Half-life of ^{241}Pu

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The half-life of ^{241}Pu was determined by studying the ingrowth of ^{241}Am by α spectrometry. A synthetic mixture was prepared by mixing different isotopes of plutonium so as to obtain a ^{238}Pu/(^{239}Pu + ^{240}Pu) α activity ratio of nearly 0.1 and an increase in the α activity ratio due to the ingrowth of ^{241}Am of about 0.1 after a period of 30 days. This was done to get a desired change periodically in the α activity ratio and to measure this change with high precision and accuracy. The initial values of ^{239}Pu/^{241}Pu and ^{240}Pu/^{241}Pu atom ratios in the mixture were obtained by mass spectrometry. The ingrowth of ^{241}Am was measured periodically by α spectrometry on electrodeposited sources using a silicon surface barrier detector. From the 80 α spectrometric measurements carried out on five electrodeposited sources over a period of 457 days, a value of 14.42 ± 0.09 yr is obtained for the half-life of ^{241}Pu using a value of 432.6 yr for the half-life of ^{241}Am. The uncertainty quoted on the value is a combination of one standard deviation on the average value and the error evaluated from the estimate on various error components. The half-life obtained in this work is in good agreement with the preliminary results reported recently by CBNM (Geel), NBS (Washington), and AERE (Harwell) using different methods.

[RADIOACTIVITY ^{241}Pu half-life; measured: ^{241}Am ingrowth by α spectrometry, ^{239}Pu/^{241}Pu and ^{240}Pu/^{241}Pu atom ratios by mass spectrometry.]

I. INTRODUCTION

The work presented here was motivated by a large discrepancy[1] between the various published values of ^{241}Pu half-life. The half-life of ^{241}Pu in the studies reported earlier has been determined mainly by the two methods: (i) by observing the decay of ^{241}Pu relative to other isotopes of plutonium using a mass spectrometer and (ii) by measuring the ingrowth of ^{241}Am by α or γ counting. The first method, though absolute, has led to half-life values ranging from 14.6 yr to 15.1 yr[2-5] while the measurements reported by the ^{241}Am ingrowth method have yielded a half-life value of about 14.0 ± 0.2 yr[6-9] based on the half-life of ^{241}Am as 432.6 yr. There were two other measurements reported by the reactivity method[10] and by calorimetry[11] which led to the half-life values as 14.63 ± 0.27 yr and 14.355 ± 0.007 yr respectively. In view of the great importance of the half-life of ^{241}Pu in nuclear technology, it was considered worthwhile to utilize the expertise developed in the fields of α spectrometry and mass spectrometry for determining the half-life of ^{241}Pu.

In the mass spectrometric method, there is a problem of measuring accurately the small change (about 1% in 3 months) in the atom ratio of ^{241}Pu relative to other isotopes of plutonium unless the measurements are carried out under strictly controlled conditions. Further, most of the measurements reported have involved the measurement of isotopic ratios much different from unity. These may be responsible for a large variation in the half-life values reported by studying the change in the isotopic ratios mass spectrometrically. This is evident from the half-life of ^{241}Pu reported by Zeigler and Ferris[4] in which six different laboratories from the USA participated in a sample exchange program and the half-life values calculated from the data reported by these laboratories varied from 14.50 yr to 15.06 yr.

The α or γ counting methods used earlier for determining the ingrowth of ^{241}Am require a knowledge of the efficiency of the detector which should be known accurately over the period of experiment. Further, the measurements have not been performed on replicate samples to observe the ingrowth of ^{241}Am periodically to confirm the reproducibility of the experimental data.

With a view to eliminating the need for the efficiency of the detector, the ingrowth of ^{241}Am in the present work was determined by α spectrometry relative to the α activity due to ^{239}Pu + ^{240}Pu which remained practically constant during the course of investigations. Further, the measurements were carried out periodically over a period of 1.25 yr on 5 electrodeposited sources prepared from a synthetic mixture of plutonium isotopes. The synthetic mixture was prepared so as to have ^{238}Pu/(^{239}Pu + ^{240}Pu) α activity ratio nearly 0.1 and an increase in the α activity ratio due to the ingrowth of ^{241}Am by about 0.1 (i.e., 100% change in the α activity ratio) after a period of 30 days. This was done with the objective of obtaining the desired change periodically in the α activity ratio and measure this change with high precision and accuracy. The initial α activity ratio was kept as 0.1 and the measurements were performed up to

TABLE I. Isotopic composition of the synthetic mixture of plutonium used for the determination of the half-life of ^{241}Pu.

Mass number	Atom percent
238	0.025 02 ± 0.000 25 [a]
239	49.057 7 ± 0.057
240	8.368 7 ± 0.017
241	40.020 3 ± 0.024
242	2.528 3 ± 0.025

[a] Determined by α spectrometry.

an activity ratio of about 2 so that the tail contribution due to energy degradation from the high energy ^{238}Pu + ^{241}Am peak (5.50 MeV) to the low energy ^{239}Pu + ^{240}Pu peak (5.17 MeV) was small and could be accounted for accurately.

II. PRINCIPLE OF THE METHOD

The method involved the measurement of (^{238}Pu + ^{241}Am)/(^{239}Pu + ^{240}Pu) α activity ratio periodically by α spectrometry. If R_α denotes the increase in the α activity ratio due to the ingrowth of ^{241}Am after a time t, then

$$R_\alpha = \frac{A(^{241}\mathrm{Am})_t}{A(^{239}\mathrm{Pu})_t + A(^{240}\mathrm{Pu})_t} = \frac{N(^{241}\mathrm{Am})_t \lambda(^{241}\mathrm{Am})}{N(^{239}\mathrm{Pu})_t \lambda(^{239}\mathrm{Pu}) + N(^{240}\mathrm{Pu})_t \lambda(^{240}\mathrm{Pu})}, \quad (1)$$

where A's denote the α activities, N's stand for the number of atoms, λ's are the decay constants, the symbols in the parentheses denote the isotope, and the subscripts to the parentheses denote the ingrowth period for ^{241}Am.

The number of atoms of ^{241}Am formed from the decay of ^{241}Pu after a time t is given by

$$N(^{241}\mathrm{Am})_t = \frac{N(^{241}\mathrm{Pu})_0}{1 - \lambda(^{241}\mathrm{Am})/\lambda(^{241}\mathrm{Pu})} \times [e^{-\lambda(^{241}\mathrm{Am})\,t} - e^{-\lambda(^{241}\mathrm{Pu})\,t}], \quad (2)$$

where $N(^{241}\mathrm{Pu})_0$ denotes the number of atoms of ^{241}Pu at zero time. Substituting the value of $N(^{241}\mathrm{Am})_t$ from Eq. (2) in Eq. (1) we get

$$R_\alpha = XY[e^{-\lambda(^{241}\mathrm{Am})t} - e^{-\lambda(^{241}\mathrm{Pu})t}], \quad (3)$$

where

$$X = \frac{\lambda(^{241}\mathrm{Am})}{R^{9/1}\lambda(^{239}\mathrm{Pu}) + R^{0/1}\lambda(^{240}\mathrm{Pu})}, \quad (4)$$

$$Y = \frac{1}{1 - \lambda(^{241}\mathrm{Am})/\lambda(^{241}\mathrm{Pu})}, \quad (5)$$

Here $R^{9/1}$ and $R^{0/1}$ denote the initial values of ^{239}Pu/^{241}Pu and ^{240}Pu/^{241}Pu atom ratios in the synthetic mixture [as t is very small compared to the half-lives of ^{239}Pu and ^{240}Pu; therefore $N(^{239}\mathrm{Pu})_t = N(^{239}\mathrm{Pu})_0$ and $N(^{240}\mathrm{Pu})_t = N(^{240}\mathrm{Pu})_0$]. Thus, knowing the values of X, Y, R_α, t and the half-life of ^{241}Am, the half-life of ^{241}Pu can be calculated using Eq. (3). It may be mentioned that an approximate value of $\lambda(^{241}\mathrm{Pu})$ suffices for calculating Y from Eq. (5).

As is seen from Eq. (3), the accuracy in the measurement of ^{241}Pu half-life by the method reported here depends on three factors: (a) change in the α activity ratio, (b) the atom ratios $R^{9/1}$ and $R^{0/1}$, and (c) the half-life values of ^{239}Pu, ^{240}Pu, and ^{241}Am. In the present work, as will be seen later, the atom ratios and the change in the α activity ratios were measured with high precision and accuracy. Further, the half-life values of the reference isotopes ^{239}Pu, ^{240}Pu, and ^{241}Am are now known accurately.

III. EXPERIMENTAL

A. Preparation and purification of synthetic mixture

A synthetic mixture of plutonium isotopes was prepared by using ^{241}Pu (enriched) and ^{239}Pu containing small amounts of other isotopes. Enriched ^{241}Pu used in this work was obtained from Oak Ridge National Laboratory, USA in 1969.

TABLE II. Illustration of tail correction factor due to energy degradation.

Sample	Counts in ^{238}Pu or ^{241}Am region (A)	Counts in ^{239}Pu + ^{240}Pu region (B)	Tail correction factor A/B
^{238}Pu-I	112 508	882	127.56
^{238}Pu-II	100 935	791	127.60
^{241}Am-I	133 007	1012	131.43
^{241}Am-II	131 926	1207	109.30
		Average =	123.97 ± 4.97 [a]

[a] Standard error of the mean calculated as $s/\sqrt{n}$, where $s^2 = \sum_{i=1}^{n}(x_i - \bar{x})^2/(n-1)$ with $n = 4$.

TABLE III. Illustration of α energy pulse height analysis.

Disk Number	1	2	3	4	5
Total counts in (^{238}Pu + ^{241}Am) region	303 555	249 777	396 137	915 465	257 136
Total counts in (^{239}Pu + ^{240}Pu) region	202 121	164 916	263 869	607 940	170 551
Tail correction [a]	−2 448	−2 015	−3 195	−7 384	−2 074
Net counts in (^{239}Pu + ^{240}Pu) region	199 672	162 901	260 674	600 556	168 477
$\left(\frac{^{238}\text{Pu} + ^{241}\text{Am}}{^{239}\text{Pu} + ^{240}\text{Pu}}\right)\alpha$ activity ratio	1.520 27	1.533 30	1.519 66	1.524 36	1.526 24
Average = 1.524 77 ± 0.002 4 [b]					

[a] Based on the tail correction factor given in Table II.

[b] Standard error of the mean calculated as $s/\sqrt{n}$, where $s^2 = \sum_{i=1}^{n} (x_i - \bar{x})^2/(n-1)$ with $n = 5$.

Precalculated and known aliquots from the solutions of ^{239}Pu and ^{241}Pu were mixed to obtain ^{238}Pu/(^{239}Pu + ^{240}Pu) α activity ratio nearly 0.1 and an increase of about 0.1 in the α activity ratio after a period of 30 days due to the ingrowth of ^{241}Am. The chemical exchange between the plutonium isotopes was ensured by using freshly prepared solutions of ferrous ammonium sulphate and sodium nitrite as the reductant and oxidant, respectively. The plutonium solution was evaporated to near dryness, treated with concentrated HNO_3 twice to break the polymer, if any, and was finally taken in 7 M HNO_3. It was subjected to a redox cycle once more and purified from ^{241}Am by using a double stage anion exchange procedure.

The plutonium solution in 7 M HNO_3 was loaded onto the jacketed column containing Dowex 1×8 resin (200–400 mesh) and operating the column at 60 °C. Americium was washed down with 3 M HNO_3 and plutonium was eluted with 0.35 M HNO_3. The purified plutonium solution (referred to as synthetic mixture) was transferred to a clean and dry volumetric flask using 1 M HNO_3. The radiochemical purity of the synthetic mixture was checked by α spectrometry and γ spectrometry. It was found to be free from ^{241}Am (by checking for the 60 keV peak on an intrinsic germanium detector) and only three α energy peaks corresponding to ^{241}Pu + ^{242}Pu (4.90 MeV), ^{239}Pu + ^{240}Pu (5.17 MeV) and ^{238}Pu (5.50 MeV) were observed.

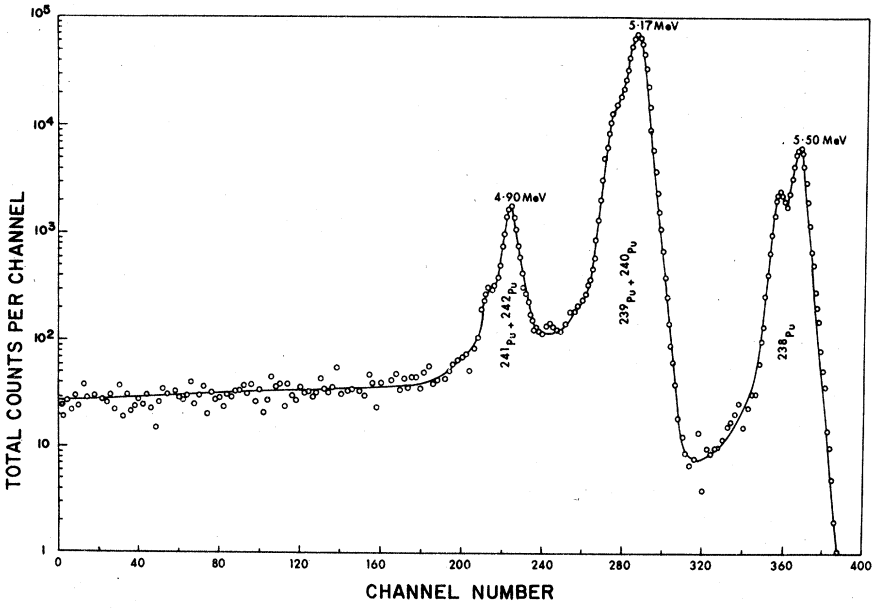

FIG. 1. The alpha particle energy spectrum of SM-241-III Pu sample (at zero time).

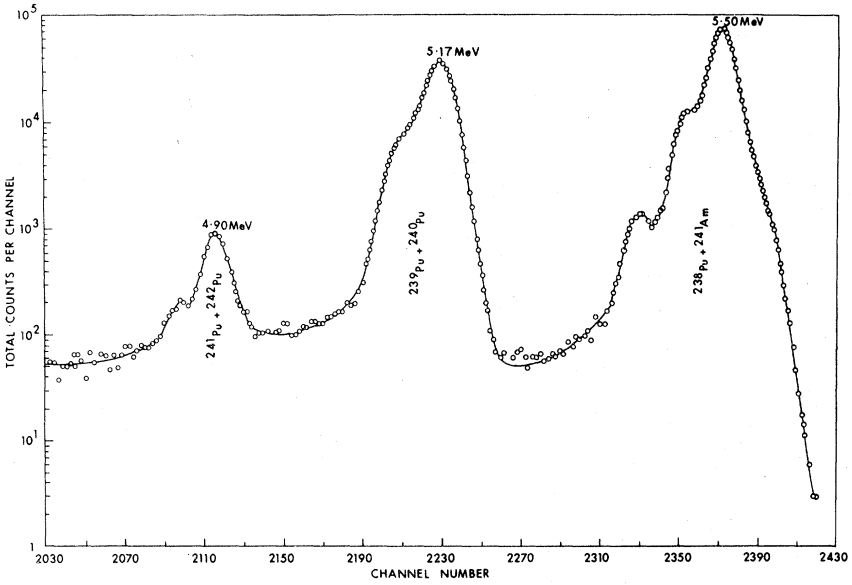

FIG. 2. The alpha particle energy spectrum of SM-241-III Pu sample (after 457 days).

B. Mass spectrometry

The isotopic composition of the synthetic mixture was determined by using a Varian MAT CH-5 mass spectrometer with a thermionic source. The instrument has a resolution of 425 (at 10% valley definition) measured at around mass 238 and an abundance sensitivity greater than 10^5. Rhenium ribbons ($0.04 \times 0.7 \times 8$ mm) were used as the sample and ionization filaments in the double filament assembly. The ionizing filament was heated to a current of about 6 A and the sample filament to a current of about 2 A. Mass spectrum was obtained by scanning the magnetic field and the output was fed to a strip chart recorder as well as to a TDC-312 computer coupled to the mass spectrometer.

The mass discrimination factor was calibrated by analyzing the isotopic standards of uranium and plutonium obtained from National Bureau of Standards. It was found to be 0.0036 per mass unit and used in the present work.

TABLE IV. Summary of ^{241}Pu half-life measurements.

Counting No.	Growth period (days)	$(^{238}Pu + ^{241}Am)/(^{239}Pu + ^{240}Pu)$ α activity ratio	Half-life of ^{241}Pu (yr) [a]
1	Taken as zero time	0.086 12 ± 0.000 16	
2	15.0	0.141 15 ± 0.000 32	14.433
3	30.0	0.196 09 ± 0.000 43	14.430
4	58.0	0.298 24 ± 0.000 06	14.435
5	90.0	0.414 99 ± 0.000 45	14.416
6	117.0	0.513 29 ± 0.000 49	14.403
7	156.0	0.653 64 ± 0.000 71	14.407
8	193.0	0.786 30 ± 0.000 68	14.389
9	218.0	0.876 34 ± 0.000 75	14.437
10	253.0	0.998 55 ± 0.001 6	14.406
11	278.0	1.087 73 ± 0.001 2	14.444
12	315.0	1.216 96 ± 0.001 1	14.445
13	350.0	1.340 10 ± 0.001 9	14.425
14	371.0	1.413 18 ± 0.001 3	14.467
15	401.0	1.524 77 ± 0.002 4	14.375
16	457.0	1.720 38 ± 0.001 2	14.353
		Mean = 14.42 ± 0.03 [b]	

[a] Half-lives of ^{239}Pu, ^{240}Pu, and ^{241}Am used are 24110 yr, 6553 yr, and 432.6 yr, respectively, Ref. 14 (1978).

[b] Standard deviation s computed from $s^2 = \sum_{i=1}^{n} (x_i - \bar{x})^2/(n-1)$ with $n = 15$.

The synthetic mixture was analyzed for $^{239}Pu/^{241}Pu$ and $^{240}Pu/^{241}Pu$ atom ratios within 24 h from the time of purification. Three filament loadings were carried out. Five runs, each consisting of 10–12 scans, were taken during each mass spectrometric determination. Table I presents the data on the isotopic composition of the synthetic mixture.

C. Alpha spectrometry

Sources for α spectrometry were prepared from the synthetic mixture by electrodeposition in aqueous HNO_3 medium (pH about 2). Platinum disks were used as the cathode and a platinum stirrer as the anode. A current density of about 200 mA/cm^2 and a voltage of 8–10 V was used. The electrodeposition was continued for about an hour. A few drops of dilute ammonia solution were added to the solution in the electrodeposition cell before stopping the electrodeposition. The electrodeposited source was washed with water, acetone, dried under an infrared lamp and ignited. Five sources were prepared from the synthetic mixture. Duplicate sources were also prepared from ^{241}Am solution and from ^{238}Pu solution on platinum planchets.

A 50 mm^2 silicon surface barrier detector mounted in a vacuum chamber (pressure $<10^{-2}$ torr) and coupled to a 4 K analyzer (TN-1700) was used for recording the α spectra. The system has a resolution of 20 keV full width at half maximum (FWHM) at 5.50 MeV. The initial activity on each source was about 2×10^5 dpm so as to eliminate the distortion and pileup effects. The source to detector geometry was such that about 3% of the α particles emitted (in 4π) by the source entered the detector. The sources were counted for a time long enough to accumulate more than 10^5 counts under each of the two peaks at 5.50 MeV and 5.17 MeV.

The α spectra from the five sources prepared from the synthetic mixture were recorded periodically for studying the ingrowth of ^{241}Am over a period of about 1.25 yr. Alpha spectra were also recorded from ^{238}Pu and ^{241}Am sources each time under the identical conditions. All the sources were kept in a perspex planchet box and handled with extreme care. The $(^{238}Pu+^{241}Am)/(^{239}Pu+^{240}Pu)$ α activity ratios were computed by taking the equal number of channels for $^{239}Pu+^{240}Pu$ and $^{238}Pu+^{241}Am$ peaks. The tail correction due to energy degradation from the high energy $^{238}Pu+^{241}Am$ peak (5.50 MeV) to the low energy $^{239}Pu+^{240}Pu$ peak (5.17 MeV) was applied based on the contribution calculated from α spectra recorded on ^{238}Pu and ^{241}Am sources. The tail contribution varied from about 0.1% of the α activity ratio at the beginning of the experiment to about 1% at the end of the experiment. An illustration of the tail correction factor due to energy degradation and the results of α energy pulse height analysis are given in Tables II and III, respectively. Figures 1 and 2 show the typical α spectra recorded from one of the sources at zero time and after the growth period of 457 days, respectively.

Our experience[12] in the field of α spectrometry shows that the accuracy in computing the α activity ratio from an α spectrum on weightless electrodeposited source is mainly dependent upon the ratio of counts in the high energy peak to those in the low energy peak and as this ratio increases, the tail contribution also goes on increasing. It was therefore considered essential to maintain the initial $^{238}Pu/(^{239}Pu+^{240}Pu)$ α activity ratio in the synthetic mixture at nearly 0.1 and carry out the measurements up to $(^{238}Pu+^{241}Am)/(^{239}Pu+^{240}Pu)$ α activity ratio nearly 2 so that the change in the α activity ratio due to the ingrowth of ^{241}Am could be obtained with high precision and accuracy while still keeping the tail contribution low. In order to determine the precision and accuracy achievable in the measurement of α activity ratios, synthetic mixtures having a wide range of $^{238}Pu/(^{239}Pu+^{240}Pu)$ α activity ratios were prepared from solutions of ^{238}Pu and ^{239}Pu isotopes. It was found[13] that following the conditions described above, an accuracy of 0.5% or better can be achieved while the precision is ±0.2%.

TABLE V. Constants used in the calculation of the ^{241}Pu half-life.

One year	=	365.24 d
Half-life of ^{238}Pu	=	87.74 ± 0.09 yr [a]
Half-life of ^{239}Pu	=	24 110 ± 30 yr [a]
Half-life of ^{240}Pu	=	6 553 ± 8 yr [a]
Half-life of ^{241}Am	=	432.6 ± 0.6 yr [a]
Half-life of ^{241}Pu	=	14.5 ± 0.5 yr [b]

[a] Reference 14 (1978).
[b] Reference 1 (1974).

IV. RESULTS AND DISCUSSION

Table IV summarizes the results on the α activity ratios obtained after different growth periods and the half-life values calculated from the data. It is worth noting that the half-life values of ^{241}Pu obtained by the α spectrometric method after different growth periods (15 days to 457 days) are in good agreement with each other, which enhances the confidence in the α spectrometric measurements. The growth interval was obtained by taking the midtime of the pulse height analysis.

The values of various constants used in the calculation of ^{241}Pu half-life are given in Table V. A small correction was applied to the initial ^{238}Pu/(^{239}Pu + ^{240}Pu) α activity ratio to account for the decay of ^{238}Pu during the period allowed for the growth of ^{241}Am. The correction varied from 0.05% after 15 days to about 1% after 457 days. As an example, the half-life of ^{241}Pu is calculated using the α spectrometric data obtained after a growth period of 401 days.

From Table IV,

$$R_\alpha = 1.524\,77 - 0.086\,12\, e^{-\lambda(^{238}\mathrm{Pu})t} = 1.439\,39,$$

where

$$t = 1.098\,56 \text{ yr}.$$

From Table I,

$$R^{9/1} = 1.225\,82, R^{0/1} = 0.209\,11,$$

so

$$X = \frac{0.693\,145/432.6}{1.225\,82(0.693\,145/24\,110) + 0.209\,11(0.693\,145/6553)}$$

$$= 27.933\,58,$$

$$Y = \frac{1}{1 - (0.693\,145/432.6)(14.5/0.693\,145)}$$

$$= 1.034\,68,$$

$$1.439\,39 = 27.933\,58 \times 1.034\,68\left[e^{-0.693\,145/432.6 \times 1.098\,56} - e^{-0.693\,145/T_{1/2} \times 1.098\,56}\right]$$

$$= 28.902\,32\left[e^{-0.001\,760\,2} - e^{-0.761\,46/T_{1/2}}\right],$$

$$T_{1/2} = 14.375 \text{ yr}.$$

TABLE VI. Estimates of errors (1σ).

S.No.	Quantity	Approximate value	Error (%)	Remarks
1	R_α	0.1 to 1.6	0.50	Evaluated by experiments conducted on synthetic mixtures
2		$X = \frac{\lambda(^{241}\mathrm{Am})}{R^{9/1}\cdot\lambda(^{239}\mathrm{Pu}) + R^{0/1}\cdot\lambda(^{240}\mathrm{Pu})}$		
(a)	$R^{9/1}$	1.225 82	0.10	Evaluated experimentally
(b)	$R^{0/1}$	0.209 11	0.20	-do-
(c)	$\lambda(^{239}\mathrm{Pu})$	$\frac{0.693\,145}{24\,110}$ yr^{-1}	0.12	Ref. 14
(d)	$\lambda(^{240}\mathrm{Pu})$	$\frac{0.693\,145}{6553}$ yr^{-1}	0.12	-do-
(e)	$\lambda(^{241}\mathrm{Am})$	$\frac{0.693\,145}{432.6}$ yr^{-1}	0.14	-do-
	X	27.938	0.19	Computed by error propagation in Eq. (4)
3		$Y = \frac{1}{1 - \frac{\lambda(^{241}\mathrm{Am})}{\lambda(^{241}\mathrm{Pu})}}$		
(a)	$\lambda(^{241}\mathrm{Am})$	$\frac{0.693\,145}{432.6}$ yr^{-1}	0.14	Ref. 14
(b)	$\lambda(^{241}\mathrm{Pu})$	$\frac{0.693\,145}{14.5}$ yr^{-1}	3.44	Ref. 1
	Y	1.034 68	0.12	Computed by error propagation in Eq. (5)
4	Growth period t	15 d to 457 d	0.10	Evaluated experimentally
	Combined error		0.55%	Computed by error propagation in Eq. (3)

TABLE VII. Comparison of various ^{241}Pu half-life values.

S.No.	Authors	Year	Method	Half-life value (yr)
1	Seaborg *et al.* (Ref. 19)	1949		10
2	Thompson *et al.* (Ref. 20)	1950	Ingrowth of ^{241}Am	15.37 [a]
3	Mackenzie *et al.* (Ref. 6)	1953	Ingrowth of ^{241}Am by α counting	14.12 ±0.2 [a]
4	Rose *et al.* (Ref. 7)	1956	Ingrowth of ^{241}Am by γ counting	13.87 ±0.28 [a]
5	Brown *et al.* (Ref. 8)	1960	Ingrowth of ^{241}Am by α counting	14.12 ±0.24 [a]
6	Smith (Ref. 9)	1961	α/β Branching ratio	13.3 ±0.3
7	French *et al.* (Ref. 2)	1966	Change in isotopic ratios by mass spectrometry	13.59 ±0.46
8	Nisle and Stepan (Ref. 10)	1970	Change in reactivity	14.63 ±0.27
9	Shields (Ref. 3)	1970	Change in isotopic ratios by mass spectrometry	14.6 ±0.4
10	Whitehead *et al.* (Ref. 21)	1972	Ingrowth of ^{241}Am	14.96 ±0.15 [a]
11	Zeigler and Ferris (Ref. 4)	1973	Change in isotopic ratios by mass spectrometry (mean of 6 laboratories)	14.89 ±0.11
12	Strohm and Jordan (Ref. 11)	1974	Calorimetric determination of power decay	14.355±0.007
13	Wilkins (Ref. 5)	1974	Change in isotopic ratios by mass spectrometry	15.02 ±0.10
14	Whitehead (Ref. 15)	1977	Ingrowth of ^{241}Am	14.56 ±0.10
15	Crouch (Ref. 16)	1978	Change in isotopic ratios by mass spectrometry on different samples	14.24 to 14.53
16	Garner (Ref. 17)	1978	Change in isotopic ratios by mass spectrometry on different samples	14.38 ±0.07
17	Vaninbroukx (Ref. 18)	1978	a) Change in isotopic ratios by mass spectrometry b) Ingrowth of ^{241}Am by α and γ counting	14.30 ±0.14 14.60 ±0.10
18	Present work	1979	Ingrowth of ^{241}Am by α spectrometry	14.42 ±0.09 [b]

[a] Half-life of ^{241}Pu recalculated using $T_{1/2}$ for ^{241}Am=432.6 yr, Ref. 14 (1978).
[b] Combination of the one standard deviation on the average value in Table IV and the estimated error given in Table VI.

The half-life of ^{241}Pu obtained in the present work is 14.42 ± 0.09 yr. The uncertainty given here is a combination of one standard deviation on the average value given in Table IV and the combined error evaluated from various error components listed in Table VI.

The various published values for the half-life of ^{241}Pu are given in Table VII. The half-life of ^{241}Pu has been recalculated for various measurements reported earlier by ^{241}Am ingrowth method using the recommended[14] half-life value (432.6 yr) of ^{241}Am. The errors reported are as those given in the original papers. As is seen from data in Table VII, the half-life of ^{241}Pu obtained in this work by an independent method is in good agreement with the measurements reported recently[15-18] by other methods during the course of these investigations.

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