so that the latter were in a constant γ-ray bath compared to which the variation in γ-flux from the 1 g Ra—Be source some distance away was negligible. The BF_3 counters were later replaced by a small G-M tube, and the constancy of the γ-flux was established experimentally.

The average value $L_r = 9.58$ cm is in agreement with previous measurements at smaller distances[1,3–5] to within experimental error of ~2 percent and justifies the use of a simple exponential decay out to at least 1 meter.

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Radioactivity of Pt^{191} and Pt^{193m}†

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A 3.2-day activity of Pt^{191} and a 4.5-day activity of Pt^{193} have been investigated. Electron-capture of Pt^{191} is followed by a complex spectrum of gamma-radiation. The 4.5-day Pt^{193m} activity is a characteristic $M4$ isomeric transition of 135-kev.

FOLLOWING recent experiments[1] with osmium, an investigation of the electron-capture decay of $_{78}Pt^{191}$ and $_{78}Pt^{193}$ was undertaken to determine whether there were any features of these decays in common with the beta-decays of $_{76}Os^{191}$ and $_{76}Os^{193}$.

Iridium metal (38.5 percent Ir^{191}, 61.5 percent Ir^{193}) was bombarded with 10-Mev deuterons, and the platinum fraction containing Pt^{191} and Pt^{193} produced by a $(d,2n)$ reaction was chemically separated. The internal-conversion spectrum of the platinum was investigated using 180°- and lens-spectrometers. Conversion lines corresponding to the following gamma-transitions were obtained: 62, 82, 94, 125, 129, 135, 171, 178, 267, 350, 359, 408, 455, and 537 kev.

Lifetime tests on individual conversion lines showed that, with the exception of the 135-kev transition, all transitions had approximately the same half-life. The best measurement of this half-life was 3.2±0.2 days. The observed half-life of the 135-kev transition was 4.5±0.2 days.

Foils of platinum (0.012 percent Pt^{190}, 0.8 percent Pt^{192}, 32.8 percent Pt^{194}, 33.7 percent Pt^{195}, 25.4 percent Pt^{196}, 7.2 percent Pt^{198}) were irradiated by gamma-rays from a 22-Mev betatron. The conversion-electron spectrum again showed strong lines of the 135-kev transition. However, none of the other lines listed above was observed. Since relatively little Pt^{191} is produced by a (γ,n) reaction on platinum, the 135-kev gamma-transition is, therefore, to be assigned to Pt^{193}. The assignments of 3.2-day and 4.5-day half-lives to Pt^{191} and Pt^{193} are in accord with those already made by Wilkinson.[2] Also observed in the gamma-irradiated sources were the 129- and 97-kev transitions of 3.8-day Pt^{195m}, the 337-kev transition of 80-minute Pt^{197m}, and the 77-kev transition and 0.7-Mev beta-spectrum of 18-hour Pt^{197}. The 129-kev transition of Pt^{195m} is characteristically an isomeric $M4$ transition, and cannot be confused with the 129-kev gamma-transition of the platinum source separated from the irradiated iridium. An isotopic chart of platinum and neighboring elements is shown in Fig. 1.

Pt^{191}. DISCUSSION

Of the thirteen gamma-transitions which are now to be allocated to Pt^{191}, measurements of conversion-electron energies show that the 82- and 129-kev transitions are converted in iridium. It is probable that all of the transitions follow the electron-capture of Pt^{191}. Further, the 129-kev transition is found to be identical with the already-observed[1] 129-kev transition following the beta-decay of Os^{191}. However, the 42-kev transition observed in the decay of Os^{191} is not observed in the decay of Pt^{191} and, relative to the 129-kev transition, is certainly not present to the extent of one-fourth of the intensity that it has in the Os^{191} decay.

No thorough experimental analysis of the complex Pt^{191} decay scheme was attempted. However, it is apparent from the transition energies that certain transitions combine to give common energy values. In particular, 455 plus 82, 408 plus 129, 359 plus 178, combine to yield an energy of 537 kev, for which energy a transition is itself found. Other combinations are: 94 plus 82 (178); 94 plus 171 (267); 267 plus 82 (350); 62 plus 125 plus 267 (455); 62 plus 125 plus 350 (537). Although a feasible decay scheme might easily be con-

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[1] J. B. Swan and R. D. Hill, Phys. Rev. 88, 831 (1952).
[2] G. Wilkinson, Phys. Rev. 73, 252 (1948).

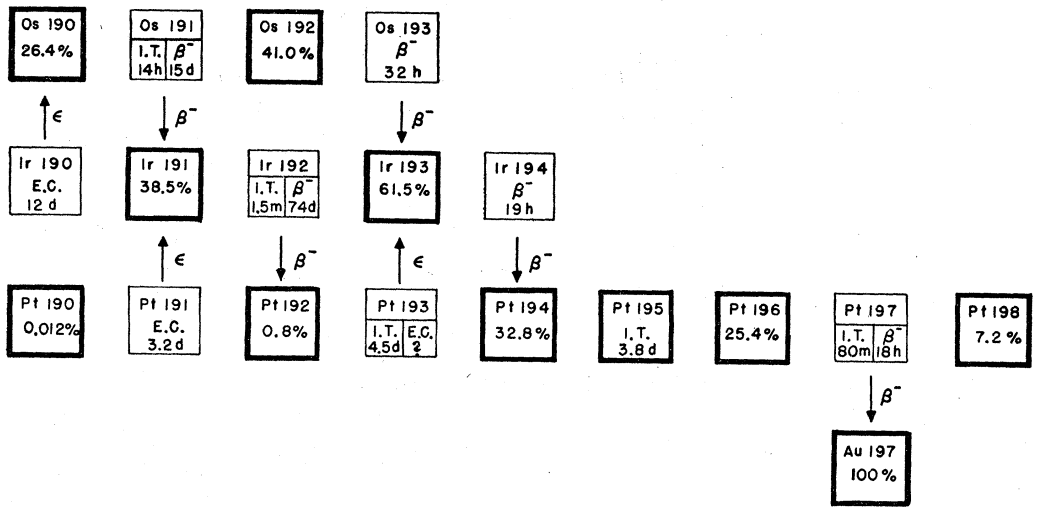

FIG. 1. Isotopic chart of platinum and neighboring elements.

structed, it is perhaps only worthwhile to point out that Pt^{191} probably decays to an upper excited state of 537 kev in Ir^{191}.

Pt^{193}. DISCUSSION

The experimental conversion-electron energies show that the 135-kev transition is an isomeric transition in Pt^{193m}.

The $M4$ nature of this transition may be inferred from its lifetime. The total conversion coefficients for an $M4$ transition of this energy, using Rose's tables,[3] is approximately 10^3. The half-life of a 135-kev $M4$ transition, using Moszkowski's lifetime formula[4] and a matrix element squared equal to unity, is then calculated to be 1.5 days, as compared with the experimental half-life of 4.5 days. If a value of the matrix element squared equal to 0.68, corresponding to the mean[4] of the $i_{13/2}\rightarrow f_{5/2}$ $M4$ transitions, is taken, the calculated half-life is 2.2 days. This value, although somewhat low, is compatible with an $M4$ transition.

The observed relative intensities of the electron conversion lines of the 135-kev transition are given in Table I.

TABLE I. Energies and relative intensities of conversion lines of the 134.9-kev transition in Pt^{193m}.

Conversion shell	K	L_I	L_{III}	M_I	M_{III}	N_I
Line energy (kev)	56.63	120.88	123.30	131.41	132.33	134.27
Line intensity	100	123	241	132		57

[3] Rose, Goertzel, Spinrad, Harr, and Strong, Phys. Rev. **83**, 79 (1951); Rose, Goertzel, and Perry, Oak Ridge National Laboratory Report ONRL-1023, 1951 (unpublished).
[4] S. A. Moszkowski, Phys. Rev. **89**, 474 (1953).

The $K/(L+M+N)$ ratio of 0.18 for the 135-kev transition is in reasonable agreement with a value of 0.27 for the empirical $K/(L+M+N)$ ratio for an $M4$ transition.[5,6] The ratio of K conversion to total conversion for an $M4$ transition, obtained from Bendel's empirical relationship $N_K/N_e=(0.91-0.0166Z^2/E)$, is 0.16, which is in excellent agreement with our experimental value of 0.15.

The observed $L_I:L_{II}:L_{III}$ ratios also support the $M4$ assignment for the 135-kev transition. The experimental values of 1:0:2.0 agree well with Tralli and Lowen's[7] theoretical value of $L_I:L_{III}=1:2.6$, and Mihelich's[8] empirical observations of $L_I:L_{II}\simeq 1:0.1$.

It is to be expected that the ground state of Pt^{193} should decay by electron-capture to stable Ir^{193}. However, no half-life which is between the limits of about 1 hour and 74 days, and which can be assigned to this activity has been observed. The lower limit of half-life is based on the observation of 80-minute Pt^{197m} in the platinum sources, and the upper limit on the presence of 74-day Ir^{192} in both cyclotron- and betatron-produced sources. Energy systematics of neighboring beta- and electron-capture-active nuclei indicate that little energy is available for the decay of Pt^{193}. This suggests a long lifetime for the ground state of Pt^{193}.

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[5] W. L. Bendel, University of Illinois Ph.D. thesis (unpublished).
[6] Graves, Langer, and Moffat, Phys. Rev. **88**, 344 (1952).
[7] N. Tralli and I. S. Lowen, Phys. Rev. **76**, 1541 (1949).
[8] J. W. Mihelich, Phys. Rev. **87**, 646 (1952).