coefficients gives

$$G_k = 1 - \frac{k(k+1)}{(2I_B+1)^2}T, \quad T = \frac{(\Delta\nu/2\gamma)^2}{1+(\Delta\nu/2\gamma)^2},$$

with the minimum value

$$(G_k)_{\min} = 1 - k(k+1)/(2I_B+1)^2.$$

For $\Delta\nu/2\gamma = 2\pi\Delta\nu c\tau_B = 1$ (τ_B mean life of the level B) the attenuation is exactly half of its maximal value; $(2\pi\Delta\nu c)^{-1} = \tau_0$ is a characteristic time for this attenuation. The values of τ_0 for different values of $\Delta\nu$ is shown in Table I. The variation of $G_{k,\min}$ as a function of k and I_B may be seen in Table II. An application of

TABLE I. τ_0 as a function of $\Delta\nu$.

$\Delta\nu$	0.001 cm^{-1}	0.01 cm^{-1}	0.1 cm^{-1}	1 cm^{-1}	10 cm^{-1}
τ_0	$5.3\cdot10^{-9}$ sec	$5.3\cdot10^{-10}$ sec	$5.3\cdot10^{-11}$ sec	$5.3\cdot10^{-12}$ sec	$5.3\cdot10^{-13}$ sec

formula (4) which permits the determination of the multipole order and the character of an electromagnetic transition is the following.

TABLE II. $G_{k,\min}$ as a function of k and I_B.

I_B \ k	2	4	6	8	10
1	0.33				
3/2	0.52				
2	0.76	0.20			
5/2	0.83	0.44			
3	0.88	0.59	0.15		
7/2	0.91	0.68	0.34		
4	0.93	0.75	0.48	0.11	
9/2	0.94	0.80	0.58	0.28	
5	0.95	0.84	0.65	0.40	0.09

If in addition to the correlation of the $\gamma-X$ transition (where X stands for any particle) it is possible to measure the e^--X correlation of the respective e^--X transition (e^- conversion electrons), then the ratio A_k/B_k is dependent only upon k and the multipole order. A_k and B_k are the coefficients of the Legendre polynomials for the $\gamma-X$ and e^--X transition, respectively.

For an electric 2^l transition we get, with $A_0=B_0=1$,

$$A_k/B_k = 1 - [k(k+1)/2l(l+1)].$$

For a magnetic 2^l transition we get

$$\frac{A_k}{B_k} = \frac{l+1}{2l+1}\,\frac{k(k+1)-2l(2l+1)}{k(k+1)-2l(l+1)}.$$

Both formulas are valid for low Z and nonrelativistic energies.

I would like to express my thanks to Professor Pauli, Professor Weisskopf, Dr. Frauenfelder, and Dr. Schafroth for their interest and many discussions.

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Properties of Plutonium-243

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To build up an appreciable concentration of higher plutonium isotopes by successive neutron capture, a sample of Pu^{239} was subjected to a prolonged neutron irradiation. After irradiation the plutonium was isolated from fission products and other impurities by extraction with di-ethyl ether. The isotopic composition of this plutonium was determined mass-spectrometrically by Inghram and Hess.[1] In addition to Pu^{239} they found measurable amounts of Pu^{240}, Pu^{241}, and Pu^{242}.

Samples of a nitrate solution of this plutonium were evaporated to dryness in a quartz tube and irradiated in the thimble of the Argonne heavy water reactor for periods of time varying from two to twenty-four hours. At the end of each irradiation the plutonium was rapidly purified from all extraneous activity by a series of precipitations and solvent extractions. The purifications were continued until the ratio of beta-activity (corrected for decay) to alpha-activity became constant. A five-hour beta-activity remained with the plutonium despite many attempted separations, and was formed with the same cross section in each of the irradiations.

Samples of Pu^{239} containing negligible quantities of higher plutonium isotopes, when subjected to irradiation and subsequent chemical purification under conditions identical to the test samples, showed no traces of the induced five-hour activity.

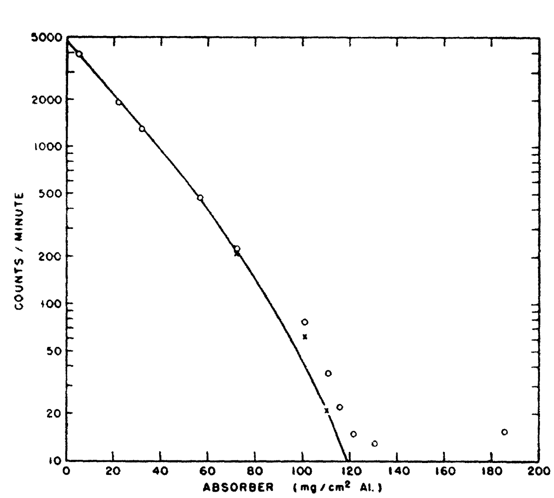

FIG. 1. Aluminum absorption curve with a helium filled, mica end-window tube. The circles represent values corrected for decay, and the crosses represent values corrected for both decay and the constant Geiger background of the plutonium.

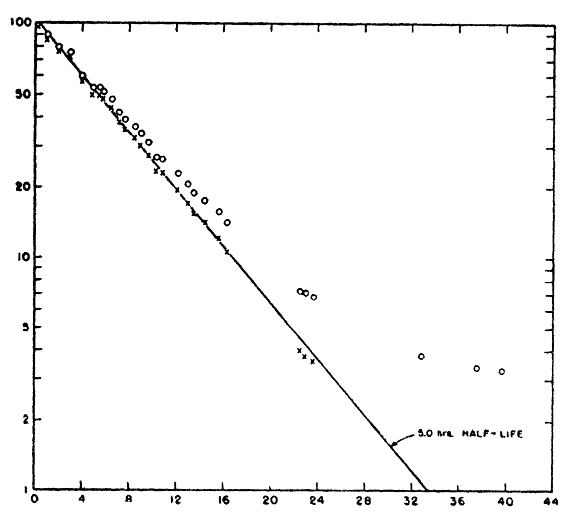

FIG. 2. Decay of Pu^{243}. The circles represent the actual values obtained, while the crosses are these values corrected for the constant Geiger background of the plutonium.

Absorption measurements indicated that the maximum beta-energy for the five-hour plutonium activity is approximately 0.5 Mev. Absorption and decay data are shown in Figs. 1 and 2.

From these results, we conclude that the five-hour activity is due to a plutonium isotope, most probably Pu^{243}. The mass 243 is favored by the following considerations: 1. The difference in yield of five-hour activity from this plutonium sample and from another sample of plutonium containing smaller amounts of Pu^{240}, Pu^{241}, and Pu^{242} fits best with the assumption that the activity was produced by neutron excitation of Pu^{242}. Moreover, except for the unlikely possibility of a short-lived isomer of the observed long-lived Pu^{242}, all plutonium isotopes of lower mass which could conceivably have been formed are long-lived. 2. Odd mass plutonium isotopes 243 or greater are certainly beta-unstable since Pu^{241} is beta-unstable. 3. Plutonium isotopes of mass higher than 243 can almost certainly be ruled out from considerations of yield and the maximum energy of the new beta-ray activity.

The capture cross section of Pu^{242} for pile neutrons, based on the yield of the five-hour activity from five separate irradiations, was estimated to be of the order of one hundred barns. The individual yields, corresponding to 90, 97, 112, 94, and 113 barns, were in close agreement, but the absolute value is uncertain by at least 50 percent because the Pu^{242} content of the sample was only about twofold above the limit of mass-spectrometric detection.

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Short μ-Meson Tracks from π-Meson Decays*

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A GROUP of Ilford C2 200-micron plates were exposed in a spiral orbit spectrometer[1] to the Berkeley cyclotron. The plates were arranged in such a manner that π-mesons of opposite signs entered the emulsions from opposite directions.

A search for unusual π−μ-decays has been continued.[2] A total of 3018 π−μ-decays have been studied where both the π- and μ-meson tracks stopped in the emulsion. Four cases were found

TABLE I. Data for four π-meson decays with short μ-meson tracks.

Event	Range of μ-track, in microns	Angle between directions of π- and μ-tracks, degrees	Energy in Mev of π-meson, assuming decay in flight
1	260	113	0.73
2	258	93	1.7
3	185	20	16.6
4	120	73	5.0

where the μ-meson tracks are unusually short. The ranges of these μ-meson tracks are given in Table I.

Photomicrographs of events 1 and 3 are shown in Figs. 1 and 2. Four additional π−μ-decays have been found where the lengths of the μ-meson tracks are between 485 and 500 microns. Sixteen π−μ-decays were found where the ranges of the μ-meson tracks are between 500 and 520 microns. These twenty events may be examples of extreme straggling. The average range of the μ meson tracks from π-meson decays is about 594 microns in these plates.

Two events were found which appear to be π−μ-decays. The μ-meson tracks are 57 and 25 microns long. Since the μ-meson tracks are short, it seems difficult to establish that these two events are π−μ-decays and not scattered μ-mesons.

If the short ranges of the μ-mesons in events 3 and 4 were due to the decay in flight of the π-mesons, the energy of the π-mesons at the time of decay would be 16.6 and 5 Mev, respectively. The grain density near the end of the π-meson tracks is much greater than along a 5-Mev meson track; hence it is concluded that the short ranges of the μ-mesons in events 3 and 4 are not due to the decay in flight of the π-mesons.

In all of the 26 cases where the μ-meson tracks are shorter than 520 microns, the π-mesons entered the emulsions from such a direction as to indicate that the π-mesons were positively charged. Approximately 3300 π-meson events have been studied in these plates. Only 5 π-meson events have been observed where the sign of the charge, as determined from the direction of the π-meson,

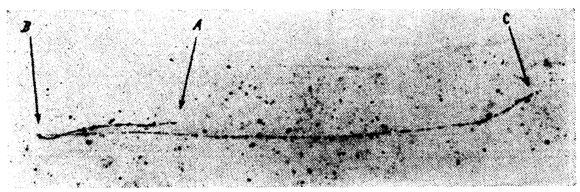

FIG. 1. Photomicrograph of an usual π−μ-decay. The π-meson enters the emulsion at point *A* and decays at point *B*. The μ-meson stops at point *C*. The μ-meson track is only 260 microns long. The grain density near the end of the π-track is much greater than along the beginning of the μ-track.

is inconsistant with the phenomena associated with the meson. Since no conclusive evidence has been found for the decay of negative π-mesons in photographic emulsions, and since the scattering in the spectrometer is small, it is concluded that the π-mesons which give rise to the short μ-meson tracks are positively charged. It is believed that events 1 through 4 are examples of an alternative mode of π-meson decay.

An unusual π−μ-decay was found by Smith,[3] where the μ-track is 275 microns long. Another π−μ-decay was found by Powell.[4]

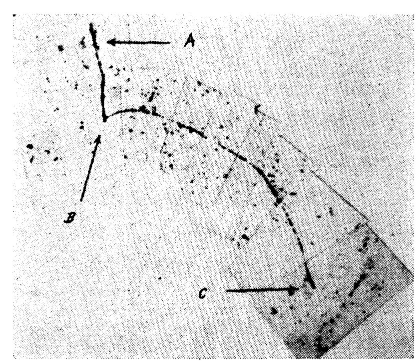

FIG. 2. Photomicrograph of a π−μ-decay where the μ-meson track is only 185 microns long. The track of the π-meson is indicated by arrow *A*. The π-meson decay is indicated by arrow *B*. The μ-meson track ends at point *C*. The track of the μ-meson is more nearly perpendicular to the plane of the emulsion than the π-meson track; nevertheless, the grain density is greater near the end of the π-meson track than along the beginning of the μ-meson track.

The μ-track did not end in the emulsion, but by grain counting and scattering it was estimated that the μ-track would have been less than 350 microns long.

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