolated directly from the target shows no short-lived decay component 36 days after bombardment. A 41-hour neutron-deficient iridium isotope, Ir^{188}, has been reported by Chu;[5] this suggests that the short-lived component in the iridium fraction isolated from the aged platinum is the Ir^{188} daughter of a long-lived Pt^{188} parent. The long-lived component is most probably platinum activity incompletely separated from this iridium fraction.

The decay of the repurified platinum fraction is shown in Fig. 3. A growth in total activity during the first 3 days after purification was followed by a simple exponential decay with a half-life of approximately 10 days. This decay curve is compatible with the total activity curve expected for the growth of a 41-hour daughter activity from a 10.3-day parent, if the disintegrations of the daughter are counted with approxi-

[5] T. C. Chu, Phys. Rev. **79**, 582 (1950).

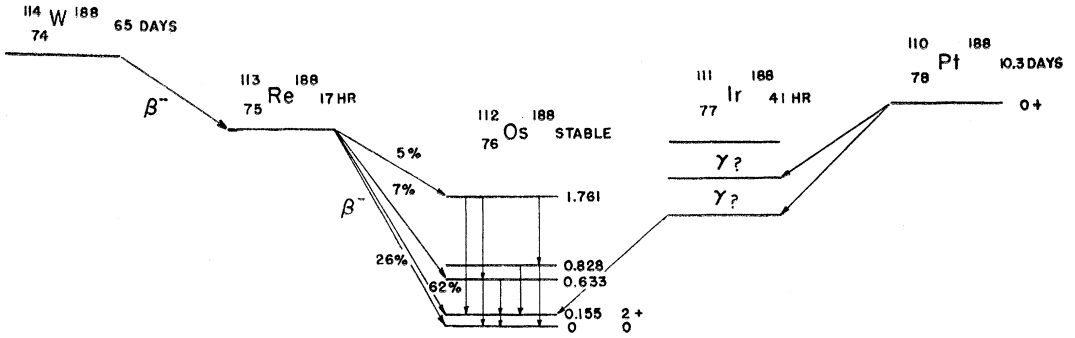

FIG. 6. Properties of the mass-188 isobars.

mately half the efficiency of those of the parent. The reappearance of the 10-day decay component preceded by the short period of growth suggests that this half-life be assigned to the decay of Pt^{188}.

CRITICAL X-RAY ABSORPTION MEASUREMENTS

As a further check on the atomic numbers involved in the postulated $Pt^{188}-Ir^{188}-Os^{188}$ decay sequence, critical absorption measurements of the x-radiations accompanying the decay of the 10-day activity were undertaken. The x-radiations expected in such a sequence would be those characteristic of iridium and osmium and would result from the filling of vacancies in the electronic shells of these elements arising from electron capture and internal conversion. The absorbers consisted of approximately $\frac{1}{2}$ gram each of the oxides HfO_2, Yb_2O_3, and Tm_2O_3 spread in a circular indentation in Lucite 1 inch in diameter. The x-rays were counted using a sodium iodide scintillation counter equipped for differential pulse-height analysis. The absorbers were first used with a known source of Pt^{191} and Pt^{193m} emitting platinum and iridium x-rays. The pulse-height curves obtained are shown in the left-hand portion of Fig. 4. Critical absorption in the ytterbium and thulium absorbers is shown by a reduction of the counting rate in the x-ray photopeak and by a shift in the location of this peak to lower energies, corresponding to the fluorescent x-radiation of the critical absorber. The pulse-height curves obtained using an aged source of the 10-day isotope in equilibrium with its daughter are shown in the right-hand portion of Fig. 4. The onset of critical absorption in ytterbium indicates that the x-rays emitted by this source are characteristic of one or all of the elements platinum, iridium, osmium; this is in agreement with the postulated decay sequence in which iridium and osmium x-rays would be expected.

CONVERSION ELECTRONS

A preliminary study of the electron lines occurring in the decay of the 10-day platinum has been made with a thin-lens β-ray spectrometer. A thin source was prepared by electrolytic deposition of high specific activity material upon 0.2-mil platinum foil. The conversion lines observed 4, 6, and 20 days after bombardment and isolation of the platinum are shown in Fig. 5. Conversion electrons having energies of 43, 53, 82, 114, and 180 kev are present. The lines at 82 and 145 kev are seen to increase in intensity between the 4-day and 6-day readings.

The 63-kev separation of these lines suggests that these are the K and L conversion lines of a gamma ray converted in either osmium or iridium. However, the initial increase in intensity suggests that these lines are associated with the decay of a daughter activity, presumably due to a level in Os^{188} reached by decay of Ir^{188}. The energy of this transition is then found to be 156 ± 3 kev from the known[6] K and L electron binding energies in osmium. This energy value is in good agreement with the values previously reported[7–11] for the lowest-lying $E2$ γ transition in Os^{188} which range from 152–160 kev. This level had been observed by the previous workers in the β^- decay of Re^{188} and its reoccurrence confirms a mass assignment of 188 to both the 10.3-day platinum and the 42-hour iridium.

The remaining conversion lines at 43, 53, 114, and 180 kev are associated with levels in Ir^{188}, the 53 and 114 or 114 and 180 may constitute a K, L conversion line pair. Figure 6 summarizes the present information available concerning the mass 188 isobars; the level scheme for Os^{188} is taken from McMullen and Johns.[11]

ACKNOWLEDGMENTS

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[6] Hill, Church, and Mihelich, Rev. Sci. Instr. **23**, 523 (1952).
[7] L. C. Miller and L. F. Curtiss, Phys. Rev. **70**, 983 (1946).
[8] Cork, Schreffler, and Fowler, Phys. Rev. **74**, 1657 (1948).
[9] Beach, Peacock, and Wilkinson, Phys. Rev. **76**, 1585 (1949).
[10] Richmond, Grant, and Rose, Proc. Phys. Soc. (London) **A65**, 484 (1952).
[11] C. C. McMullen and M. W. Johns, Phys. Rev. **91**, 418 (1953).