Nuclear Data Sheets for $A = 241^*$

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Abstract: Available information pertaining to the nuclear structure of ground and excited states for all known nuclei with mass numbers $A=241$ have been compiled and evaluated. The adopted level and decay schemes, as well as the detailed nuclear properties and configuration assignments based on experimental data are presented for these nuclides. When there are insufficient data, expected values from systematics of nuclear properties or/and theoretical calculations are quoted. Unexpected or discrepant experimental results are also noted. A summary and compilation of the discovery of various isotopes in this mass region is given in 2013Fr02 (^{241}Np , ^{241}Pu , ^{241}Am , ^{241}Cm , ^{241}Bk , and ^{241}Cf), 2011Me01 (^{241}Es), and 2013Th02 (^{241}Fm).

General Policies and Organization of Material: see <http://www.nndc.bnl.gov/nds/NDSPolicies.pdf>.

General Comments: This work supersedes the 2005 evaluation by M.J. Martin (2005Ma88), and the evaluated ^{241}Fm nuclide by Balraj Singh (ENSDF online, 2011).

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Skeleton Scheme for A=241

NUCLEAR DATA SHEETS

Ground-State and Isomeric-Level Properties for A=241

Nuclide	Level	J π	T _{1/2}	Decay Modes
²⁴¹ Np	0.0	5/2+	13.9 min 2	% β^- =100
²⁴¹ Pu	0.0	5/2+	14.329 y 29	% β^- =99.998; % α =2.47 $\times 10^{-3}$; %SF<2.4 $\times 10^{-14}$
	=2200		20.5 μ s 22	%SF=100
	2200+x		32 ns 5	%SF=100
²⁴¹ Am	0.0	5/2-	432.6 y 6	% α =100; %SF=3.6 $\times 10^{-10}$ 9
	=2200		1.2 μ s 3	%SF=100
²⁴¹ Cm	0.0	1/2+	32.8 d 2	% ϵ =99.0 1; % α =1.0 1
	=2300		15.3 ns 10	%SF=100
²⁴¹ Bk	0.0	(7/2+)	4.6 min 4	% α =?; % ϵ +% β^+ =?
²⁴¹ Cf	0.0	(7/2-)	3.78 min 70	% α =25; % ϵ +% β^+ =75
²⁴¹ Es	0.0		8 s +6-5	% α =?; % ϵ +% β^+ =?
²⁴¹ Fm	0.0		0.73 ms 6	%SF>78; % α <14; % ϵ <12
²⁴⁵ Cm	0.0	7/2+	8423 y 74	% α =100
²⁴⁵ Bk	0.0	3/2-	4.95 d 3	% α =0.12 1; ...
²⁴⁵ Cf	0.0	1/2+	45.0 min 13	% α =35.3 25; ...
²⁴⁵ Es	0.0	(3/2-)	1.1 min 1	% α =40 10; ...
²⁴⁵ Fm	0.0		4.2 s 13	% α $\leq$ 100
²⁴⁵ Md	=300	(7/2)	0.35 s +23-16	% α =?; ...

Adopted Levels

Q(β⁻)=1300 70; S(n)=6130 70; S(p)=5740 70; Q(α)=4310 70 2012Wa38.

Experimental Studies:

1981Pa20: ²⁴¹Np produced via ²³⁸U(α,p) with Eα=32 MeV and ²⁴⁴Pu(n,p3n) with En=30–160 MeV at the Brookhaven MEIN facility. Irradiation was followed by chemical separation. Decay of ²⁴¹Np was studied by γ spectroscopy, using a high resolution Ge(Li) detector, and by β emission by a 4π proportional counter. Measured T_{1/2} for ²⁴¹Np from least squares decay analyses.

1966Qa02: ²⁴¹Np produced via ²³⁸U(α,p) at Nuffield Cyclotron at Birmingham University with Eα=40 MeV. Irradiation was followed by chemical separation. A Geiger counter, anthracene crystal scintillation β spectrometer, Xe proportional counter, NaI(Tl) detector, and a ZnS–Ag scintillation α counter were used to measure γ and β radiations. The half-life from decay curves for ²⁴¹Np was 16.0 min 2 with an end-point energy of 1.25 MeV. The 3.4 hour activity reported by 1960Le03 was not detected.

1960Le03: ²⁴¹Np produced via ²³⁸U(α,p) at Crocker Laboratory cyclotron with Eα=35 MeV and 48 MeV. Irradiation was followed by chemical and time of flight separation. γγ and βγ coincidences measured with NaI detector. Decay curves identified the 16 min half-life with strong evidence for an isomer with 3.4 hour half-life.

1959Va32: ²⁴¹Np produced via ²³⁸U(α,p) at Argonne cyclotron followed by chemical separation and measured with a 2π and end-window proportional counters. β and γ spectrum were measured with the anthracene crystal and a NaI(Tl) detectors. The beta spectrum end-point energy of the 16 minute component was 1.36 MeV 10 with logft of 5.8.

Theoretical/Systematical Studies:

2004Pa40: Calculated deformation parameters and the proton one quasiparticle states of heaviest nuclei using the macroscopic–microscopic approach. Systematics as function of of neutron number for odd A isotopes in Np were also calculated.

²⁴¹Np Levels

E(level)	Jπ	T _{1/2}	Comments
0.0	5/2+	13.9 min 2	<p>%β=100.</p> <p>%α<1×10⁻⁶ given by 1966Qa02, however no α branch was observed in their study. Using the ALPHAD program, evaluator estimated %α <1.7×10⁻¹⁴ with the assumption HF ≥4 for a non-favored transition.</p> <p>T_{1/2}: From 1981Pa20. Others: 16.0 min 2 (1966Qa02), 16 min (1960Le03,1959Va32).</p> <p>Jπ: ²³⁵Np, ²³⁷Np, and ²³⁹Np have the ground-state configuration 5/2[642]. The only other orbital lying within 100 keV of the g.s. configuration for these nuclides is the 5/2[523] orbital, which is the probable configuration for the ²⁴³Np g.s. Logft =5.87 9 for the branch to the 5/2[622] ²⁴¹Pu g.s. rules out the negative-parity alternative.</p>

Adopted Levels, Gammas

$Q(\beta^-)=20.78\ 13$; $S(n)=5241.52\ 3$; $S(p)=6650\ 17$; $Q(\alpha)=5140.0\ 5$ 2012Wa38.

$S(n)$: From adjusted value of 1998Wh01. The authors' value of 5241.57 3 is corrected to 5241.52 3 by 2012Wa38 to take account of changes in calibration energies used by the authors.

Experimental Studies:

2013Ca16: Investigation of fission fragment yields from transfer induced fission between ^{238}U and ^{12}C . Fission fragments detected with VAMOS spectrometer in GANIL.

2013Cr05: Reanalyzed the $T_{1/2}$ from measured $T_{1/2}$ by 2009We08.

2011Gu21: Study of Photon Strength Function by measuring γ cascade from neutron capture on ^{240}Pu at the n-TOF facility at CERN using the Total Absorption Calorimeter.

2011Ko21, 2010Lo14: Measured β spectrum using a cryogenic detector. 2009We08: Determined $T_{1/2}$ from 15 independent set of measurements over ≈ 31 years using the thermal ionization mass spectrometry (TIMS) on samples of Pu that have been chemically stripped of ^{241}Am and the double ratio method. The measurements were combined with previous measured results and a $t_{1/2}$ was recommended.

1999Dr13: Measured β spectrum and deduced the upper limits for heavy neutrino admixture.

1989Pa21: Re-measurement of ^{241}Pu half-life by gamma ray spectrometry and the ratio method with statistical analysis.

1985Ag02: Measurement of half-life by thermal ionization mass spectrometry and isotope single and double ratio method.

1974Ba73: Measured the fission probability in $^{239}\text{Pu}(t,p)$ and deduced fission barrier parameters.

Theoretical/Systematical Studies:

2015Er03: Calculation of fission probabilities with a dynamic statistical approach.

2014Ga18: Calculated spontaneous fission $T_{1/2}$ in framework of the generalized liquid drop model with new numerical method.

2013IS13: Prediction of spins from systematic studies of preformation probability for α decay and the neutron number of parent.

2013Bo29, 1986Ko28: Calculated (n,F) and $(n,n'F)$ cross sections.

2012Ni16: α decay branching ratio and $T_{1/2}$ for transitions from ground state to favored rotational bands using Multichannel Cluster Model.

2012Sa31: Calculated cluster decay half-lives using the Coulomb and Proximity Potential Model (CPPM).

2011Ad11: One-quasiparticle levels using the microscopic-macroscopic modified TCSM, QPM and the self-consistent SHFB approaches.

2011Zh36: Systematic analysis of α decay to members of favored bands using the Geiger-Nuttall law. Calculated the partial half-lives.

2011He12: Compilation of longest lived known in nuclides with $Z \geq 82$ with half-life, spin, excitation energy, and primary reference.

2010Ni02: Systematics and calculations of $T_{1/2}$ and relative intensities of α decay within the generalized density-dependent cluster model.

2009Go05: Estimation of fission cross section with global renormalization of the barrier height and the microscopic nuclear level densities at the fission saddle points.

2008ChZU: Decay data evaluation project (DDEP) for ^{241}Pu .

2006Sh19: Possible alternative parity bands using the cluster model features of reflection asymmetric states.

2005Pa73: Calculated neutron one quasi-particle states of heaviest nuclei within a macroscopic-microscopic approach.

2005Re16: Calculated spontaneous fission half-lives using Swiatecki's formula, by its generalized form, and by a new formula where the blocking effect of unpaired nucleon on the half-lives has been taken into account with different mechanisms.

1996St28: Calculated branching ratios using WKB and couple channel transmission matrices.

1990Bh02, 1985Ig01, 1984Ku05, 1984Oh09, 1982Ku09, 1980Ku14, 1972We09: Calculated fission barrier parameters.

1982Li02: Calculated energy band heads, magnetic moments, $B(E2)$ and $B(M1)$ using the rotor plus quasiparticle approximation.

1971Ga20, 1976Ch22: Calculated energies and wave functions for non-rotational single-particle states.

 ^{241}Pu Levels

Adopted Levels, Gammas (continued)

²⁴¹Pu Levels (continued)

Cross Reference (XREF) Flags

A ²⁴⁰Pu(n,γ) E=th: Secondary γ's
B ²⁴⁰Pu(n,γ) E=th: Primary γ's
C ²⁴⁰Pu(n,γ) E=res
D ²⁴⁵Cm α Decay
E ²⁴¹Np β⁻ Decay

F ²⁴⁰Pu(d,p)
G ²⁴²Pu(d,t)
H ²⁴²Pu(³He,α)
I ²⁴¹Pu(d,d')
J ²⁴²Pu(d,tγ)

E(level) [†]	Jπ ^{‡§}	XREF	T _{1/2}	Comments
0.0&	5/2+	A DEFG	14.329 y 29	<p>μ=-0.683 15; Q=+6 2. μ measured by optical spectroscopy (1969Ge04). Compiled by 2014StZZ. μ: Others: 1954Bl72, 1963Bl16. See 1982Li02 for theoretical μ calculations. Q measured by optical spectroscopy (1964Ch10) and recommended by 2013StZZ. Compiled by 2014StZZ. Q: Relative isotope shifts for plutonium isotopes were measured, and by using intrinsic Q values of even mass plutonium nuclei, intrinsic Q(²⁴¹Pu) was deduced by 1985Ge08 as 11.5 5 which yields Q(²⁴¹Pu)=4.11 18. See 1982Li02 and 1983Ga20 for theoretical calculations of Q. Jπ: From paramagnetic resonance (1976Fu06 and 1968Ah01 and references therein). The measured magnetic moment indicates a 5/2[622] orbital assignments. %β⁻=99.998; %α=2.47×10⁻³; %SF<2.4×10⁻¹⁴. α/β⁻=2.45×10⁻⁵ 8 (1968Ah01), 2.45×10⁻⁵ 4 from Iγ(148γ)=1.855 16 photons per 1×10⁶ ²⁴¹Pu decays, as measured by 1985Wi04, and Iγ(148γ)=7.57 8 per 100 α decays (1985El03). Others: 1950Th54, 1958BiZZ, 1960Br15, 1961Sm03, 1963Iv01, 1966Be24, 1976GuZN, 1978VaZC. % branching of β, α and SF from T_{1/2} and partial T_{1/2}(SF) =6×10¹⁶ y (1985Dr09) and T_{1/2}(α)=5.8×10⁵ y (1966Be24). T_{1/2}: From 2013Cr05 who reanalyzed the data of 2009We08 (thermal ionization mass spectrometry (TIMS) and double ratio method) to include assumptions from experimental uncertainties. The data of 2009We08 with t_{1/2}=14.325 y 24 agrees well with the value by 2013Cr05 Others: 14.290 y 6 (1997De54), 14.355 y 40 (1989Pa21), 14.57 y 10 (1986Ti04), 14.38 y 2 (double ratio method in 1985Ag02), 14.38 y 6 (1980Ma45). For earlier measurements see 1978El02. See also 1987Ag03 for a compilation of measured half-lives. Discrepancies in the measurements were examined and explained by 1986Ha06 and 1987Ba84 in terms of chemical dependency of low-energy β decay. T_{1/2}(SF)=6×10¹⁶ y measured by 1985Dr09. See 1992Gr16 for calculation of T_{1/2}(SF) using a thermodynamic method. Jπ: M1+E2 γ to 5/2+ g.s. Reaction data. Jπ: E2 γ to 5/2+ g.s. Reaction data and band ass. Jπ: M1 γ to 9/2+ 96 level. Energy fit to 5/2[622] band. Jπ: Strongly fed by primary γ in (n,γ) from 1/2+ capture state. E2 γ to 5/2+. Energy fit to band. T_{1/2}: by pulsed beam-γ delay coincidence in ²⁴²Pu(d,tγ) reaction (1975Ya03). Jπ: M1 γ to 5/2+ g.s. Fed by primary γ in (n,γ) from 1/2+ capture state. Jπ: HF=1.0 for α decay from 7/2+ [624] in ²⁴⁵Cm. Jπ: E2 γ to 1/2+. M1+E2 γ to 7/2+. Jπ: M1+E2 γ's to 7/2+ and 9/2+. α hindrance factor. E(level): Unresolved in (³He,α). Jπ: Reaction data. Fit to 5/2[622] band. Jπ: E2 γ to 3/2+. M1+E2 γ to 9/2+. Jπ: M1 γ to 231 9/2+. α hindrance factor. Reaction data. Jπ: Populated strongly in average resonance (n,γ).</p>
41.9722& 9	7/2+	A DE G		
95.7795& 12	9/2+	A DEFGH		
161.314& 4	11/2+	A D FGH		
161.6853 ^a 9	1/2+	ABCDEFGH J	0.88 μs 5	
170.9399 ^a 9	3/2+	AB FGH		
175.0523 ^b 14	7/2+	A DE		
222.9879 ^a 11	5/2+	A GH		
231.935 ^b 9	9/2+	A D FG		
235?& 4	(13/2+)	H		
244.8895 ^a 13	7/2+	A FGH		
301.172 ^b 16	11/2+	D FGH		
337	1/2, 3/2	C		

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Adopted Levels, Gammas (continued)

²⁴¹Pu Levels (continued)

E(level) [†]	Jπ ^{‡§}	XREF	T _{1/2}	Comments
337.1363 ^a 23	9/2+	A FGH		Jπ: M1+E2 γ to 9/2+. E2 γ to 5/2+. Energy fit to band. Reaction data.
373 ^a 2	11/2+	G		Jπ: Energy fit to band.
376	1/2, 3/2	CD		Jπ: Populated strongly in average resonance (n,γ).
385 ^b 3	(13/2+)	D G		Jπ: Fit to band.
404.4526 ^c 17	(9/2)-	A E		Jπ: E1 γ's to 7/2+ and 9/2+ from the 404 and 409 levels allow Jπ=7/2- or 9/2- for both levels. 1998Wh01 assign these two levels as the 7/2- and 9/2- members of the 7/2[743] band whose 11/2 and 15/2 members have been established by reaction data at 446 and 570 keV. 1998Wh01 point out that the Alaga branching ratios predict that the strongest branch in decay of the 7/2[743] band head to the 5/2[622] band should be to the 5/2+ member of that band. This is the case in ²³⁹ Pu; however, this transition is not observed here. 1998Wh01 suggest that Coriolis mixing with the unobserved, but expected, 9/2[734] band may depress the 9/2 member of the 7/2[743] band below the 7/2 member, in which case the transition to the 5/2+ g.s., if present, would be very weak.
408.899 ^c 3	(7/2)-	A		Jπ: See comment for 404 level.
446 ^c 2	11/2-	FGH		Jπ: Reaction data.
473	(1/2, 3/2)	C		Jπ: Populated in average resonance (n,γ).
495 10		I		Jπ: Seen only in (d,d'). 1972Br46 suggest that this may be part of a rotational band built on a vibrational state.
503 ^a 3	13/2+	GH		Jπ: Reaction data.
518.8121 ^g 25	5/2- [#]	A E I		Jπ: E1 γ to 5/2+. E1+M2 to 7/2+. Agreement of branching ratios with Alaga rules for assigned band.
534.202 13	+	A		Jπ: E2 γ to 7/2+.
561.421 ^g 5	7/2- [#]	A E I		Jπ: E1+M2 γ's to 7/2+ and 9/2+. Agreement of branching ratios with Alaga rules for the assigned configuration. Also, probable E1+M2 γ to 5/2+.
570 ^c 2	15/2-	FGH		Jπ: Reaction data.
614.836 ^g 9	(9/2-) [#]	A I		
645 9		H		
681	(1/2, 3/2)	C		Jπ: Populated strongly in average resonance (n,γ).
755.1743 ^d 21	1/2+	ABC FGH		Jπ: M1 γ to 1/2+. Reaction data.
769.270 ^h 4	1/2-	ABC G		Jπ: E1 γ's to 1/2+ and 3/2+. Fit to a band.
779.1502 ^h 21	3/2-	A C G		Jπ: E1 γ's to 1/2+ and 5/2+.
784.1524 ^d 25	3/2+	AB		Jπ: M1 γ's to 1/2+ and 5/2+.
800.443 ^e 5	3/2+	ABC FG		Jπ: M1+E2 γ to 1/2+.
800.479 ^d 6	5/2+	A FG		Jπ: M1+E2 γ to 3/2+. E2 γ to 9/2+.
810.946 ^h 4	5/2-	A FG		Jπ: E1 γ's to 3/2+ and 7/2+.
831.587 ^e 7	5/2+	A FGH		Jπ: M1 γ to 7/2+. M1+E2 γ to 3/2+.
833.34 ^h 10	7/2-	A FG		Jπ: E1 γ to 9/2+. Fit to band.
834.839 17	3/2+, 5/2+, 7/2+	A E		Jπ: M1+E2 γ to 5/2+.
841.9574 ⁱ 22	1/2-	AB FG		Jπ: E1 γ's to 1/2+ and 3/2+. Fit to band.
850.5394 ⁱ 21	3/2-	ABC FG		Jπ: E1 γ'a to 1/2+ and 5/2+.
863 2		FG		
869.383 ^d 7	7/2+	A		Jπ: M1+E2 γ's to 5/2+ and 9/2+.
877 ^e 2	(7/2+)	F H		Jπ: Fit to band.
897.503? ^{@i} 22	(5/2-) [@]	A FG		
898 ^d 2	(9/2+)	FG		Jπ: Fit to band. Reaction data. Not resolved from 5/2+ in (d,p) and (d,t) datasets.
918 ^{@i} 2	(7/2-) [@]	FG		
929.70 20	3/2, 5/2, 7/2	E		Jπ: log ft=7.0 from 5/2+.
931 ^e 2	(9/2+)	FGH		Jπ: Fit to band. Reaction data.
937 ^h 2	(11/2-)	FG		Jπ: Fit to band.
940.311 10	3/2+	ABC		Jπ: M1+E2 γ to 5/2+. Fed by primary from 1/2+ capture state.
942.584 5	3/2+	AB		Jπ: M1+E2 γ to 1/2+.
950 3		FG		
964.940 ^f 10	1/2-	ABC FG		Jπ: M1 γ to 1/2-. Fit to band. Reaction data.
974 2		FG		
994 ^e 3	(11/2+)	FGH		Jπ: Fit to band. Reaction data.

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Adopted Levels, Gammas (continued) ^{241}Pu Levels (continued)

E(level) [†]	J $\pi^{\ddagger\S}$	XREF	T _{1/2}	Comments
995.603 f 11	3/2-	ABC	FG	J π : E1 γ 's to 1/2+ and 5/2+.
1009.438 7	3/2-	AB	G	J π : M1 γ 's to 1/2- and 5/2-.
1020 3	(1/2, 3/2)	C	F	J π : Average resonance capture to E(level)=1016. If different from the 1020 (d,p) level, then there is a (1/2,3/2) level at 1016 and a level at 1020 with unknown J π .
1049	(1/2, 3/2)	C		J π : Populated strongly in average resonance (n, γ).
1062 3			G	
1073	(1/2, 3/2)	C	F	J π : Populated in average resonance (n, γ).
1084 3			F	
1090.023 5	3/2-	ABC	GH	J π : M1+E2 γ to 1/2-.
1118 3			G	
1173	(1/2, 3/2)	C		J π : Populated in average resonance (n, γ).
1179 2	(9/2+)		GH	J π : From ($^3\text{He},\alpha$).
1196	(1/2, 3/2)	C		J π : Populated in average resonance (n, γ).
1206 3			FG	
1223.841 9	1/2, 3/2	AB	F	J π : Fed by primary from 1/2+ capture state. The two deexciting transitions have mult=E1, but the 444 γ feeds a 3/2- level and the 1053 γ feeds a 3/2+ level. One or both of these transitions must belong elsewhere.
1244 3			F	
1253.792 13	1/2-, 3/2-	AB	F	J π : E1 γ 's to 1/2+ and 3/2+.
1268.86 5	1/2, 3/2	B		J π : Fed by primary from 1/2+ capture state.
1277 4			F	
1288 4			F	
1296.70 5	3/2-	AB	F	J π : M1+E2 γ to 5/2-. Fed by primary from 1/2+ capture state.
1309 4			F	
1316.24 10	1/2, 3/2	B		J π : Fed by primary from 1/2+ capture state.
1347 3			F	
1351.60 20	1/2, 3/2	B	F	J π : Fed by primary from 1/2+ capture state.
1357.682 22	1/2, 3/2	AB	F	J π : Fed by primary from 1/2+ capture state. The two de-exciting transitions have mult=M1 or M1+E2, but the 516 γ feeds a 1/2- level and the 603 γ feeds a 1/2+ level. One or both of these transitions must belong elsewhere.
1362.83 8		B		
1384 3			F	
1390 6			G	
1441 4			F	
1452 5			F	
1472.08 12		B	G	
1478.18 13		B		
1489 5			F	
1501.32 21		B		
1505.21 19		B		
1513.97 10		B		
1523.73 5		B		
1530.91 20		B		
1546 5			F	
1594			F	
1611.02 3		B		
1762 3			F	
1801 4			F	
1826 4			F	
1868 5	(15/2)-		H	J π : L=7 in ($^3\text{He},\alpha$). 1971El02 propose the configuration 15/2-, 5/2[752].
1944 5			H	
1991 4			H	
$\approx 2045?$			H	
2199	(1/2, 3/2)	C		J π : Populated strongly in average resonance (n, γ).

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

²⁴¹Pu Levels (continued)

E(level) [†]	T _{1/2}	Comments
≈2200	20.5 μs 22	<p>%SF=100.</p> <p>Only SF decay has been observed.</p> <p>Γ(γ)/Γ(SF)<1 (no ce 161γ, 169γ observed) (1976BeZM).</p> <p>Theoretical calculations by 1972We09 estimate T_{1/2}(SF)/T_{1/2}(γ)=4.4×10⁻⁶/2.8×10⁻⁴.</p> <p>No α with E>7 MeV and T_{1/2}=10 μs – 0.01 s was observed (1973Be05).</p> <p>T_{1/2}: From 1981Gu04. Others: 23 μs 1 (1970Ga10), 27 μs 3 (1970Po01).</p> <p>E(level): 2.1 MeV (from spacings in neutron resonances, 1968Mi14), 2.90 MeV 15 (from excitation threshold, 1970Ga10), 2.6 MeV 3 (deduced by from data of 1970Ga10), 2.0 MeV 2 (from neutron resonance structure, 1973Br38). See 1972We09 for calculated level energy.</p> <p>Assignment: ²⁴²Pu(γ,n) excit (1970Ga10); ²⁴¹Pu(d,pn) excit; ²⁴⁰Pu(d,p) (1970Po01).</p>
2200+x	32 ns 5	<p>%SF=100.</p> <p>Only SF activity has been observed.</p> <p>T_{1/2}: Weighted mean from measured values of 30 ns 5 (1969La14) and 34 ns 7 (1981Gu04).</p> <p>E(level): the value of 'x' is not known. It could be a negative number. Systematics of short-lived SF isomers in plutonium isotopes suggest that x ≈100 keV.</p> <p>Assignment: ²⁴⁰Pu(13-MeV d,p) (1969La14); ²⁴²Pu(γ,n) (1981Gu04).</p>

[†] For levels seen in (n,γ), the energies are from a least-squares fit to the E_γ values. An additional uncertainty of 20 ppm due to the uncertainty in the E_γ calibration must be added to get absolute excitation energies.

[‡] 1998Wh01 contains a thorough discussion of the spin-parity assignments and the configurations based on their own work and earlier work.

[§] Assignments given as "Reaction data" are based on one or more of the following pieces of data. Cross sections, cross section ratios, measured L transfers, and on a comparison of the observed spectroscopic factors with calculated values. See 1998Wh01, 1972Br46, and 1971E102 for details.

[#] Levels at 495 10, 520 10, 560 10, and 620 10 are reported in (d,d') and suggested by the authors, 1972Br46, to be part of a rotational band built on a vibrational state. Levels at 519 and 561 are known from β⁻ decay, and 1998Wh01, in (n,γ), propose that these levels are the bandhead and first-excited state of a band with configuration 5/2[622]@0-. They further propose that the 9/2- member of this band lies at 615 keV, deexciting via a 573γ. No correspondence in (n,γ) with the 495 (d,d') level has been found. These levels decay only to the g.s. 5/2[622] band and are expected to have mult=E1; however, except for the 518.8γ, the α(K)exp values measured by 1998Wh01 in (n,γ) are all larger than the theoretical E1 value and require some M2 admixture. For the 561.44γ and 572.86γ, in fact, α(K)exp is larger than the E2 value. For consistency with the proposed configuration, the mults for the 561 and 572γ's are assumed to be E1+M2 rather than M1+E2. Note that if the 572γ is placed elsewhere, then the energy for the possible 9/2- band member would be 620 10, the value from (d,d').

[@] 1998Wh01 report a peak at 897 in their (d,p) and (d,t) work that they assign as the 9/2+ member of the 1/2[620] band, in agreement with the earlier assignment of 1972Br46. 1998Wh01 also establish the 1/2- and 3/2- members of the of the 1/2[620]x0- + 1/2[631]x0- band at 842 and 851. Both of these levels are seen in the authors' (d,p) and (d,t) work. They further propose that the 5/2- member of this band is defined by the 726.562γ feeding the 3/2+ 171 level, giving E(5/2-)=897.503 22. The 898 level seen in reaction data may thus be a doublet. The 726γ, however, has an α(K)exp that is consistent with E2, not with E1. If the placement is correct, the transition must have an M2 component. From inertial parameters derived from these levels, the authors then propose that the 918 level, also seen in their reaction data, is the 7/2- member of this band. See 1998Wh01 for a discussion of the configuration of this proposed band.

[&] (A): 5/2+[622] band.

a (B): 1/2+[631] band.

b (C): 7/2+[624] band.

c (D): 7/2-[743] band.

d (E): 1/2+[620] band.

e (F): 3/2+[631] band.

f (G): 1/2-[501] band.

g (H): 5/2-[622]@0- band.

h (I): 1/2[761] + 1/2[631]@0-.

i (J): 1/2[620]@0- + 1/2[631]@0-.

γ(²⁴¹Pu)

E(level)	E _γ [†]	I _γ [‡]	Mult. ^b	δg	α	Comments
41.9722	41.972 1	100	M1+E2	0.186 4	102.4 20	
95.7795	53.807 1	100	M1+E2	0.201 8	44.7 11	
	95.786 3	15 3	E2		19.3	
161.314	65.535 3	100	M1 (+E2)	≤0.44	27 8	
161.6853	161.685 1	100	E2		1.96	B(E2)(W.u.)=0.0221 13.
170.9399	170.940 1	100	M1		5.76	

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

 $\gamma(^{241}\text{Pu})$ (continued)

E(level)	$E_{\gamma}^{\dagger}$	$I_{\gamma}^{\ddagger}$	Mult. ^b	δg	α	Comments
175.0523	79.262 7	1.37 ^{&} 11	M1+E2	0.65 +25-22	22 6	
	133.081 2	28.9 ^{&} 3	M1+E2	0.222 9	11.36 17	
	175.051 2	100.0 ^{&} 10	M1+E2	0.217 19	5.21	
222.9879	52.048 2	21.6 24	M1+E2	0.498 6	100.3 19	
	61.303 1	36.4 12	E2		160.0	
	181.017 2	100.0 28	M1+E2	0.19 4	4.77 9	
	222.971 20	50.4 20	M1+E2	0.609 23	2.14 5	
231.935	56.89 [§] 3	16.5 ^a 11	M1+E2 ^c	0.68	92.4 14	E_{γ}, I_{γ} : Not seen in (n, γ) spectrum. Values are from ^{245}Cm α decay, where $I_{\gamma}/I_{\gamma}(190\gamma)=0.165$ 11. δ : From ^{245}Cm α decay. I_{γ} : Taken from $I_{\gamma}/I_{\gamma}(190\gamma)=0.555$ 16 in ^{245}Cm α decay. since the measured I_{γ} of 0.029 5 from 1998Wh01 is too large and apparently includes a contribution from a fission product γ -rays according to the authors. E_{γ} : From ce spectrum in 1998Wh01.
	136.127 20	55.5 ^a 15	M1+E2	0.63 21	9.0 10	
	189.965 10	100.0 ^a 15	M1+E2	0.63 +6-7	3.36 16	
	231.96 [§] 3	5.9 ^a 8	[E2]		0.497	
244.8895	73.950 1	100 6	E2		65.3	Mult.: $\alpha(\text{L2})_{\text{exp}}$ gives $\delta=1.8 +10-4$; however, placement in the level scheme requires $\Delta J=2$.
	149.107 6	62 9	M1		8.48	
	202.910 7	70 13	M1+E2	0.66 3	2.72 7	
301.172	69.17 [§] 6	78 ^a 44	M1(+E2) ^c	≤ 1.2	38 22	α : Symmetrized value. $\delta < 1.1$ gives $\alpha=25 +35-11$.
	126.09 [§] 4	78 ^a 22	[E2]		5.59	
	139.87 [§] 4	89 ^a 11	[M1, E2]		7 4	
	205.404 [§] 20	100 ^a 11	[M1, E2]		2.1 14	
337.1363	114.148 2	100 5	E2		8.55	
	241.381 17	54 6	M1+E2	1.8 3	0.85 13	
404.4526	308.674 2	39.6 6	E1		0.0389	
	362.479 2	100 1	E1		0.0276	
	$\approx 405^{\text{h}}$					E_{γ} : From β^- decay.
408.899	233.844 3	32.7 11	E1		0.0719	
	313.123 4	29.7 19	E1		0.0377	
	367.10 8	100 4	E1		0.0269	
518.8121	476.840 3	32.4 17	E1+M2 ^d	0.104 +20-25	0.025 4	
	518.810 4	100	E1		0.01340	
534.202	359.149 13	100	E2		0.1240	Mult.: $\alpha(\text{K})_{\text{exp}}$ gives $\delta > 5.2$.
561.421	465.646 5	54.4 21	E1+M2 ^d	0.088 +21-28	0.024 4	
	519.433 8	100 7	E1+M2 ^d	0.24 +9-11	0.05 3	
	561.437 20	69 4	(E1+M2) ^e	0.27 4	0.048 11	
614.836	572.863 9	100	(E1+M2) ^e	0.18 5	0.027 10	
755.1743	593.488 4	100 1	M1		0.186	Mult.: $\alpha(\text{K})_{\text{exp}}$ gives $\delta < 0.64$.
	755.154 14	21.5 19	E2		0.0214	Mult.: $\alpha(\text{K})_{\text{exp}}$ gives $\delta > 3.2$.
769.270	598.328 6	100 2	E1		0.01021	
	607.580 5	62.5 16	E1		0.00992	
779.1502	556.164 3	100 17	E1		0.01172	
	608.229 9	14.8 6	E1		0.00990	
	617.457 5	73.6 11	E1		0.00962	
784.1524	561.168 4	100.0 23	M1(+E2)	≤ 0.66	0.19 3	
	622.464 14	8.5 6	M1(+E2)	≤ 0.71	0.142 23	
	784.153 16	23.0 7	E2		0.0198	Mult.: $\alpha(\text{K})_{\text{exp}}$ gives $\delta > 3.1$.
800.443	638.757 5	100.0 23	M1+E2	0.68 22	0.114 18	
	758.494 [@]	$\leq 37^{\text{@}}$				
	800.461 [#]	$\leq 71^{\text{#}}$				
800.479	629.539 6	100.0 20	M1+E2	0.57 23	0.128 19	
	704.70 14	6.2 17	E2		0.0247	Mult.: $\alpha(\text{K})_{\text{exp}}$ gives $\delta > 4.5$.
	758.494 [@]	$\leq 27^{\text{@}}$				
	800.461 [#]	$\leq 52^{\text{#}}$				

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

 $\gamma(^{241}\text{Pu})$ (continued)

E(level)	$E\gamma^{\dagger}$	$I\gamma^{\ddagger}$	Mult. ^b	δg	α	Comments
810.946	566.057 4	100 4	E1		0.01134	
	587.953 24	8.5 9	[E1]		0.01055	
	640.001 6	94 3	E1		0.00900	
831.587	586.703 16	16.4 17	M1(+E2)	≤ 0.32	0.185 8	
	608.608 10	63.9 20	M1+E2	0.54 +23-26	0.142 22	
	660.625 13	100 5	M1+E2	0.54 24	0.114 17	
	789.63 4	37 4	M1+E2	0.6 3	0.069 13	
833.34	496.2 1		E1		0.01462	
834.839	834.837 17		M1+E2	0.94 +25-20	0.048 7	
841.9574	57.806 2	17.6 27	E1		0.555	
	86.783 1	35.6 16	E1		0.191	
	671.007 9	81 4	E1		0.00824	
	680.274 16	100.0 27	(E1)		0.00804	
850.5394	71.390 2	3.15 23	M1+E2	0.10 +4-5	15.7 7	
	95.365 1	5.8 3	E1		0.1495	
	627.552 5	100.0 19	E1		0.00933	
	688.851 14	50.8 18	E1		0.00785	
869.383	68.904 2	15 3	M1+E2	0.14 5	18.1 12	
	773.59 4	100 11	M1+E2	1.2 +4-3	0.050 11	
897.503?	726.562 ^h 22		(E1+M2) ^f	0.24 4	0.021 5	
929.70	929.7 2					$E\gamma, I\gamma$: From β^- decay.
940.311	185.132 22	0.18 9				
	765.23 3	9.6 7				
	940.315 12	100 4	M1+E2	1.09 +28-21	0.032 5	
942.584	187.414 6	2.2 5	M1+E2	1.1 3	2.6 6	
	771.64 4	8 5	M1+E2	1.5 +52-7	0.043 22	
	780.889 8	100.0 17	M1+E2	0.57 23	0.072 10	
	942.58 4	26 3				
964.940	195.669 10	3.5 5	M1		3.93	
	793.95 5	100 8	[E1]		0.00607	
	803.265 19	53.9 15	E1		0.00595	
995.603	772.645 21	60 6	E1		0.00638	
	833.904 13	100 4	E1		0.00557	
1009.438	240.167 12	8.2 10	M1(+E2)	≤ 0.33	2.13 10	
	490.624 9	38 3	M1(+E2)	≤ 0.6	0.28 4	
	786.454 16	100 6	[E1]		0.00618	
1090.023	239.493 8	72 7	M1(+E2)	≤ 0.35	2.13 11	
	248.066 6	100 8	M1+E2	0.28 5	1.90 5	
	320.746 7	74 5	M1(+E2)	≤ 0.47	0.92 8	
1223.841	444.687 ^h 9	15.4 22	E1		0.0182	Mult.: See comment on $J\pi(1224)$ level).
	1052.93 ^h 3	100 5	E1		0.00370	Mult.: See comment on $J\pi(1224)$ level).
1253.792	403.260 14	6.9 10	M1+E2	2.9 +9-6	0.137 24	
	1082.80 4	70 4	E1		0.00353	
	1092.08 5	100 6	E1		0.00348	
1296.70	496.217	≤ 377	(E1)		0.01462	
	777.89 5	100 10	M1+E2	0.88 +30-24	0.060 11	
1357.682	515.70 ^h 3	46 9	M1+E2	1.0 +5-3	0.16 5	Mult.: See comment on $J\pi(1358)$ level).
	602.53 ^h 3	100 23	M1(+E2)	≤ 0.82	0.15 3	Mult.: See comment on $J\pi(1358)$ level).

[†] From (n, γ), except where noted otherwise. See (n, γ) for a listing of unplaced transitions.

[‡] Relative photon branching from each level. Data are from (n, γ), except where noted otherwise.

[§] From α decay.

[#] The authors report E=800.461 11 doubly placed from the 800.44 and 800.48 levels. $I\gamma/I\gamma(638.8\gamma)=0.688$ 28 and $I\gamma/I\gamma(629.5\gamma)=0.498$ 20, respectively, for these two placements. These transitions are not included in the least-squares fit. For these placements, the least-squares fit gives $E\gamma=800.443$ 5 and $E\gamma=800.478$ 6, respectively.

[@] The authors report E=758.494 15 doubly placed from the 800.44 and 800.48 levels. $I\gamma/I\gamma(638.8\gamma)=0.349$ 16 and $I\gamma/I\gamma(629.5\gamma)=0.253$ 11, respectively for these two placements. These transitions are not included in the least-squares fit. For these placements, the least-squares fit gives $E\gamma=758.470$ 6 and $E\gamma=758.506$ 6, respectively.

[&] Weighted average from (n, γ) and α decay.

^a From α decay.

^b From (n, γ), except where noted otherwise.

^c From α decay.

Adopted Levels, Gammas (continued)

 $\gamma(^{241}\text{Pu})$ (continued)

- ^d $\alpha(\text{K})_{\text{exp}}$ lies between the theory values for E1 and E2. Its placement in the level scheme requires $\Delta\pi=\text{yes}$. See footnote on $J\pi$ for the 519 level.
- ^e $\alpha(\text{K})_{\text{exp}}$ is larger than the E2 theory value; however, placement in the level scheme requires $\Delta\pi=\text{yes}$. See footnote on $J\pi$ for the 561 level.
- ^f $\alpha(\text{K})_{\text{exp}}$ is consistent with the E2 theory value; however, placement in the level scheme requires $\Delta\pi=\text{yes}$. See footnote on $J\pi$ for the 897.5 level.
- ^g If no value given it was assumed $\delta=1.00$ for E2/M1, $\delta=1.00$ for E3/M2 and $\delta=0.10$ for the other multipolarities.
- ^h Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas (continued)

(A) 5/2+[622] band

(B) 1/2+[631] band

(C) 7/2+[624] band

(D) 7/2-[743] band

 $15/2-$ 570 $13/2+$ 503 $11/2-$ 446 $(7/2)-$ 408.899 $(9/2)-$ 404.4526 $11/2+$ 373 $(13/2+)$ 385 $9/2+$ 337.1363 $11/2+$ 301.172 $(13/2+)$ 235 $7/2+$ 244.8895 $5/2+$ 222.9879 $9/2+$ 231.935 $3/2+$ 170.9399 $1/2+$ 161.6853 $7/2+$ 175.0523 $(A)11/2+$ $11/2+$ 161.314 $9/2+$ 95.7795 $(A)9/2+$ $(A)9/2+$ $(A)9/2+$ $7/2+$ 41.9722 $(A)7/2+$ $(A)7/2+$ $(A)7/2+$ $5/2+$ 0.0 $(A)5/2+$ $(A)5/2+$ $(A)5/2+$ $^{241}_{94}\text{Pu}_{147}$

Adopted Levels, Gammas (continued)

Adopted Levels, Gammas (continued)

 (I) $1/2[761] + 1/2[631] \otimes 0-$

 (J) $1/2[620] \otimes 0- + 1/2[631] \otimes 0-$

²⁴¹Np β⁻ Decay 1981Pa20

Parent ²⁴¹Np: E=0.0; Jπ=5/2⁺; T_{1/2}=13.9 min 2; Q(g.s.)=1300 70; %β⁻ decay=100.

²⁴¹Np-J: From Adopted Levels in ²⁴¹Np.

²⁴¹Np-T_{1/2}: From least squares decay analyses of the 175 keV γ.

²⁴¹Np-Q(β⁻): From 2012Wa38.

1981Pa20: ²⁴¹Np produced via ²³⁸U(α,p) with Eα=32 MeV and ²⁴⁴Pu(n,p3n) with En=30-160 MeV at the Brookhaven MEIN facility. Irradiation were followed by chemical separation. Decay of ²⁴¹Np was studied by γ spectroscopy using a high resolution Ge(Li) detector and by β emission by a 4π proportional counter. Measured Eγ, absolute Iγ, and T_{1/2}.

1966Qa02: ²⁴¹Np produced via ²³⁸U(α,p) at Nuffield Cyclotron at Birmingham University with Eα= 40 MeV. Irradiation was followed by chemical separation. A Geiger counter, anthracene crystal scintillation β spectrometer, Xe proportional counter, NaI(Tl) detector, and a ZnS-Ag scintillation α counter were used to measure γ and β radiations. The half life from decay curves for ²⁴¹Np was 16.0 min 2 with an end-point energy of 1.25 MeV. The 3.4 hour activity was not detected.

1959Va32: ²⁴¹Np produced via ²³⁸U(α,p) at Argonne cyclotron followed by chemical separation and measured with a 2π and end window proportional counters. β and γ spectrum were measured with the anthracene crystal and a NaI(Tl) detectors. The beta spectrum end point energy of the 16 minute component was 1.36 MeV 10 with logft of 5.8.

²⁴¹Pu Levels

E(level) [†]	Jπ [‡]	Comments
0.0	5/2 ⁺	
41.97	7/2 ⁺	
95.78	9/2 ⁺	
161.69	1/2 ⁺	E(level): The feeding of this level has not been established. It cannot be directly fed by a β branch, and no transitions feeding the level have been observed.
175.05	7/2 ⁺	
404.45	(9/2) ⁻	Jπ: See comment on Jπ(404 level) in adopted levels.
518.81	5/2 ⁻	
561.42	7/2 ⁻	
834.84	3/2 ⁺ , 5/2 ⁺ , 7/2 ⁺	
929.7 2	3/2, 5/2, 7/2	

[†] Rounded-off values from adopted levels, except for the 930 level, whose de excitation transition is seen only in β decay.

[‡] From Adopted Levels.

β⁻ radiations

Eβ ⁻	E(level)	Iβ ^{-†‡}	Log ft	Comments
(370 70)	929.7	0.080 20	7.0 4	
(470 70)	834.84	=0.12	=7.1	
(740 70)	561.42	0.28 6	7.41 18	
(780 70)	518.81	0.42 4	7.32 15	
(900 70)	404.45	0.27 3	7	
(1120 70)	175.05	30.8 15	6.00 10	
(1260 70)	41.97			Iβ ⁻ : The intensity balance gives Iβ ⁻ =2 4.
1300 70	0.0	70 4	5.87 9	Eβ ⁻ : From adopted Q(β ⁻). Measured values are 1360 100 (1959Va32) and 1250 (1966Qa02).

[†] From an intensity balance at each level.

[‡] Absolute intensity per 100 decays.

γ(²⁴¹Pu)

Iγ normalization: Iγ(133γ)=0.86 5 per 100 disintegrations (4π proportional counter 1981Pa20).

Eγ [†]	E(level)	Iγ ^a	Mult. [‡]	δ ^{‡&}	α	Comments
42.0 1	41.97	0.10 3	M1+E2	0.186 4	102.2 22	
(53.81 [#])	95.78	0.020 ^{\$} 6	M1+E2	0.201 8	44.7 11	
(79.26 [#])	175.05	0.040 4	M1+E2	0.65 +25-22	22 6	Iγ: From Iγ/Iγ(133γ+175γ)=0.010 1 in α decay.
(95.79 [#])	95.78	0.003 ^{\$} 1	E2		19.3	
133.1 1	175.05	0.86 5	M1+E2	0.222 9	11.35 17	
161.6 2	161.69	0.07 1	E2		1.97	
175.1 1	175.05	3.1 2	M1+E2	0.217 19	5.20	

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²⁴¹Np β⁻ Decay 1981Pa20 (continued)

γ(²⁴¹Pu) (continued)

Eγ [†]	E(level)	Iγ ^a	Mult. [‡]	δ [‡] &	α	Comments
308.8 2	404.45	0.07 2	E1		0.0388	
362.4 1	404.45	0.19 2	E1		0.0276	
≈405 ^b	404.45					Eγ: Only a slight indication for its existence was found in the γ spectrum. One expects Eγ=404.453. This transition is not seen in (n,γ). If one assumes that Iγ is smaller than that for the adjacent 404.707 and 405.90 γ's in (n,γ), one can estimate Iγ<0.01.
(465.65 [#])	561.42	0.064 17	E1+M2	0.088 +21-28	0.024 4	Iγ: From Iγ/Iγ(519γ+562γ)=0.321 20 in (n,γ).
476.6 2	518.81	0.10 1	E1+M2	0.104 +20-25	0.025 4	
518.81 [@]	518.81	0.31 [@] 3	E1		0.01340	
519.43 [@]	561.42	0.12 [@] 4	E1+M2	0.24 +9-11	0.05 3	
561.1 2	561.42	0.08 3	(E1+M2)	0.27 4	0.048 11	
834.6 2	834.84	0.11 3	M1+E2	0.94 +25-20	0.048 7	
929.7 2	929.7	0.08 2				

[†] From 1981Pa20. Others: 1966Qa02.

[‡] From (n,γ) as given in adopted γ's.

[§] From an intensity balance at the 96 level and Iγ(96γ)/Iγ(54γ)=0.15 3 from (n,γ).

[#] Rounded-off value from adopted γ's. Not seen in β decay.

[@] The authors report Eγ=518.8 1 with Iγ=0.44 3 for a transition doubly placed from the 519 and 561 levels. From Iγ/Iγ(477γ)=3.09 16 for the 519 level, and Iγ/Iγ(561γ)=1.45 13 for the 561 level, both from (n,γ), one gets Iγ=0.31 3 and 0.12 4 for these two placements, in agreement with the measured value for the doublet. The energies are rounded-off values from (n,γ).

& If no value given it was assumed δ=1.00 for E2/M1, δ=1.00 for E3/M2 and δ=0.10 for the other multipolarities.

^a Absolute intensity per 100 decays.

^b Placement of transition in the level scheme is uncertain.

Decay Scheme

²⁴⁵Cm α Decay 1975Ba65,1994Sh31,1980Di13

Parent ²⁴⁵Cm: E=0.0; J π =7/2⁺; T_{1/2}=8423 y 74; Q(g.s.)=5622.0 5; % α decay=100.

²⁴⁵Cm-J,T_{1/2}: From Adopted Levels in ²⁴⁵Cm (2011Br03).

²⁴⁵Cm-Q(α): the evaluator adopts Q(α)=5622.0 5, a weighted average of values deduced from α branches to the g.s., 42, 96, 175, 232, and 301 levels. The authors of 2012Wa38 gave an adjusted value of Q(α)=5623.0 10 from 1975Ba65. 2012Ch30: Energy and intensity from ²⁴⁵Cm α decay were evaluated by the Decay Data Evaluation Project (DDEP) which are based generally on 2005Ma88.

1998Wh01: α decay from a 0.3 mg ²⁴⁵Cm source was measured with a Ge(Li) detector and pulse height analyzer.

1994Sh31: Alpha decay of a ²⁴⁵Cm source prepared at Argonne National Laboratory by chemical separation. Measured $\gamma\gamma$ coincidence using two HpGe detectors with one surrounded by a BGO compton suppression shield and a Low Energy Photon Spectrometer (LEPS). $\alpha\gamma$ coincidence was measured with a Si(Au) surface barrier detector and a HpGe detector.

1991Po17: Measured γ emission from decay of the radio-chemically separated ²⁴⁵Cm using Ge(Li) detectors.

1980Di13: α decay from ²⁴⁵Cm. Gammas measured by 90 cm² Ge(Li) detector and an X-ray detector.

1976BaZZ: Review of status of alpha decay data for transactinium isotopes.

1975Ba65: α decay from ²⁴⁵Cm studied using a magnetic spectrograph. Measured E α and I α .

1966Ba07: α decay from ²⁴⁵Cm studied using a magnetic spectrograph; measured E α and I α . γ spectra were measured for energy region up to 100 keV with a proportional counter and for medium energy gammas (60–500 keV) with a Ge detector. $\alpha\gamma$ coincidence measured with a semiconductor detector and a NaI(Tl) scintillation spectrometer.

1966Fr03: α decay from ²⁴⁵Cm studied using a Si surface barrier detector; measured E α and I α . γ spectrum measured with NaI and GeLi detectors.

²⁴¹Pu Levels

E(level) [†]	J π [‡]	T _{1/2}	Comments
0.0	5/2 ⁺	14.290 y 6	T _{1/2} : From Adopted Level.
41.969 14	7/2 ⁺		
95.786 3	9/2 ⁺		
161.26 3	11/2 ⁺		
161.73 5	1/2 ⁺		
175.043 17	7/2 ⁺		
231.933 13	9/2 ⁺		
260.5? 13			
301.166 17	11/2 ⁺		
$\approx$ 376	1/2, 3/2		
$\approx$ 384			

[†] From least-squares fit to E γ data.

[‡] From Adopted Levels.

α radiations

E α [†]	E(level)	I α #&	HF@	Comments
$\approx$ 5119	$\approx$ 376	$\leq$ 0.004	$\geq$ 1370	
$\approx$ 5151	$\approx$ 384	$\leq$ 0.005	$\geq$ 974	
5234.4 12	301.166	0.32	51	
5272.8 ^a 12	260.5?	0.07	419	E α : May possibly belong to ²⁴³ Am α decay (1975Ba65).
5304.3 [§] 10	231.933	5.0 1	8.78 20	E α : The uncorrected measurements are 5303.8 12 (1975Ba65) and 5303 2 (1966Fr03).
5361.1 [§] 11	175.043	93.2 5	1.043 12	I α : From 1976BaZZ. An intensity balance at the 231 level gives I α =5.0 2. E α : The uncorrected measurements are 5362.0 12 (1975Ba65) and 5356 2 (1966Fr03).
				I α : From 1976BaZZ. An intensity balance at the 175 level gives I α =94.6 21.
5371.1 [‡] 5	161.73	0.020 1	5840 300	I α : From an intensity balance at the 161.72 level.
5371.6 [‡] 5	161.26	0.43 18	270 120	I α : From an intensity balance at the 161.26 level.
5436.1 5	95.786	0.04	7197	
5488.5 5	41.969	0.83	715	
5529.0 [§] 5	0.0	0.58	1786	E α : The uncorrected measurements are 5529.2 5 (1975Ba65) and 5527 3 (1966Fr03).

[†] From 1975Ba65, except where noted otherwise. The authors' values have been lowered by 0.2 keV as recommended by 1991Ry01 to account for changes in calibrations energies. Others: 1954Hu50, 1963Dz07, 1966Fr03, 1966Ba07.

[‡] From E(level) and Q(α). E α = 5370 was measured for the doublet.

Footnotes continued on next page

²⁴⁵Cm α Decay 1975Ba65,1994Sh31,1980Di13 (continued)

 α radiations (continued)

§ Weighted average of values of 1975Ba65 and 1966Fr03 as recommended by 1991Ry01, and including the corrections recommended by 1991Ry01 to account for changes in the calibration energies, -0.2 keV for 1975Ba65 and +3.3 for 1966Fr03.

From 1975Ba65, except where noted otherwise. Others: 1966Ba07.

@ $r_0=1.4966$ 8, average of $r_0(^{240}\text{Pu})=1.4979$ 7 and $r_0(^{242}\text{Pu})=1.4954$ 10, is used in the calculations.

& Absolute intensity per 100 decays.

^a Existence of this branch is questionable.

 $\gamma(^{241}\text{Pu})$

$\alpha\gamma$ coin: (133 γ)(5360 α), (174 γ)(5360 α) (1966Ba07) and (205 γ)(=5230 α), (232 γ)(=5300 α) (1994Sh31).

K x-rays (Pu):

1980Di13

I(x-rays)
relative to
E(x ray) I γ (175 γ)=100

99.55 3	198 7	K α_2 x ray
103.76 3	306 10	K α_1 x ray
116.27 6	39.4 22	K β_3 x ray
117.26 6	70.7 32	K β_1 x ray
120.60 15	27.2 16	K β_2 x ray
121.55 6	9.6 13	K-O ₂ x ray + K-O ₃ x ray

M and L x-rays(Pu):

see 1990Po14 for intensities measured
relative to I(L γ x ray+L β x ray).

I γ normalization: From two sources referenced by 1994Sh31. 1980Di13 report relative I γ values along with

I γ (175 γ)=9.5 7 per 100 ²⁴⁵Cm α decays. The values from the thesis referenced by 1994Sh31 report I γ (175 γ)=10.1 1 per 100 ²⁴⁵Cm α decays. With I γ values chosen as a weighted average from these two sources, the total I γ (1+ α) feeding the g.s. is 102 4. With I α (g.s.)=0.58, given with no uncertainty, but assumed by the evaluator to be accurate to 0.6 1, one gets I γ normalization=I(γ +ce) normalization=0.97 17. This normalization is adopted by the evaluator. It gives I γ (175 γ)=9.8 3.

E $\gamma^{\dagger}$	E(level)	I $\gamma^{\ddagger}$ @	Mult.§	$\delta^{\S\#}$	α	I(γ +ce)@	Comments
41.93 3	41.969	0.374 31	M1+E2	0.186 4	102.8 20		
53.73 4	95.786	0.075 5	M1+E2	0.201 8	44.9 11		
56.89 3	231.933	0.0345 22	M1+E2	0.68	92.4 14	3.1 2	E γ : From 1998Wh01. 1994Sh31 report E γ =56.79 4. I(γ +ce): From an intensity balance at the 232 level. Mult., δ : From I(γ +ce) and I γ one deduces α =92 8 which corresponds to mult=M1+E2 with δ =0.68.
65.44 4	161.26	0.018 4	M1(+E2)	≤ 0.44	27 8		
69.17 6	301.166	0.007 3	M1(+E2)	≤ 1.2	38 22	0.18 5	E γ : Reported only by 1980Di13, but adopted in the level scheme of 1994Sh31. I(γ +ce): From an intensity balance at the 301 level, with a 10% uncertainty assigned to the α branch feeding this level. Mult., δ : From I(γ +ce) and I γ one deduces α =26 +33-11 which corresponds to mult=M1(+E2) with δ ?<1.2.
79.27 4 (95.786 3)	175.043 95.786	0.132 13 0.0112 23	M1+E2 E2	0.65 +25-22	22 6 19.3		E γ ,I γ : Obscured by the K α_2 x ray (1980Di13). The energy is from the adopted level scheme and the intensity is from I γ (96 γ)/I γ (54 γ)=0.15 3 in adopted gammas.
126.09 4	301.166	0.007 2	[E2]		5.59		E γ ,I γ : Reported only by 1998Wh01.
133.08 3	175.043	2.89 3	M1+E2	0.222 9	11.36 17		

Continued on next page (footnotes at end of table)

²⁴⁵Cm α Decay 1975Ba65,1994Sh31,1980Di13 (continued)

 $\gamma(^{241}\text{Pu})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger@$	Mult.§	$\delta^\S\#$	α	Comments
136.127 20	231.933	0.116 3	M1+E2	0.63 21	9.0 10	E γ : From 1998Wh01. 1994Sh31 report E γ =136.15 4.
139.87 4	301.166	0.008 1	[M1, E2]		7 4	E γ : From 1998Wh01. 1994Sh31 report E γ =139.80 4. I γ : Weighted average of values of 1994Sh31 and 1998Wh01.
161.73 5	161.73	0.0068 2	E2		1.96	
175.01 3	175.043	10.1 1	M1+E2	0.217 19	5.21	
189.965 10	231.933	0.209 3	M1+E2	0.63 +6-7	3.36 16	E γ : From 1998Wh01. 1994Sh31 report E γ =189.94 4.
205.404 20	301.166	0.009 1	[M1, E2]		2.1 14	E γ : From 1998Wh01. 1994Sh31 report E γ =205.58 7. I γ : Weighted average of values of 1994Sh31 and 1998Wh01.
231.96 3	231.933	0.0123 16	[E2]		0.497	E γ : From 1998Wh01. 1994Sh31 report E γ =232.17 7.
*388.16 5		0.019 1				E γ , I γ : Reported only by 1998Wh01.

† Weighted average values from 1994Sh31 unless stated otherwise. Transitions with energy 89.58, 93.82, and 165.3 reported by 1980Di13 have been shown by 1994Sh31 to be Ge escape peaks. While the reported 185.8 and 210.6 transitions are background and ²⁴³α decay contaminant, respectively. Others: 1998Wh01, 1991Po17, 1966Ba07.

‡ Weighted average of values in 1994Sh31, except where noted otherwise. Note: for I γ from 1998Wh01, the transitions listed in the authors' Table I (1998Wh01) with footnote *i* should be divided by 10 and for I γ from values in Table 1 of 1994Sh31 should be multiplied by 100.

§ From adopted levels, except where noted otherwise.

If no value given it was assumed $\delta=1.00$ for E2/M1, $\delta=1.00$ for E3/M2 and $\delta=0.10$ for the other multiplicities.

@ For absolute intensity per 100 decays, multiply by 0.975.

* γ ray not placed in level scheme.

Decay Scheme

Intensities: I(γ +ce) per 100 decays by this branch

²⁴⁰Pu(n,γ) E=th: Primary γ's 1998Wh01

1998Wh01: Primary gammas measured with a three-crystal pair spectrometer located at GAMS1 spectrometer at Institut-Langevin, Grenoble. The pair spectrometer consist of Ge(Li) and two Na(Tl) detectors for coincidence detection of the 511 keV annihilation radiations.
1972Br46:²⁴⁰Pu source from α decay of ²⁴⁰Cm irradiated with thermal neutrons from Argonne CP-5 reactor. Measured γ rays with a Ge(Li) detector.

²⁴¹Pu Levels

E(level) [†]	Jπ [‡]	Comments
161.72 2	1/2+	E(level): Observed also by 1972Br46 with E=162 2.
169.7 10	3/2+	
755.34 19	1/2+	E(level): Observed also by 1972Br46 with E=755 2.
769.24 4	1/2-	E(level): Observed also by 1972Br46 with E=770 2.
784.11 3	3/2+	
800.41 9	3/2+	
834 3	3/2+, 5/2+, 7/2+	E(level): Observed only by 1972Br46.
841.99 10	1/2-	E(level): Observed also by 1972Br46 with E=845 3.
850.56 3	3/2-	
940.28 5	3/2+	
942.58 6	3/2+	
964.92 2	1/2-	E(level): Observed also by 1972Br46 with E=970 3.
995.69 4	3/2-	
1009.49 5	3/2-	
1090.00 2	3/2-	E(level): Observed also by 1972Br46 with E=1094 3.
1223.74 6	1/2, 3/2	
1253.80 2	1/2-, 3/2-	
1268.86 5	1/2, 3/2	E(level): The authors' uncertainty of 0.03 keV appears to be a misprint since the uncertainty in the primary transition is 0.05 keV.
1296.73 4	3/2-	E(level): The authors' uncertainty of 0.02 keV appears to be a misprint since the uncertainty in the primary transition is 0.04 keV.
1316.24 10	1/2, 3/2	
1351.60 20	1/2, 3/2	
1357.65 4	1/2, 3/2	E(level): The authors' uncertainty of 0.02 keV appears to be a misprint since the uncertainty in the primary transition is 0.04 keV.
1362.83 8		
1472.08 12		
1478.18 13		
1501.32 21		
1505.21 19		
1513.97 10		
1523.73 5		E(level): The authors' uncertainty of 0.04 keV appears to be a misprint since the uncertainty in the primary transition is 0.05 keV.
1530.91 20		
1611.02 3		
(5241.52 3)	1/2+	E(level): Neutron capture state. E=S(n)=5241.52 3 in 2012Wa38. Jπ: From s-wave n capture by the g.s of ²⁴⁰ Pu with Jπ=0+.

[†] Except as noted, the energies are from population of the primary transitions from the capture state in 1998Wh01, along with the level energies deduced from the secondary gammas from the same work yield S(n)=5241.57 3, as given by the authors. The level energies listed here have been deduced by the authors using this value of S(n). The uncertainties do not include the uncertainty in S(n).

[‡] From Adopted Levels except as noted.

γ(²⁴¹Pu)

Eγ	E(level)	Iγ [†]	Eγ	E(level)	Iγ [†]	Eγ	E(level)	Iγ [†]
3630.52 3	(5241.52)	2.4 6	3878.71 8	(5241.52)	2.12 14	4151.53 2	(5241.52)	6.6 3
3710.63 20	(5241.52)	1.9 5	3883.89 4	(5241.52)	13.0 7	4232.04 5	(5241.52)	1.65 10
3717.81 5	(5241.52)	4.67 27	3889.94 20	(5241.52)	1.9 4	4245.84 4	(5241.52)	2.39 14
3727.57 10	(5241.52)	1.49 11	3925.30 10	(5241.52)	0.90 6	4276.61 2	(5241.52)	6.1 3
3736.33 19	(5241.52)	0.74 8	3944.81 4	(5241.52)	12.7 7	4298.95 6	(5241.52)	2.50 28
3740.22 21	(5241.52)	0.64 8	3972.68 5	(5241.52)	0.54 3	4301.25 5	(5241.52)	2.7 3
3763.36 13	(5241.52)	0.58 5	3987.74 2	(5241.52)	6.4 3	4390.97 3	(5241.52)	5.42 4
3769.46 12	(5241.52)	0.58 12	4017.80 6	(5241.52)	3.19 23	4399.54 10	(5241.52)	2.12 15

Continued on next page (footnotes at end of table)

$^{240}\text{Pu}(\text{n},\gamma)$ E=th: Primary γ 's 1998Wh01 (continued) $\gamma(^{241}\text{Pu})$ (continued)

E_γ	E(level)	$I_\gamma^\dagger$
4441.12 9	(5241.52)	0.53 3
4457.42 3	(5241.52)	2.34 13
4472.29 4	(5241.52)	3.7 3
4486.19 19	(5241.52)	0.48 5
5071.8 10	(5241.52)	0.58 24
5079.80 2	(5241.52)	2.76 14

† Relative photon intensities in arbitrary units.

 $^{240}\text{Pu}(\text{n},\gamma)$ E=th: Secondary γ 's 1998Wh01

Evaluator would like to acknowledge M. Martin (ORNL) for assisting in this dataset and for providing copies of the private communication between him and R.W.Hoff (co-author of 1998Wh01).

1998Wh01: Secondary gammas measured using curved crystal spectrometer GAMS1 and GAMS2/3 at Institut-Langevin, Grenoble. GAMS1 was used to measure γ rays between 35–500 keV and GAMS2/3 was used to measure the 15–1500 keV γ rays. Conversion electrons were studied with the BILL electron spectrometer.

 ^{241}Pu Levels

E(level) ‡	$J\pi^\dagger$	Comments
0.0 §	5/2+	
41.9722 § 9	7/2+	
95.7795 § 12	9/2+	
161.315 § 4	11/2+	
161.6853 $^\#$ 9	1/2+	
170.9399 $^\#$ 9	3/2+	
175.0523 $^\circ$ 14	7/2+	
222.9879 $^\#$ 11	5/2+	
231.934 $^\circ$ 9	9/2+	
244.8895 $^\#$ 13	7/2+	
337.1363 $^\#$ 23	9/2+	
404.4526 $^\&$ 17	(9/2)–	
408.899 $^\&$ 3	(7/2)–	
518.8121 $^\text{d}$ 25	5/2–	
534.202 13	+	
561.421 $^\text{d}$ 5	7/2–	
614.836 $^\text{d}$ 9	(9/2)–	
755.1743 $^\text{a}$ 21	1/2+	
769.270 $^\text{e}$ 4	1/2–	
779.1504 $^\text{e}$ 21	3/2–	
784.1525 $^\text{a}$ 25	3/2+	
800.443 $^\text{b}$ 5	3/2+	
800.479 $^\text{a}$ 6	5/2+	
810.945 $^\text{e}$ 4	5/2–	
831.587 $^\text{b}$ 7	5/2+	
833.4 $^\text{e}$ 10	7/2–	E(level): See comment on the 496 γ doublet.
834.839 17	3/2+, 5/2+, 7/2+	
841.9575 $^\text{f}$ 22	1/2–	
850.5395 $^\text{f}$ 21	3/2–	
869.383 $^\text{a}$ 7	7/2+	
897.503? $^\text{f}$ 22	(5/2)–	
940.311 10	3/2+	
942.584 5	3/2+	
964.940 $^\text{c}$ 10	1/2–	
995.603 $^\text{c}$ 11	3/2–	
1009.438 7	3/2–	$J\pi$: M1 γ 's to 1/2– and 5/2–.
1090.023 5	3/2–	
1223.841 9	1/2, 3/2	
1253.792 13	1/2–, 3/2–	

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²⁴⁰Pu(n,γ) E=th: Secondary γ's 1998Wh01 (continued)

²⁴¹Pu Levels (continued)

E(level) [‡]	Jπ [†]
1296.70 5	3/2-
1357.682 22	1/2, 3/2

[†] From Adopted Levels.

[‡] From a least-squares fit to the E_γ values except as noted otherwise. An additional uncertainty of 20 ppm due to the uncertainty in the E_γ calibration must be added to get absolute level energies.

§ (A): 5/2[622] band.

(B): 1/2[631] band.

@ (C): 7/2[624] band.

& (D): 7/2[743] band.

a (E): 1/2[620] band.

b (F): 3/2[631] band.

c (G): 1/2[501] band.

d (H): 5/2[622]@0- band.

e (I): 1/2[761] + 1/2[631]@0-.

f (J): 1/2[620]@0- + 1/2[631]@0-.

γ(²⁴¹Pu)

E _γ [†]	E(level)	I _γ ^{‡d}	Mult.&	δ ^c	α	Comments
^x 35.788 1		0.100 12				
41.972 1	41.9722	0.146 5	M1+E2	0.186 4	102.4 20	
^x 51.325 2		0.049 5				
52.048 2	222.9879	0.054 6	M1+E2	0.498 6	100.3 19	
53.807 1	95.7795	0.086 11	M1+E2	0.201 8	44.7 11	
56.89 3	231.934	0.0033 4	M1+E2	0.68	92.4 14	E _γ , I _γ : Not seen in (n,γ) spectrum. Values are from ²⁴⁵ Cm(α) decay, where I _γ /I _γ (190γ)=0.165 11.
57.806 2	841.9575	0.066 10	E1 ^a		0.555	
61.303 1	222.9879	0.091 3	E2		160.0	Mult.: δ>2.4 from α(L2)exp, >0.64 from L3/L2, and 5.5 +8-6 from L1/L2. Placement in the level scheme requires ΔJ=2, Δπ=no.
^x 62.812 2		0.067 5				
65.535 3	161.315	0.164 7	M1 (+E2)	≤0.44	27 8	
68.904 2	869.383	0.029 5	M1+E2	0.14 5	18.1 12	
71.390 2	850.5395	0.042 3	M1+E2	0.10 +4-5	15.7 7	
^x 72.584 3		0.018 3				
73.950 1	244.8895	0.056 3	E2		65.3	Mult.: δ=1.8 +10-4 from α(L2)exp, >0.77 from L3/L2, and >0.56 from M3/M2. Placement in the level scheme requires ΔJ=2.
^x 75.331 2		0.034 6				
79.262 7	175.0523	0.007 2	M1+E2	0.65 +25-22	22 6	
86.783 1	841.9575	0.134 6	E1 ^a		0.191	
^x 86.965 4		0.023 4				
95.365 1	850.5395	0.077 4	E1 ^a		0.1495	
95.786 3	95.7795	0.013 2	E2		19.3	
114.148 2	337.1363	0.097 5	E2		8.55	
^x 119.734 5		0.032 4				
133.081 2	175.0523	0.111 3	M1+E2	0.222 9	11.36 17	Mult.: The authors' value for I _γ (ce(L3)) in Table II is incorrect (priv comm from R. W. Hoff. The correct value is not available). δ is from L2/L1 and M2/M1.

Continued on next page (footnotes at end of table)

$^{240}\text{Pu}(n,\gamma)$ E=th: Secondary γ 's 1998Wh01 (continued) $\gamma(^{241}\text{Pu})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger d}$	Mult.&	δ^c	α	Comments
136.127 20	231.934	0.0111 1	M1+E2	0.63 21	9.0 10	$I\gamma$: $I\gamma$ is taken from $I\gamma/I\gamma(190\gamma)=0.555$ 16 in $^{245}\text{Cm}(\alpha)$ decay since the measured $I\gamma$ of 0.029 5 from 1998Wh01 is too large and apparently includes a contribution from fission product γ -rays according to the authors. $E\gamma$: From ce spectrum in 1998Wh01.
149.107 6	244.8895	0.035 5	M1		8.48	
161.685 1	161.6853	20.57 20	E2		1.96	
170.940 1	170.9399	0.378 7	M1		5.76	
175.051 2	175.0523	0.362 4	M1+E2	0.217 19	5.21	
181.017 2	222.9879	0.250 7	M1+E2	0.19 4	4.77 9	
185.132 22	940.311	0.004 2				Mult.: $\alpha(K)\text{exp}=0.08$ 3 compared with 0.095 (E1) and 0.166 (E2). The probable $J\pi$ of the 940 level requires $\Delta\pi=\text{no}$. See comment on $J\pi(940 \text{ level})$ in adopted levels.
187.414 6	942.584	0.042 9	M1+E2	1.1 3	2.6 6	
189.965 10	231.934	0.020 2	M1+E2	0.63 +6-7	3.36 16	
195.669 10	964.940	0.038 5	M1		3.93	Mult.: $\alpha(K)\text{exp}$ allows an E2 admixture with $\delta<0.34$; however, the placement is from $J=1/2$ to $J=1/2$.
202.910 7	244.8895	0.039 7	M1+E2	0.66 3	2.72 7	
$^x209.745$ 9		0.037 9	M1+E2	3.0 +21-7	0.97 16	$E\gamma$: Placed by the authors from the 965 level; however, that placement requires mult=E1. Removal of this transition from that level is done with permission of R. W. Hoff (priv comm).
$^x211.666$ 11		0.063 18				
222.971 20	222.9879	0.126 5	M1+E2	0.609 23	2.14 5	$E\gamma$: Uncertainty in authors' table I is 3 eV. The value should be 20 eV (priv comm from R. W. Hoff). Mult.: the value for M3/M2 given in the authors' Table II is incorrect (priv comm from R. W. Hoff). The δ value is deduced from L2/L1 and L3/L1.
$^x229.403$ 4		0.095 6	E2		0.517	Mult.: $\alpha(K)\text{exp}$ gives $\delta>7.8$. $E\gamma$: Placed by the authors from the 404 level; however, that placement requires mult=E1. Removal of this transition from that level is done with permission of R. W. Hoff (priv comm).
231.96 3	231.934	0.00118 20	[E2]		0.497	$E\gamma, I\gamma$: Not seen in (n, γ) spectrum. Values are from $^{245}\text{Cm}(\alpha)$, where $I\gamma/I\gamma(190\gamma)=0.059$ 8.
233.844 3	408.899	0.121 4	E1 ^a		0.0719	
239.493 8	1090.023	0.055 5	M1 (+E2)	≤ 0.35	2.13 11	
240.167 12	1009.438	0.040 5	M1 (+E2)	≤ 0.33	2.13 10	
$^x240.986$ 7		0.054 4	M1+E2	3.7 +10-5	0.55 5	
241.381 17	337.1363	0.052 6	M1+E2	1.8 3	0.85 13	
$^x247.129$ 23		0.063 8	M1+E2	3.9 +14-7	0.50 5	
$^x247.591$ 4		0.099 9				
248.066 6	1090.023	0.076 6	M1+E2	0.28 5	1.90 5	
$^x277.992$ 9		0.062 16				
$^x278.420$ 20		0.053 5				

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²⁴⁰Pu(n,γ) E=th: Secondary γ's 1998Wh01 (continued)

γ(²⁴¹Pu) (continued)

Eγ [†]	E(level)	I _γ ^{‡d}	Mult.&	δ ^c	α	Comments
308.674 2	404.4526	0.503 8	E1		0.0389	
313.123 4	408.899	0.110 7	E1 ^a		0.0377	
320.746 7	1090.023	0.056 4	M1 (+E2)	≤0.47	0.92 8	
359.149 13	534.202	0.045 11	E2		0.1240	Mult.: α(K)exp gives δ>4.9.
362.479 2	404.4526	1.271 18	E1		0.0276	
367.10 8	408.899	0.370 13	E1 ^a		0.0269	
^x 382.164 15		0.047 5				
^x 402.54 3		0.101 23	E1		0.0222	
403.260 14	1253.792	0.061 9	M1+E2	2.9 +9-6	0.137 24	
^x 404.707 10		0.056 8				
^x 405.90 5		0.056 12	E2		0.0887	Mult.: α(K)exp gives δ>4.3.
^x 408.70 3		0.048 7	M1 (+E2)	0.8 4	0.35 11	
^x 429.139 22		0.040 6	M1+E2	2.4 +9-4	0.132 24	
^x 439.382 20		0.066 7	M1+E2	3.5 +19-7	0.098 15	
^x 439.750 6		0.117 7				Mult.: α(K)exp=0.025 5. Theory values are 0.0150 5 (E1) and 0.0394 12 (E2).
444.687 9	1223.841	0.126 18	E1 ^b		0.0182	
^x 464.78 6		0.063 13	E1		0.01663	
465.646 5	561.421	0.287 11				Mult.: α(K)exp=0.019 3 compared with 0.0134 (E1) and 0.0356 (E2). Placement in the level scheme requires Δπ=no. See comment on Jπ(561 level) in adopted levels.
^x 468.23 5		0.071 15	M1+E2	3.1 +20-7	0.089 17	
476.840 3	518.8121	1.04 5	(E1)		0.01581	Mult.: α(K)exp=0.020 3 compared with 0.013 (E1) and 0.034 (E2). Placement in the level scheme requires Δπ=yes.
^x 483.662 6		0.53 7				
^x 484.521 7		0.422 20	E1		0.01532	Eγ: Placed by the authors from the 1253 level; however, mult=E1 to the 1/2- 769 level is inconsistent with π=- given by the other three transitions de-exciting this level.
490.624 9	1009.438	0.184 14	M1 (+E2)	≤0.6	0.28 4	
^x 490.927 8		0.195 16				
^x 491.423 10		0.409 23	E2		0.0548	
496.217#e	833.4	≤0.498#e	(E1)		0.01462	
	1296.70	≤0.498#e	(E1)		0.01462	
^x 501.45 3		0.121 14	E1		0.01432	
^x 513.504 9		0.177 17				
515.70 3	1357.682	0.101 20	M1+E2 ^b	1.0 +5-3	0.16 5	
^x 515.95 3		0.103 19	M1+E2	2.2 +8-4	0.087 16	
518.810 4	518.8121	3.21 6	E1		0.01340	
519.433 8	561.421	0.53 4				Mult.: α(K)exp=0.040 21 compared with 0.0108 (E1) and 0.0288 (E2). See comment on Jπ(561 level) in adopted levels.
^x 520.505 23		0.094 13				
^x 521.11 3		0.073 13	M1+E2	2.6 +13-6	0.076 16	
^x 527.258 25		0.064 18	M1+E2	1.6 +9-4	0.11 3	
^x 528.20 5		0.079 9	(M1+E2+E0)		0.15 11	Mult.: α(K)exp=0.35 7 compared with 0.217 7 for mult=M1 suggests the possibility of an E0 component.
^x 541.594 6		0.44 4	E1		0.01234	
^x 546.479 25		0.081 10	E1		0.01213	
^x 549.115 9		0.244 11				
556.164 3	779.1504	2.95 5	E1		0.01172	
561.168 4	784.1525	2.25 5	M1 (+E2)	≤0.66	0.19 3	

Continued on next page (footnotes at end of table)

²⁴⁰Pu(n,γ) E=th: Secondary γ's 1998Wh01 (continued)

γ(²⁴¹Pu) (continued)

Eγ [†]	E(level)	I _γ ^{‡d}	Mult.&	δ ^c	α	Comments
561.437 20	561.421	0.365 19				Mult.: α(K)exp=0.038 8 gives mult=M1+E2 with δ=3.2 +21-8; however, placement in the level scheme requires Δπ=yes. See comment on Jπ(561 level) in adopted levels.
566.057 4	810.945	1.17 5	E1		0.01134	
572.863 9	614.836	0.134 12				Mult.: α(K)exp=0.022 6 compared with 0.0089 (E1) and 0.024 (E2) favors E2. See comment on Jπ(615 level) in adopted levels.
x575.084 20		0.200 18	M1+E2	1.6 3	0.084 15	
x576.68 9		0.045 12	M1(+E2)	≤0.61	0.179 23	
x577.561 4		1.14 3	M1+E2	0.62 23	0.155 24	
x584.431 12		0.191 25				
586.703 16	831.587	0.097 10	M1(+E2)	≤0.32	0.185 8	
587.953 24	810.945	0.099 10	[E1]		0.01055	
593.488 4	755.1743	2.70 4	M1		0.186	Mult.: α(K)exp allows an E2 admixture with δ<0.55; however, the placement is from J=1/2 to J=1/2.
598.328 6	769.270	2.51 4	E1		0.01021	
x598.830 24		0.133 15	M1+E2	1.2 3	0.095 21	
602.53 3	1357.682	0.22 5	M1(+E2) ^b	≤0.82	0.15 3	
x605.546 7		0.518 11	E1,E2			
607.580 5	769.270	1.57 4	E1		0.00992	
608.229 9	779.1504	0.437 16	E1		0.00990	
608.608 10	831.587	0.379 12	M1+E2	0.54 +23-26	0.142 22	
617.457 5	779.1504	2.17 3	E1		0.00962	
x618.95 8		0.051 13				
622.464 14	784.1525	0.190 12	M1(+E2)	≤0.71	0.142 23	
x624.02 4		0.079 10	M1+E2	0.62 28	0.126 23	
627.552 5	850.5395	1.335 25	E1		0.00933	Mult.: α(K)exp=0.0110 17 compared with 0.0075 (E1) and 0.0206 (E2). Placement in the level scheme requires Δπ=yes.
629.539 6	800.479	1.49 3	M1+E2	0.57 23	0.128 19	
x634.193 23		0.172 8	M1+E2	0.67 +23-21	0.117 18	
638.757 5	800.443	1.079 25	M1+E2	0.68 22	0.114 18	
640.001 6	810.945	1.10 4	E1		0.00900	
x642.25 3		0.067 23	M1(+E2)	≤1.1	0.12 4	
x652.38 8		0.111 11	E2		0.0290	Mult.: α(K)exp gives δ>5.0.
x656.035 23		0.141 13	M1+E2	2.0 +6-3	0.051 9	
660.625 13	831.587	0.59 3	M1+E2	0.54 24	0.114 17	
x663.37 3		0.08 7	M1+E2	2.8 +6-3	0.040 4	
671.007 9	841.9575	0.303 14	E1		0.00824	
680.274 16	841.9575	0.376 10	(E1)		0.00804	Mult.: α(K)exp=0.0114 4 compared with 0.0065 (E1) and 0.0179 (E2). Placement in the level scheme requires Δπ=yes.
688.851 14	850.5395	0.678 24	E1		0.00785	
x698.661 24		0.143 8	M1+E2	3.2 +15-7	0.034 5	
704.70 14	800.479	0.093 25	E2		0.0247	Mult.: α(K)exp gives δ>4.2.
x708.01 6		0.138 23	M1+E2	1.2 +5-3	0.062 14	Eγ: Placed by the authors from the 869 level; however, that placement requires ΔJ=2, and α(K)exp=0.050 11 compared with 0.0167 (E2) and 0.092 (M1) requires an M1 admixture.

Continued on next page (footnotes at end of table)

²⁴⁰Pu(n,γ) E=th: Secondary γ's 1998Wh01 (continued)

γ(²⁴¹Pu) (continued)

Eγ [†]	E(level)	I _γ ^{‡d}	Mult.&	δ ^c	α	Comments
726.562 22	897.503?	0.180 8				Mult.: α(K)exp=0.017 3 is consistent with mult=E2; however; the authors' suggested Jπ(897 level) requires Δπ=yes. Mult=E1+M2 would require δ=0.24 4. See comment on Jπ(897 level) in adopted levels.
x737.922 20		0.219 14	M1(+E2)	≤0.6	0.093 11	
x742.250 9		1.09 4	M1+E2	1.1 +3-2	0.058 10	
x749.67 5		0.240 25	E2		0.0217	Mult.: α(K)exp gives δ>3.5.
x750.19 4		0.31 4	M1+E2	0.9 +3-2	0.065 12	
x751.16 6		0.125 22	M1+E2	3.0 +31-8	0.029 6	
x751.92 6		0.126 22	M1+E2	0.9 3	0.064 15	
755.154 14	755.1743	0.58 5	E2		0.0214	Mult.: α(K)exp gives δ>3.2.
758.494 ^{§e}	800.443	≤0.400 ^{§e}				
	800.479	≤0.400 ^{§e}				
x760.13 8		0.084 21	M1		0.0960	Mult.: The authors suggest an E0 component, but α(K)exp=0.11 3 overlaps the M1 value of 0.082.
765.23 3	940.311	0.212 16				Mult.: α(K)exp=0.0090 19 compared with 0.0053 (E1) and 0.0146 (E2). The probable Jπ of the 940 level requires Δπ=no. See comment on Jπ(940 level) in adopted levels.
771.64 4	942.584	0.16 8	M1+E2	1.5 +52-7	0.043 22	
772.645 21	995.603	0.49 5	E1		0.00638	Mult.: On the authors' level scheme, Fig. 1, the mult for this transition is shown as M1. This is a typo. The mult is given as E1 in table I based on α(K)exp.
773.59 4	869.383	0.197 21	M1+E2	1.2 +4-3	0.050 11	
777.89 5	1296.70	0.132 13	M1+E2	0.88 +30-24	0.060 11	
780.889 8	942.584	1.90 3	M1+E2	0.57 23	0.072 10	
784.153 16	784.1525	0.518 16	E2		0.0198	Mult.: α(K)exp gives δ>3.1.
786.454 16	1009.438	0.49 3	[E1]		0.00618	
789.63 4	831.587	0.218 23	M1+E2	0.6 3	0.069 13	
793.95 5	964.940	1.08 8	[E1]		0.00607	
x794.27 5		1.13 8	M1+E2	0.83 +26-22	0.058 9	
800.461@e	800.443	≤0.767@e				
	800.479	≤0.767@e				
803.265 19	964.940	0.583 16	E1		0.00595	
x811.982 19		0.480 23	M1+E2	1.25 +35-24	0.043 7	
833.904 13	995.603	0.81 3	E1		0.00557	
834.837 17	834.839	0.51 3	M1+E2	0.94 +25-20	0.048 7	
x838.646 22		0.449 24	E2		0.01736	Mult.: α(K)exp gives δ>3.0.
x844.200 20		0.31 5	M1+E2	1.5 +6-4	0.034 8	
x845.07 5		0.215 23	E1		0.00544	
x848.12 6		0.172 22				
x853.31 6		0.106 12	M1+E2	1.2 +4-3	0.039 8	
x876.58 10		0.28 10	E1,E2			
x892.934 18		0.419 21	M1(+E2)	≤0.36	0.060 3	
x931.667 20		0.74 4	M1+E2	1.5 +4-3	0.027 5	
940.315 12	940.311	2.21 9	M1+E2	1.09 +28-21	0.032 5	
x941.12 3		1.23 6	E2		0.01387	
942.58 ^f 4	942.584	0.49 6				Mult.: α(K)exp=0.0040 8, consistent with the E1 value of 0.0045; however, placement requires Δπ=no.
x953.20 4		0.73 5	E2		0.01354	Mult.: α(K)exp gives δ>4.1.
x958.30 11		0.17 4	E2		0.01340	
x965.07 12		0.15 4				

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$^{240}\text{Pu}(n,\gamma)$ E=th: Secondary γ 's 1998Wh01 (continued) $\gamma(^{241}\text{Pu})$ (continued)

$E\gamma^\dagger$	E(level)	$I\gamma^\ddagger$	Mult.&	δ^c	α	Comments
$^x967.46\ 13$		0.19 4				
$^x973.70\ 10$		0.55 11	M1+E2	3 +7-1	0.017 4	
$^x999.37\ 15$		0.175 24	M1+E2+E0		0.029 17	Mult.: $\alpha(K)\text{exp}=0.58\ 2$ compared with $\alpha(K)=0.040$ for mult=M1 indicates the presence of an E0 component.
$^x1003.25\ 9$		0.34 3	E2		0.01228	Mult.: $\alpha(K)\text{exp}$ gives $\delta>3.3$.
$^x1006.21\ 13$		0.47 15	E1		0.00401	
$^x1006.95\ 12$		0.57 15				
$^x1009.30\ 10$		0.31 11				
$^x1020.39\ 6$		0.28 7	E2		0.01189	
$^x1022.95\ 7$		0.28 4	E2		0.01183	Mult.: $\alpha(K)\text{exp}$ gives $\delta>2.8$.
$^x1025.98\ 7$		0.29 4	E1		0.00387	
$^x1034.75\ 18$		0.26 3	E1		0.00382	
$^x1037.26\ 10$		0.27 4				
$^x1039.89\ 13$		0.19 4	M1(+E2)	≤ 0.95	0.034 8	
$^x1045.00\ 6$		0.36 7	E1,E2			
1052.93 3	1223.841	0.82 4	E1 ^b		0.00370	
$^x1060.64\ 15$		0.21 4	E1,E2			
$^x1062.31\ 4$		0.81 11	E1		0.00365	
$^x1064.28\ 11$		0.21 4	M1+E2	0.9 +5-3	0.027 6	
$^x1073.00\ 10$		0.38 5	E1,E2			
$^x1074.44\ 11$		0.46 5				
$^x1078.15\ 7$		0.32 7				
1082.80 4	1253.792	0.62 4	E1		0.00353	
$^x1089.94\ 4$		1.06 8	E1		0.00349	
1092.08 5	1253.792	0.88 6	E1		0.00348	
$^x1134.44\ 8$		0.53 4	E1		0.00326	
$^x1146.49\ 8$		0.44 4	E1,E2			
$^x1155.26\ 10$		0.39 3	E1,E2			
$^x1170.02\ 6$		0.63 4	M1+E2	2.2 +9-5	0.0128 19	
$^x1174.00\ 15$		0.23 4				
$^x1177.84\ 10$		0.40 4				
$^x1180.64\ 7$		0.60 6	M1+E2	2.4 +18-6	0.0121 20	
$^x1196.31\ 20$		0.60 5	E1,E2			
$^x1200.87\ 11$		0.42 5	M1+E2	1.6 +7-4	0.014 3	
$^x1203.34\ 8$		0.54 5	E1,E2			
$^x1206.57\ 5$		1.34 7	M1+E2	2.0 +8-5	0.0126 21	
$^x1214.65\ 12$		0.48 4	E1,E2			
$^x1228.02\ 19$		0.36 7	E1,E2			
$^x1235.28\ 8$		0.57 5	M1+E2	1.9 +11-5	0.0122 22	
$^x1255.32\ 11$		0.64 4	M1(+E2)	≤ 0.67	0.023 3	
$^x1266.14\ 11$		0.60 7	E1		0.00274	
$^x1267.95\ 10$		0.85 11	E1		0.00273	
$^x1276.7\ 12$		0.57 10				
$^x1301.0\ 14$		0.49 9				
$^x1303.5\ 4$		0.30 6	E1,E2			
$^x1315.59\ 6$		0.96 5	E1,E2			
$^x1332.30\ 15$		0.85 8	E1,E2			
$^x1352.64\ 10$		0.63 14	E2		0.00705	Mult.: $\alpha(K)\text{exp}$ gives $\delta>1.4$.
$^x1378.52\ 22$		0.26 4	E2		0.00682	Mult.: $\alpha(K)\text{exp}$ gives $\delta>2.1$.
$^x1393.49\ 10$		0.77 5	M1(+E2)	≤ 0.85	0.017 3	
$^x1423.89\ 20$		0.59 11				
$^x1491.35\ 11$		0.80 13	M1+E2	1.0 +7-3	0.0110 25	
$^x1502.8\ 3$		0.48 10	E1,E2			
$^x1512.38\ 13$		0.70 7	E1		0.00217	

[†] The uncertainties do not include the calibration uncertainty of 20 ppm. Note that the transitions listed in the authors' table I with energies between the 999.37 and 1052.927 transitions should have the decimal point shifted one place to the right.

[‡] Intensity per 100 neutron captures, obtained by the authors under the assumption that they observe about 95% of the transitions feeding the ground state.

[§] The authors report E=758.494 15 with $I\gamma=0.377\ 23$ doubly placed from the 800.44 and 800.48 levels. These transitions are not included in the least-squares fit. For these placements, the least-squares fit gives $E\gamma=758.470\ 6$ and $E\gamma=758.506\ 6$, respectively. $\alpha(K)\text{exp}=0.0080\ 16$ for the doublet, compared with 0.00534 (E1) and 0.0148 (E2). Both placements require $\Delta\pi=\text{no}$.

²⁴⁰Pu(n,γ) E=th: Secondary γ's 1998Wh01 (continued)

γ(²⁴¹Pu) (continued)

- # The authors report E=496.217 4 with I_γ=0.489 9 doubly placed from the 833 and 1297 levels. This transition is not included in the least-squares fit for the 1297 level. The output yields an expected energy of E_γ=496.26 5. The 496γ is the only transition shown de-exciting the 833 level. The evaluator adopts E_γ=496.2 1 for this placement, yielding E(level)=833.3 1. α(K)exp=0.0140 22 compared with 0.0117 (E1) and 0.0313 (E2) suggests that both components are E1; however, α(K)exp could be reproduced with a weak E2 component with intensity I_γ=0.05 5. Placement from the 1297 level requires Δπ=yes so there is a slight possibility that the component from the 833 level is E2, in which case π(833 level) would be +.
- @ The authors report E=800.461 11 with I_γ=0.742 25 doubly placed from the 800.44 and 800.48 levels. These transitions are not included in the least-squares fit. For these placements, the least-squares fit gives E_γ=800.443 5 and E_γ=800.478 6, respectively. α(K)exp gives mult=M1+E2 for the doublet, consistent with both placements requiring Δπ=no.
- & From conversion coefficient and subshell ratio data of the authors. The conversion coefficients are normalized to values of known E1 and E2 transitions (unspecified). The evaluator has reanalyzed the authors' ce for subshells data using the internal conversion coefficient calculations of 2008Ki07 so the deduced δ values are slightly different from those of the authors, who used the calculations of 1968Ha53.
- a Non-observation of ce lines and the observed I_γ is consistent only with mult=E1.
- b Refer to Adopted Levels, Gammas for comments on Jπ and multi.
- c If no value given it was assumed δ=1.00 for E2/M1, δ=1.00 for E3/M2 and δ=0.10 for the other multiplicities.
- d Absolute intensity per 100 neutron captures.
- e Multiply placed; undivided intensity given.
- f Placement of transition in the level scheme is uncertain.
- x γ ray not placed in level scheme.

²⁴⁰Pu(n,γ) E=res 1975ThZN

1975ThZN: ²⁴⁰Pu was bombarded with neutron at the Harwell 45 MeV Linac. Spectra of γ rays in the energy range 2.5 MeV to 5 MeV were taken for 17 resonances below 300 eV, and for several averaged regions up to 2 keV using a 40 cm² GeLi detector. Intensities are given for transitions seen in the energy intervals E(n)=735–845 eV, 1300–1480 eV, and 1840–2170 eV. The authors state that these intensities are somewhat uncertain and they are not given here.

²⁴¹Pu Levels

E(level) [†]	Jπ&	E(level) [†]	Jπ&	E(level) [†]	Jπ&
161	1/2+	779@	3/2-	1049§@	(1/2, 3/2)
337‡@	1/2, 3/2	797‡@	3/2+	1073@	(1/2, 3/2)
376§#@	1/2, 3/2	852§#	3/2-	1091	3/2-
473@	(1/2, 3/2)	941§	3/2+	1173@	(1/2, 3/2)
681#@	(1/2, 3/2)	967	1/2-	1196@	(1/2, 3/2)
755‡	1/2+	999	3/2-	2199‡§@	(1/2, 3/2)
770	1/2-	1016@	(1/2, 3/2)	(5241 4)	

- [†] Except where noted otherwise, the levels are those populated directly in decay of the resonances below 300 keV. They are deduced by the authors by assuming that the highest-energy transition, E_γ=5080, populates the 161 level.
- [‡] Populated by primary from E(n)=735–845 eV resonance region.
- [§] Populated by primary from E(n)=1300–1480 eV resonance region.
- [#] Populated by primary from E(n)=1840–2170 eV resonance region.
- @ Not populated by primary from E(n)<300 eV resonance region.
- & From Adopted Levels.

²⁴⁰Pu(d,p) 1998Wh01,1972Br46

1998Wh01: ²⁴⁰Pu on carbon backing was bombarded with a 12.0 MeV deuteron beam at the Argonne FN tandem Van de Graaff accelerator. The emitted protons were momentum analyzed with an ENGE split-pole magnetic spectrometer and detected at the focal plane with emulsion plates with FWHM= 7.0 keV. (d,p) spectra was measured at 90°, 120°, and 150°.

1972Br46: ²⁴⁰Pu source that was prepared at Argonne isotope separator was irradiated with 12 MeV deuterons from the Argonne Tandem Van de Graaff accelerator. (d,p) spectra was measured at 90° and 140° using a Browne–Buechner spectrograph with FWHM=17 keV (estimated by the evaluator from authors' spectrum).

$^{240}\text{Pu}(\text{d},\text{p})$ 1998Wh01,1972Br46 (continued) ^{241}Pu Levels

E(level) [‡]	$J\pi^{\dagger}$	Comments
0.0@	5/2+	
42\$@ 2	7/2+	
96@ 1	9/2+	
162@& 1	1/2+, 11/2+	E(level): Doublet.
171& 2	3/2+	
231 ^a 2	9/2+	
244& 2	7/2+	
301\$ ^a 2	11/2+	
337& 1	9/2+	
373\$& 2	11/2+	
448\$b 2	11/2-	
571\$b 2	15/2-	
755 ^c 1	1/2+	
780 ^f 1	3/2-	
801 ^c d 1	3/2+, 5/2+	E(level): Doublet.
810 ^f 1	5/2-	
831d ^f 1	5/2+, 7/2-	E(level): Doublet.
842g 1	1/2-	
852g 1	3/2-	
863 2		
877 ^d 2	7/2+	
898 ^c g 2	9/2+, 5/2-	$J\pi$: See Adopted Levels. E(level): Doublet.
918g 2	7/2-	
937d ^f 2	9/2+, 11/2-	E(level): Doublet.
950 3		
965\$ ^e 1	1/2-	
974 2		
996d ^e 2	3/2-, 11/2+	E(level): Doublet.
1020 3		
1062\$ 3		
1075# 3		
1084 3		
1206 3		
1219# 4		
1244 3		
1258# 4		
1277# 4		
1288# 4		
1299# 4		
1309# 4		
1347 3		
1356# 4		
1384 3		
1441# 5		
1452# 5		
1489# 5		
1546# 5		
1594# 5		
1762 3		
1801# 4		
1826# 4		

[†] The configuration assignments are those of 1998Wh01 based on data from (d,p) and their $^{242}\text{Pu}(\text{d},\text{t})$ work. The ratio of cross sections at 90° and 150° gives information about the l transfer, and the ratio of (d,p) and (d,t) cross sections gives information about the particle or hole character of the level being populated. The assignments are, in most cases, consistent with those of 1972Br46.

[‡] From 1998Wh01, except as noted otherwise. The authors give one set of energies for their (d,p) and (d,t) work, averaged over all spectra.

\$ Seen by 1972Br46 but seen only in (d,t) by 1998Wh01. The energy given is that of 1998Wh01 from (d,t).

From 1972Br46. The level is not reported by 1998Wh01.

@ (A): 5/2[622] band.

& (B): 1/2[631] band.

Footnotes continued on next page

$^{240}\text{Pu}(\text{d},\text{p})$ 1998Wh01,1972Br46 (continued) **^{241}Pu Levels (continued)**

- a (C): 7/2[624] band.
 b (D): 7/2[743] band.
 c (E): 1/2[620] band.
 d (F): 3/2[631] band.
 e (G): 1/2[501] band.
 f (H): 1/2[761] + 1/2[631]@0-.
 g (I): 1/2[620]x0- + 1/2[631]@0-.

 $^{241}\text{Pu}(\text{d},\text{d}')$ 1972Br46

Levels observed in (d,d') were not populated in the (d,p),(d,t) transfer reactions. 1972Br46 suggest that these levels may be members of a rotational band based on a vibrational state.

1972Br46: ^{241}Pu source that was prepared at Argonne isotope separator was irradiated with 12 MeV deuterons from the Argonne Tandem Van de Graaff accelerator. (d,d') spectra was measured at 140° using a Browne-Buechner spectrograph with FWHM=25 keV.

 ^{241}Pu Levels**E(level)**

0.0
 495 10
 520 10
 560 10
 620 10

 $^{242}\text{Pu}(\text{d},\text{t})$ 1998Wh01,1972Br46

1998Wh01: ^{240}Pu on carbon backing was bombarded with a 12.0 MeV deuteron beam at the Argonne FN tandem Van de Graaff accelerator. The emitted protons were momentum analyzed with an ENGE split-pole magnetic spectrometer and detected at the focal plane with emulsion plates with FWHM= 7.0 keV. (d,p) spectra was measured at 90°, 120°, and 150°.

1972Br46: ^{240}Pu source that was prepared at Argonne isotope separator was irradiated with 12 MeV deuterons from the Argonne Tandem Van de Graaff accelerator. (d,p) spectra was measured at 90° and 140° using a Browne-Buechner spectrograph with FWHM= 17 keV (estimated by the evaluator from authors' spectrum).

1971El02: ^{240}Pu on carbon backing bombarded by 17 MeV deuterons from the Emperor Tandem Van de Graaff accelerator of the University of Rochester. Triton spectra at 60° was analyzed with the ENGE split-pole magnetic spectrometer and detected with emulsion plates with FWHM= 25 keV (estimated by the evaluator from the authors' spectrum). Elastic scattered deuterons were measured with a scintillation counter for intensity normalization and absolute reaction cross sections.

 ^{241}Pu Levels

E(level) [‡]	Jπ [†]	Comments
0.0@	5/2+	
42@ 2	7/2+	
96@ 1	9/2+	
162@& 1	1/2+, 11/2+	E(level): Doublet.
171& 2	3/2+	
221& 3	5/2+	
231 ^a 2	9/2+	
244& 2	7/2+	
301 ^a 2	11/2+	
337& 1	9/2+	
373& 2	11/2+	
385 ^a 3	13/2+	
448 ^b 2	11/2-	
505& 2	13/2+	E(level): Not included in authors' table IV, but shown in table V as being populated in (d,t).
571 ^b 2	15/2-	

Continued on next page (footnotes at end of table)

$^{242}\text{Pu}(\text{d},\text{t})$ 1998Wh01,1972Br46 (continued) **^{241}Pu Levels (continued)**

$E(\text{level})^{\ddagger}$	$J\pi^{\dagger}$	Comments
755 ^c 1	1/2+	
770 ^f 1	1/2-	
780 ^f 1	3/2-	
801 ^{c,d} 1	3/2+, 5/2+	E(level): Doublet.
810 ^f 1	5/2-	
831 ^{d,f} 1	5/2+, 7/2-	E(level): Doublet.
842 ^g 1	1/2-	
852 ^g 1	3/2-	
863 [§] 2		
898 ^{c,g} 2	9/2+, 5/2-	J π : See Adopted Levels. E(level): Doublet.
918 ^{§,g} 2	7/2-	
932 2		
937 ^{§,d,f} 2	9/2+, 11/2-	E(level): Doublet.
950 [§] 3		
965 ^e 1	1/2-	
974 [§] 2		
996 ^{d,e} 2	3/2-, 11/2+	E(level): Doublet.
1008 2		
1062 3		
1090 3		
1118 3		
1178 3		
1206 3		
1390 6		
1471 3		
1801 [#] 4		

[†] The configuration assignments are those of 1998Wh01 based on data from (d,t) and their $^{240}\text{Pu}(\text{d},\text{p})$ work. The ratio of cross sections at 90° and 150° gives information about the L transfer, and the ratio of (d,p) and (d,t) cross sections gives information about the particle or hole character of the level being populated. The assignments are, in most cases, consistent with those of 1972Br46 and 1971El02. See 1998Wh01 for a discussion of the differences.

[‡] From 1998Wh01, except as noted otherwise. The authors give one set of energies for their (d,p) and (d,t) work, averaged over all spectra.

[§] Seen by 1972Br46 but seen only in (d,p) by 1998Wh01. The energy given is that of 1998Wh01 from (d,p).

[#] From 1972Br46. The level is not reported by 1998Wh01.

@ (A): 5/2[622] band.

& (B): 1/2[631] band.

a (C): 7/2[624] band.

b (D): 7/2[743] band.

c (E): 1/2[620] band.

d (F): 3/2[631] band.

e (G): 1/2[501] band.

f (H): 1/2[761] + 1/2[631]x0-.

g (I): 1/2[620]x0- + 1/2[631]x0-.

 $^{242}\text{Pu}(\text{d},\text{t}\gamma)$ 1975Ya03

1975Ya03: 16 MeV pulsed deuterons beam from the Argonne National Laboratory tandem Van de Graaff bombarded a 0.5 g ^{242}Pu target. Gammas detected with a 11-cm³ intrinsic Ge detector with FWHM =1.1 keV for 122-keV γ of ^{57}Co .

Lifetime of E2 transitions between 1/2+[631] and 5/2+[622] single particle states measured in ^{241}Pu by pulsed beam technique.

$^{242}\text{Pu}(\text{d},\text{t}\gamma)$ 1975Ya03 (continued) ^{241}Pu Levels

The authors calculate $B(E2)$ for the 161.4 level using the $5/2[622]$ and $1/2[631]$ Nilsson states as the initial and finals states, respectively. They obtained $B(E2)=0.538\times 10^{-4} \text{ e}^2\text{b}^2$. When they included the pairing corrections the calculations yielded $B(E2)(\text{Nilsson} + \text{pairing})=0.075\times 10^{-4} \text{ e}^2\text{b}^2$. The enhancement of the 161.4 E2 transition was explained as due to possible admixtures of collective components in the nuclear wave functions. Second-order Coriolis coupling between the two bands was also considered.

E(level)	$J\pi$	$T_{1/2}$	Comments
0.0	5/2+		
161.4 2	1/2+	0.88 μs 5	$B(E2)\uparrow=6.57\times 10^{-5} \text{ I}$. $T_{1/2}$: From decay curve of the $1/2+[631]$ state. $B(E2)\uparrow$: Recalculated by evaluator using authors' $T_{1/2}$ and $\alpha=1.98$ value of BrIcc (2008Ki07).

 $\gamma(^{241}\text{Pu})$

$E\gamma$	E(level)	Mult.	α
161.4 2	161.4	[E2]	1.98

 $^{242}\text{Pu}(^3\text{He},\alpha)$ 1971El02

1971El02: ^{240}Pu on carbon backing bombarded by 30 MeV ^3He particles from the Emperor Tandem Van de Graaff accelerator of the University of Rochester. Alpha spectra at 25° , 35° , 60° , and 90° was analyzed with the ENGE split-pole magnetic spectrometer and detected with emulsion plates with FWHM= 25 keV (estimated by the evaluator from the authors' spectrum). Elastic scattered ^3He particles were measured with a scintillation counter for intensity normalization and absolute reaction cross sections.

The authors also studied the $^{242}\text{Pu}(\text{d},\text{t})$ reaction, with FWHM= 25 keV, but these data are superseded by those of 1998Wh01, with FWHM=7 keV.

 ^{241}Pu Levels

E(level) [†]	$J\pi^\#$	Comments
92& 2	9/2+	
167&a 3	1/2+, 3/2+, 11/2+	
235&a 4	5/2+, 13/2+	
244&a 4	7/2+	
296 ^b	11/2+	
334 ^a 3	9/2+	
444 ^c 3	11/2-	
499 ^a 3	13/2+	
568 ^c 2	15/2-	
645 [§] 9		
752 ^{§d} 6	1/2+@	
835 ^e 3	5/2+	$J\pi$: Assignment considered tentative by the authors; however, it is confirmed in (d,p) and (d,t) where the peak is a doublet consisting of the $5/2+, 3/2[631]$ and $7/2-, 1/2[761]$ band members.
875 ^e	7/2+	$J\pi$: Assignment considered tentative by the authors; however, it is confirmed in (d,p) and (d,t).
931 ^e 2	9/2+	$J\pi$: Assignment considered tentative by the authors; however, it is confirmed in (d,p) and (d,t) where the peak is a doublet consisting of the $9/2+, 3/2[631]$ and $11/2-, 1/2[761]$ band members.
994 ^{§e} 3	11/2+	$J\pi$: Assignment considered tentative by the authors; however, it is confirmed in (d,p) and (d,t) in 1998Wh01 where the peak is a doublet consisting of the $11/2+, 3/2[631]$ and $3/2-, 1/2[501]$ band members.
1090 2		
1181 ^f 3	(9/2+)	$J\pi$: The assignment is considered tentative by the authors.
1868 ^{§g} 5	(15/2-)	$J\pi$: The assignment is considered tentative by the authors.
1944 [§] 5		
1991 [§] 4		
=2045? [§]		

Footnotes continued on next page

 $^{242}\text{Pu}(^3\text{He},\alpha)$ 1971El02 (continued)

 ^{241}Pu Levels (continued)

† All levels are seen also in (d,t), except where noted otherwise.

‡ From authors' (d,t) work. The 235 and 244 levels are not resolved in ($^3\text{He},\alpha$).

§ Not seen in authors' (d,t) work.

Except where noted otherwise, the $J\pi$ and configuration assignments are those of the authors. They agree with the (d,p) and (d,t) assignments of 1998Wh01.

@ Added by the evaluator on the basis of assignment of 1998Wh01.

& (A): 5/2[622] band.

a (B): 1/2[631] band.

b (C): 7/2[624] band.

c (D): 7/2[743] band.

d (E): 1/2[620] band.

e (F): 3/2[631] band.

f (G): 5/2[633] band.

g (H): 5/2[752] band.

Adopted Levels, Gammas

Q(β⁻)=-767.4 12; S(n)=6647 14; S(p)=4479.96 13; Q(α)=5637.82 12 2012Wa38.

Experimental Studies.

2011He12: Determined beta shape function and activity of ²⁴¹Pu β decay. Resolved the difference between efficiency tracing method and the triple-to-double coincidence ratio (TDCR) method using a shape function derived from experimental data.

Theoretical/Systematical Studies:

- 2015Er03: Calculation of fission probabilities with a dynamic statistical approach.
 2013Zd01: T_{1/2} for α decay calculated with phenomenological model based on Gamow theory with WKB approximation for Coulomb barrier penetration.
 2013Af01: Calculated pairing and rotational properties in the density functional framework.
 2013Ni13: Study of α decay of g.s Bk to rotational bands using the multichannel cluster model (MCCM).
 2013Ta07: Partial T_{1/2} for cluster decay of ²⁴¹Am using semi-empirical model.
 2013Zd02: Coupled-channel calculation to describe α transition to several rotational bands in ²⁴¹Am.
 2012Ba35, 2011Sh13: Calculated T_{1/2} of cluster decay for ²⁴¹Am using a generalized liquid-drop model.
 2012Ni16: α decay branching ratio and T_{1/2} for transitions from ground state to favored rotational bands using Multichannel Cluster Model.
 2012Sa05, 2012Sa31: Calculated cluster decay half-lives using the Coulomb and Proximity Potential Model (CPPM).
 2012Ta10: Partial T_{1/2}, Q-values, branching ratios using a semi-empirical with the one-parameter model dependence on cluster radius.
 2011He12: Compilation of longest lived known in nuclides with Z≥ 82 with half-life, spin, excitation energy, and primary reference.
 1990Bh02: Calculated T_{1/2}(SF).
 1982Li02: Calculated energy band heads, magnetic moments, B(E2) and B(M1) using the rotor plus quasiparticle approximation.
 1992Gu10, 1990Sh01, 1989Ba20, 1989Si13, 1989Sh37, 1989Ma43, 1988Bl11, 1986Po15, 1987GrZO, 1987Po08, 1987Sh04, 1988Ba01: Theoretical calculations and discussions on decays by heavy ions such as ³⁴Si, ²⁸Si, and neon isotopes.
 1988Io05: Decay by ion emission was considered and compared with SF decay.
 1983Penetration parameters for the 32.639- and 41.176-keV transitions have been calculated by 1983Bh10 as a function of nuclear deformation.
 1977Ch27: Calculated Proton occupation probabilities for various Nilsson states.
 1976Ch22, 1971Ga20: Calculations of excited-state energies and configurations.

²⁴¹Am Levels

Cross Reference (XREF) Flags

A ²⁴⁵Bk α Decay
 B ²⁴¹Pu β⁻ Decay
 C ²⁴¹Am(²⁰⁹Bi, ²⁰⁹Bi'γ)

D ²⁴¹Cm ε Decay
 E ²⁴³Am(p,t)
 F ²⁴⁰Pu(α,t)

E(level)	Jπ [†]	XREF	T _{1/2}	Comments
0.0 [±]	5/2-	ABCDE	432.6 y 6	<p>%α=100; %SF=3.6×10⁻¹⁰ 9. %SF is obtained from adopted T_{1/2} and T_{1/2}(SF) values. T_{1/2}: From evaluated t_{1/2} as recommended by 2004ChZX. T_{1/2}: Measured values 432.7 y 7 by calorimetry (1967Oe01) 433 y 7 by specific activity (1968Br22) 436.6 y 30 by specific activity (1968St02) 426.3 y 21 by calorimetry (1972Jo07) 432.8 y 16 by specific activity (1974Po16) 432.5 y 7 by calorimetry (1974StYG) 432.0 y 2 by calorimetry (1975Ra35) 1989Ho24 recommend T_{1/2}=432.7 y 6, 1991BaZS recommend 432.2 y 7, 2004ChZX recommend 432.6 y 6, 2004Wo02 recommend 433.1 11 Earlier t_{1/2} measurements prior to 1967: 470 +6-10 y (1952Ha68), 458.1 y 5 (1957Ha10), 457.7 y 18 (1958Wa69). These measurements have been excluded from 2004ChZX's evaluation due to large systematic uncertainties.</p> <p>T_{1/2}(SF): Measured values 2.3×10¹⁴ y 8 (1961Dr03) 0.90×10¹⁴ y 4 (1970Ga27) 1.147×10¹⁴ y 24 (1970Go06) 1.8×10¹⁴ y 4 (1986Pa17) 1.2×10¹⁴ y 6 (1993Ku16)</p>

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)

²⁴¹Am Levels (continued)

E(level)	Jπ [†]	XREF	T _{1/2}	Comments
			1.2×10 ¹⁴ y 3	Adopted as recommended by 2000Ho27.
				No ³⁴ Si decay was observed: ³⁴ Si/α<3.0×10 ⁻¹² (1985Ho21), <4.2×10 ⁻¹³ (1986Pa17), <8.7×10 ⁻¹⁵ (1985TrZY), <7.4×10 ⁻¹⁶ (1987Mo28). No other cluster emission was observed: cluster/α<5.0×10 ⁻¹⁵ (1986Tr10). See also 1995Ar33.
				μ=+1.58 I; Q=+4.34 5. MOMM1 measured by atomic beam with laser fluorescent spectroscopy (1990Iz01). Compiled by 2014StZZ, others:+1.61 3 (1966Ar04). MOME2 measured by Muonic X-ray hyperfine structure method (1985Jo04) (1990Iz01) and recommended by 2013StZZ. Compiled by 2014StZZ, others: +3.8 2 (1989DrE26), +3.14 5 (1990Iz01), +4.2 13 (1988Be30). Jπ: J from optical spectroscopy (1953Fr01 and 1956Th18) and atomic beam (1960Ma30). Configuration 5/2[523] Nilsson-state assignment is from the measured magnetic moment. Jπ: M1+E2 γ to 5/2-. Reaction data. Jπ: Energy fit to a band. Reaction data. Jπ: Energy fit to a band. Reaction data. Jπ: E1 γ to 5/2-. γ to 7/2-. Reaction data. Jπ: γ to 9/2-. Energy fit to a band. Jπ: Fit to a band.
41.176 [§] 3	7/2-	A CDE		
93.70 [‡] 10	9/2-	A CDEF		
157.50 [§] 18	11/2-	A C EF		
205.883 [#] 10	5/2+	A CD		
233.68 [‡] 20	13/2-	C E		
235.2 [@] 5	7/2+	A F		
239?		A		
270?		A		
273.2 [#] 5	9/2+	A C F		Jπ: Reaction data. Fit to a band.
319.8 [@] 10	11/2+	A C F		
319.82 [§] 23	15/2-	C		
381.1 [#] 5	13/2+	A C F		
418.18 [‡] 23	17/2-	C		
453.1 [@] 9	15/2+	C		
459?		A		
471.810 ^{&} 9	3/2-	A CD F		Jπ: α hindrance factor is 1.8 from 3/2-.
495		A		
504.449 ^a 9	5/2-	A CD F		Jπ: M1+E2 γ to 3/2-. Anomalous M1+E2 γ to 7/2-.
525.67 [§] 25	19/2-	C		
530.9 [#] 4	17/2+	C		
543?		A		
550.4 ^{&} 4	7/2-	A C F		
623.10 ^b 4	(1/2+)	D F		Jπ: E2 γ to 5/2+. log ft=8.2 from 1/2+. Likely configuration 1/2[400].
625.2 ^a 5	9/2-	C		
629.8 [@] 7	19/2+	C		
636.861 ^c 10	3/2-	D		Jπ: M1+E2 γ's to 3/2- and 5/2-. log ft=6.25 from 1/2+.
645.0 [‡] 3	21/2-	C		
652.089 ^c 10	(1/2)-	D		Jπ: M1+E2 γ to 3/2-. log ft=6.32 from 1/2+ rules out 5/2-. In ε decay, 1974Po08 suggest that the 652 level is the bandhead of the 1/2[530] band with the 3/2- member at 637 keV.
653.23 ^b 4	3/2+	D F		Jπ: M1+E2 γ to 5/2+. log ft=8.2 from 1/2+ rules out 5/2+ and 7/2+.
670.24 8	3/2+	D		Jπ: M1+E2 γ to 5/2+. log ft=7.7 from 1/2+ rules out 5/2+ and 7/2+.
				Configuration 3/2[651].
682.1 ^{&} 6	11/2-	C F		
723.9 [#] 4	21/2+	C		
732 4	(11/2+)	F		Jπ: 1975Er01 propose an 11/2+,7/2[633] assignment on the basis of their (α,t) work.
773.8 [§] 3	23/2-	C		
787.2 ^a 6	13/2-	C		
822 4	(13/2+)	F		Jπ: 1975Er01 propose a 13/2+,7/2[633] assignment based on their (α,t) work.
851.3 [@] 5	23/2+	C		
863.8 ^{&} 7	15/2-	C		
884 4		F		
912.7 [‡] 3	25/2-	C		

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) ^{241}Am Levels (continued)

E(level)	$J\pi^\dagger$	XREF	$T_{1/2}$	Comments
952 1	5/2-	E		$J\pi$: L=0 in $^{243}\text{Am}(p,t)$ with target $J\pi=5/2-$. 1974Fr01 interpret this level as a pairing excitation.
959.4 [#] 4	25/2+	C		
982 2		E		
989.1 ^a 7	17/2-	C		
1020 4		F		
1061.7 [§] 4	27/2-	C		
1064 4		F		
1084.6 ^{&} 7	19/2-	C		
1106 4		F		
1117.6 [@] 5	27/2+	C		
1132 5		F		
1136 3		E		
1163 3		F		$J\pi$: 1975Er01 propose a tentative assignment of 9/2-, 7/2[514] on the basis of their (α,t) work.
1219.2 [‡] 4	29/2-	C		
1227 3		F		
1230.9 ^a 8	21/2-	C		
1235.9 [#] 5	29/2+	C		
1345.0 ^{&} 8	23/2-	C		
1387.5 [§] 4	31/2-	C		
1426.4 [@] 6	31/2+	C		
1510.2 ^a 8	25/2-	C		
1550 4	(5/2-)	E		$J\pi$: L=(0) in $^{243}\text{Am}(p,t)$ with target $J\pi=5/2-$.
1551.2 [#] 6	33/2+	C		
1562.6 [‡] 4	33/2-	C		
1642.7 ^{&} 9	27/2-	C		
1749.4 [§] 5	35/2-	C		
1775.2 [@] 7	35/2+	C		
1826.9 ^a 9	29/2-	C		
1903.5 [#] 7	37/2+	C		
1940.6 [‡] 5	37/2-	C		
1975.8 ^{&} 9	31/2-	C		
2145.4 [§] 5	39/2-	C		
2161.6 [@] 7	39/2+	C		
2178.0 ^a 10	33/2-	C		
≈ 2200			1.2 μs 3	Assignment: $^{242}\text{Pu}(p,2n)$ excit (1969La14); $^{241}\text{Pu}(13\text{-MeV } d,2n)$ (1969La14); $^{241}\text{Am}(14.7\text{-MeV } n,n')$ (1973Be04). E(level): Threshold energy of (p,2n) reaction, obtained by 1969La14 yielded E=2500 100; from fit to excitation function for (p,2n) reaction of 1969La14, E(level)=2200 200 obtained by 1971Br39, 1972Br35. For calculated isomeric level energy, see, for example, 1970Ja16, 1972We09, 1987Gu03. %SF=100. Only SF decay was observed. $\Gamma(\gamma)/\Gamma(\text{SF}) < 1$ from absence of 472 γ (1976Be55). 1972We09 calculated $T_{1/2}(\gamma)/T_{1/2}(\text{SF}) = 2.7 \times 10^{-3}/0.45 \times 10^{-6}$. $T_{1/2}$: Unweighted average of 1.5 μs 6 (1969La14) and 0.9 μs 3 (1993Ku16). For calculated $T_{1/2}(\text{SF})$, see 1990Bh02, for example. Fission-barrier parameters were deduced from fission probability measured in $^{240}\text{Pu}(^3\text{He},d)$ reaction (1974Ba73, 1976Ga11). 1981Re06 deduced barrier heights from fission probability data of 1976Ga11. See 1980Ku14, 1984Ku05, 1987Gu03, 1989Bh01, 1990Bh02, 1992Gr10 for calculated barrier parameters.
2289.7 [#] 9	41/2+	C		
2343.9 ^{&} 10	35/2-	C		
2352.2 [‡] 6	41/2-	C		
2561.5 ^a 11	37/2-	C		
2574.6 [§] 8	43/2-	C		
2582.7 [@] 9	43/2+	C		
2708.0 [#] 10	45/2+	C		
2743.8 ^{&} 11	39/2-	C		
2794.7 [‡] 8	45/2-	C		

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued)241Am Levels (continued)

E(level)	Jπ [†]	XREF	E(level)	Jπ [†]	XREF	E(level)	Jπ [†]	XREF
2977.2 ^a 12	41/2-	C	3635.1& 13	47/2-	C	4669.4 [#] 14	61/2+	C
3035.1§ 9	47/2-	C	3767.7‡ 11	53/2-	C	4845.9‡ 13	61/2-	C
3036.3@ 10	47/2+	C	3903.0 ^a 14	(49/2-)	C	5117.2§ 14	63/2-	C
3156.7 [#] 11	49/2+	C	4034.4@ 13	55/2+	C	5228.9 [#] 15	65/2+	C
3174.7& 12	43/2-	C	4043.2§ 12	55/2-	C	5407.9‡ 14	65/2-	C
3266.9‡ 9	49/2-	C	4122.5& 14	51/2-	C	5816.8 [#] 16	(69/2+)	C
3424.3 ^a 13	45/2-	C	4137.6 [#] 14	57/2+	C	5980.9‡ 14	(69/2-)	C
3520.8@ 12	51/2+	C	4294.9‡ 12	57/2-	C			
3525.1§ 10	51/2-	C	4575.6§ 13	59/2-	C			
3633.5 [#] 13	53/2+	C	4577.5@ 14	(59/2+)	C			

[†] The argument "Reaction data" includes assignments from ²⁴⁰Pu(α,t) that are based on a comparison of the observed spectroscopic factors with calculated values, and assignments from ²⁴³Am(p,t) that are based on angular distributions. Assignments for higher band members, given with no argument are from 2004Ab16 from their ²⁴¹Am(²⁰⁹Bi, ²⁰⁹Bi'γ) work and are based on observation of these bands individually in triple coincidence runs gated on multiplicity and sum energy.

[‡] (A): 5/2[523] band, α=+1/2.

§ (B): 5/2[523] band, α=-1/2.

[#] (C): 5/2[642] band, α=+1/2.

@ (D): 5/2[642] band, α=-1/2.

& (E): 3/2[521] band, α=-1/2.

^a (F): 3/2[521] band, α=+1/2.

^b (G): 1/2[400] band.

^c (H): 1/2[530] band.

γ(241Am)

E(level)	Eγ [†]	Iγ [§]	Mult. [@]	δ ^c	α	I(γ+ce) ^a	Comments
41.176	41.176 3		M1+E2	0.486 23	295 17		
157.50	116.4 2						
205.883	164.8 2	16 3	[E1]		0.1635		Eγ: Eγ=165.1 2 in 241Am(²⁰⁹ Bi, ²⁰⁹ Bi'γ).
							Iγ: Iγ=21 6 in α decay.
	205.879 13	100 6	E1		0.0980		
233.68	139.9 2	100					
235.2	194.0 5	100	[E1]		0.1123 17		
273.2	179.5 5	100					
319.82	162.4 2	100					
381.1	108.0 ^d 5	100					
	147.6 5	100					
418.18	98.0 5	4.6 [#] 23					
	184.4 2	100 43					
453.1	133.3 5						
471.810	265.922 12	0.56 6	[E1]&		0.0552	3.0 ^b 2	
	430.634 20	5.7 3	E2		0.0805	5.1 3	
	471.805 20	100 4	M1+E2&		0.22 16	100 ^b 4	
504.449	32.639 3	16.5 6	M1+E2	0.124 4	220 5	100 3	
	298.57 5	6.4 16	[E1]&		0.0429	0.29 ^b 7	
	410.8 1	7.0 7	[E2]		0.0910	2.11 22	
	463.273 20	100 7	M1+E2&		0.23 17	3.38 ^b 18	
	504.45 3	48 3	M1+E2&		0.18 13	1.49 ^b 9	
525.67	107.2 2	13 [#] 5					
	206.0 2	100					
530.9	149.9 5	100 50					
	211.0 5	10 5					
550.4	77.0 ^d 5						
	455.9 5						
	510.0 5						
623.10	151.4 4	=3	[E1]		0.199		
	417.24 4	100 6	E2		0.0874		
	623.1 3	1.8 5	[M2]		0.433		
625.2	120.8 5						

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{241}\text{Am})$ (continued)

E(level)	E $\gamma^{\dagger}$	I $\gamma^{\S}$	Mult.@	δ^c	α	I($\gamma+ce$) ^a	Comments
629.8	176.7 5						
636.861	132.413 7	100 5	M1+E2&	0.061 +13-17	12.94	100 ^b 4	
	165.049 8	77 5	M1+E2&	0.22 3	6.73 12	44.9 ^b 18	
	430 1	=1.0	[E1]		0.0200	=0.09	
	595.8 3	0.38 8	[E2]		0.0373	0.036 7	
	636.88 3	40 3	M1+E2	0.59 18	0.133 16	3.9 3	
645.0	120.3 5	4.1 [#] 13					
	226.9 2	100 43					
652.089	15.228 2	11.4 5	M1+E2	0.0302 14	437 8		
	29.02 5	6.3 13	[E1]		3.42		
	147.67 3	2.75 23	[E2]		3.08		
	180.277 8	100 9	M1 (+E2)	<0.25	5.31 14		
	652.1 4	8.3 21	[E2]		0.0306		
653.23	447.35 4	80 10	M1+E2	<0.77	0.37 7		
	653.2 2	100 7	[E1]		0.00898		
670.24	464.36 8	14.8 24	M1+E2	1.5 +17-5	0.17 8		
	670.2 2	100 7	[E1]		0.00856		
682.1	131.7 5						
723.9	193.0 5	100					
	198.0 5	10 [#] 7					
773.8	129.1 2	45 25					
	247.9 2	100					
787.2	106.2 ^d 5	10 9					
	162.0 5	100 90					
851.3	127.3 5	29 14					
	221.5 5	100 43					
863.8	181.7 5						
912.7	139.1 5	16 [#] 6					
	267.8 2	100					
959.4	108.1 5	10 [#] 5					
	185.6 5	10 [#] 5					
	235.5 5	100 50					
989.1	124.5 5	10 8					
	201.9 5	100 92					
1061.7	149.6 5	36 13					
	287.8 2	100					
1084.6	91.3 ^d 5	10 [#] 14					E γ : The energy fit is poor. The least-squares adjustment gives 95.5 5.
	221.5 5	100					
1117.6	158.2 5	100					
	266.3 5	31 22					
1219.2	157.3 5	30 12					
	306.6 2	100					
1230.9	147.2 5	10 [#] 12					
	241.0 5	100					
1235.9	118.3 5	10 [#] 5					
	174.3 5	10 [#] 5					
	276.5 5	100 43					
1345.0	113.7 ^d 5	10 [#] 13					
	260.3 5	100					
1387.5	168.6 5	19 7					
	325.8 5	100					
1426.4	190.5 5	100					
	308.8 5	97 64					
1510.2	164.9 5	10 [#] 12					
	279.5 5	100					
1551.2	124.8 5	10 [#] 6					
	315.3 5	100					
1562.6	175.1 5	22 7					
	343.3 2	100					
1642.7	132.9 5	10 [#] 7					
	297.8 5	100					

Continued on next page (footnotes at end of table)

Adopted Levels, Gammas (continued) $\gamma(^{241}\text{Am})$ (continued)

E(level)	$E\gamma^\dagger$	$I\gamma^\S$	E(level)	$E\gamma^\dagger$	$I\gamma^\S$	E(level)	$E\gamma^\dagger$
1749.4	186.6 5	17 8	2343.9	367.8 5	100	3633.5	476.8 5
	361.9 2	100	2352.2	207.1 5	16# 7	3635.1	460.4 5
1775.2	224.0 5	21 40		411.2 5	100	3767.7	500.8 5
	348.8 5	100	2561.5	383.5 5		3903.0	479.3 ^d 5
1826.9	184.5 5	10# 9	2574.6	429.2 5		4034.4	513.6 5
	316.1 5	100	2582.7	421.1 5		4043.2	518.1 5
1903.5	352.3 5		2708.0	418.3 5		4122.5	487.4 5
1940.6	191.1 5	15 6	2743.8	399.9 5		4137.6	504.1 5
	378.0 2	100	2794.7	442.5 5		4294.9	527.2 5
1975.8	148.2 5	10# 7	2977.2	415.7 5		4575.6	532.4 5
	333.6 5	100	3035.1	460.5 5		4577.5	542.8 ^{‡d} 5
2145.4	204.9 5	18# 9	3036.3	453.6 5		4669.4	531.8 5
	396.3 5	100	3156.7	448.7 5		4845.9	551.0 5
2161.6	258.1 5	41 41	3174.7	430.9 5		5117.2	541.6 5
	386.4 5	100	3266.9	472.2 5		5228.9	559.5 5
2178.0	351.3 5		3424.3	447.1 5		5407.9	562.0 5
2289.7	386.2 5		3520.8	484.5 5		5816.8	587.6 ^{‡d} 5
2343.9	166.2 5	10# 6	3525.1	490.0 5		5980.9	573.0 ^{‡d} 5

[†] From ^{241}Cm ϵ decay where available. Others are from (^{209}Bi , $^{209}\text{Bi}'\gamma$).

[‡] The tentative placement assigned to this transition results from the observation of a weak transition at this energy in sums of coincidence spectra double gated on transitions between high-spin levels in the g.s. band.

[§] Relative photon branching from each level taken from ^{241}Cm ϵ decay where available. Others are from (^{209}Bi , $^{209}\text{Bi}'\gamma$).

Value given is an upper limit.

@ From ^{241}Cm ϵ decay.

& Probable anomalous conversion. See 1974Po08 in ϵ decay for calculations of penetration effects.

a Relative $I\gamma$ +Ice from each level, given for levels for which one or more of the deexciting transitions exhibits anomalous conversion.

b From sum of $I\gamma$ and Ice. Given where internal conversion is anomalous.

c If no value given it was assumed $\delta=1.00$ for E2/M1.

d Placement of transition in the level scheme is uncertain.

Adopted Levels, Gammas (continued)

Adopted Levels, Gammas (continued)(E) 3/2[521] band, $\alpha=-1/2$ (F) 3/2[521] band, $\alpha=+1/2$

(G) 1/2[400] band.

$^{241}_{95}\text{Am}_{146}$

Adopted Levels, Gammas (continued)

(H) 1/2[530] band.

(H) 1/2[530] band.

^{241}Pu β^- Decay

Parent ^{241}Pu : $E=0.0$; $J\pi=5/2+$; $T_{1/2}=14.329$ y 29; $Q(\text{g.s.})=20.78$ 13; $\%\beta^-$ decay=99.998.

$^{241}\text{Pu}-Q(\beta^-)$: From 2012Wa38.

$^{241}\text{Pu}-J, T_{1/2}$: From Adopted Levels in ^{241}Pu .

 ^{241}Am Levels

E(level)	$J\pi$
0.0	5/2-

 β^- radiations

$E\beta^-$	E(level)	$I\beta^{-\dagger}$	Comments
20.78 13	0.0	100	$E\beta^-$: weighted average of 20.78 20 (1999YaZX), 20.7 3 (2000Dr02,1999Dr13), and 20.8 2 (1956Sh31). av $E\beta^-$ =5.78 31 measured by calorimeter; $T_{1/2}=14.30$ y 30 was used (1968Oe01). The calculated value is av $E\beta^-$ =5.23 5.

$\dagger$ For β^- intensity per 100 decays, multiply by 0.99998.

 ^{241}Cm ϵ Decay 1974Po08

Parent ^{241}Cm : $E=0.0$; $J\pi=1/2+$; $T_{1/2}=32.8$ d 2; $Q(\text{g.s.})=767.4$ 12; $\%\epsilon$ decay=99.0 1.

$^{241}\text{Cm}-J$: From Adopted Levels in ^{241}Cm .

$^{241}\text{Cm}-T_{1/2}$: From least squares decay analyses of the 471.8 keV γ .

$^{241}\text{Cm}-Q(\epsilon)$: From 2012Wa38.

1974Po08: ^{241}Cm source prepared by irradiating ^{239}Pu with 40 MeV α particles at the Argonne 60-in. cyclotron.

Following decay and chemical separation, Cm was prepared for electron and γ spectroscopy in the Argonne electromagnetic isotope separator. γ -rays were measured with Ge(Li) detectors with FWHM=600 keV at the 100 keV γ -ray energy. Conversion electron lines were measured with the Argonne toroidal-filed spectrometer (FWHM=0.05 %). Measured $\gamma\gamma$ -coincidence Ge(Li) diodes.

 ^{241}Am Levels

E(level) †	$J\pi^\ddagger$	$T_{1/2}$	Comments
0.0 §	5/2-	432.6 y 6	$T_{1/2}$: From Adopted Levels.
41.176 § 3	7/2-		
93.65 § 10	9/2-		
205.883 # 10	5/2+		
471.810 @ 9	3/2-		
504.448 @ 9	5/2-		
623.10 & 4	(1/2+)		
636.861 a 10	3/2-		
652.089 a 10	(1/2)-		
653.23 & 4	3/2+		
670.24 b 8	3/2+		

$\dagger$ From least-squares fit (by evaluator) to $E\gamma$ data.

$\ddagger$ From Adopted Levels.

§ (A): 5/2[523].

(B): 5/2[642].

@ (C): 3/2[521].

& (D): 1/2[400]?

a (E): 1/2[530].

b (F): 3/2[651].

²⁴¹Cm ε Decay 1974Po08 (continued)

β⁺, ε Data

Eε	E(level)	I _ε ^{†‡}	Log ft
(97.2 12)	670.24	0.68 5	7.74 4
(114.2 12)	653.23	0.313 25	8.24 4
(115.3 12)	652.089	27.0 12	6.318 23
(130.5 12)	636.861	42.6 21	6.251 25
(144.3 12)	623.10	0.62 5	8.22 4
(263.0 § 12)	504.448	2.3 21	7.81u 4
(295.6 12)	471.810	26 6	7.62 10

[†] Deduced from the requirement of an intensity balance at each level.

[‡] For intensity per 100 decays, multiply by 0.990.

§ Existence of this branch is questionable.

γ(²⁴¹Am)

The γγ coincidence relationships shown on the decay scheme drawing are from 1974Po08.

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X rays: 1974Po08

E(x ray)	I(x ray)	
(% per ε decay)		
102.024 20	23.2 14	Kα ₂ x ray
106.465 20	36.8 21	Kα ₁ x ray
119.255 30	4.5	Kβ ₃ x ray
120.274 30	9.4	Kβ ₁ x ray
123.750 30	3.8	Kβ ₂ x ray+Kβ ₄ x ray
124.816 30	1.1	K-O ₂₃ x ray

=====

I_γ normalization: Photon intensities per 100 ε decays are obtained from the requirement that ΣI(γ+ce)=100 for transitions feeding the g.s. band, namely, the g.s., 41, and 94 levels. With this normalization one gets Kα₂ x ray and Kα₁ x ray intensities of 22.4 20 and 36 4, respectively, in good agreement with the measured values listed above, and thus consistent with the assumption of negligible ε feeding to the g.s.

Eγ [†]	E(level)	I _γ ^{‡a}	Mult. [§]	δ§&	α	I(γ+ce) ^a	Comments
15.228 2	652.089	0.0548 25	M1+E2	0.0302 14	437 8	24.0 11	I _γ : From I(γ+ce) and α. I(γ+ce): From Ice(M) and (1+α)/ce(M)=1.357. The authors Ice values sum to 24.8 7; however, the intensities of the N1, N2, O1 and higher components had to be calculated, and one notes that Ice(P1)/Ice(M1)=0.030 4 compared with the theoretical values of 0.0135 3 and 0.0154 3 for M1 and E2, respectively. Mult.: M1:M2:M3:N3:O2:P1=15.3 7:3.0 3:1.0 1:0.51 15:0.21 6:0.46 5.
29.02 5	652.089	0.030 6	[E1]		3.42		
32.639 3	504.448	0.21 3	M1+E2	0.124 4	220 5	45.0 13	Mult.: L1:L2:L3:M1:M2:M3:M4:M5:N1:N2:N3:N4:N5:O1:O2:O3:P1=24.7 13: 7.9 4: 4.9 2:5.6 3:1.50 18:0.94 14:9: ≤0.04: ≤0.03:1.71 8:0.47 4: 0.28 4: ≤0.08: ≤0.08:0.39 2:0.16 2:0.08 2:0.12 2. I _γ : The calculated value from I(γ+ce) and α is 0.204 9. I(γ+ce): From sum of Ice and I _γ .

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^{241}Cm ϵ Decay 1974Po08 (continued) $\gamma(^{241}\text{Am})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger a}$	Mult. [§]	$\delta^{\S\&}$	α	$I(\gamma+ce)^a$	Comments
41.176 3	41.176	0.017 4	M1+E2	0.486 23	295 17		Mult.: L1:L2:L3:M1:M2:=0.90 19:1.76 16:1.20 6:0.16 5:0.42 5. I($\gamma+ce$): From the measured $I\gamma$, and the deduced α one gets I($\gamma+ce$)=5.0 12 compared with a feeding of the 41 level of $\Sigma I(\gamma+ce)=6.5$ 3.
132.413 7	636.861	3.9 2	M1+E2	0.061 +13-17	12.94	45.0 16	Mult.: K:L1:L2:L3:M1:M2:N1:N2:N3:O1: O23:P1=33.0 16:7.7 4:1.00 7: 0.056 11: 1.85 8:0.27 9:0.56 3: 0.082 22: ≤ 0.02 :0.153 14: ≤ 0.02 :0.054 22. δ : From L3/L1 and L3/L2. All other ratios give only upper limits, the largest being 0.20. I($\gamma+ce$), δ , α : The adopted I($\gamma+ce$)=45.0 16 is from the sum of Ice and $I\gamma$. The δ value gives $\alpha=12.94$ which, along with the measured $I\gamma$ value of 3.9 2, gives I($\gamma+ce$)=54 3. The difference between these two values of I($\gamma+ce$) lies with Ice(K). From K/L=4.84 10 one expects Ice(K)=42.4 21, compared with the experimental value of 33.0 16. Expressed another way, $\alpha(K)_{\text{exp}}$ is 22% 6 lower than the theoretical value. See the authors' comment on this discrepancy. From an intensity balance at the 504 level, one gets an upper limit on I($\gamma+ce$)(132 γ) of 47.4 13. This I($\gamma+ce$), along with $I\gamma$, gives an upper limit on α of 11.2 6, corresponding to $\delta \geq 0.53$ 10, a value inconsistent with those from the ce ratios (excluding the K shell), all of which are < 0.2 . The smaller than expected Ice(K) leads to consistency with the intensity balance, but at the same time leads to an α anomaly that needs to be investigated.

Continued on next page (footnotes at end of table)

^{241}Cm ϵ Decay 1974Po08 (continued) $\gamma(^{241}\text{Am})$ (continued)

$E\gamma^{\dagger}$	E(level)	$I\gamma^{\ddagger a}$	Mult. [§]	$\delta^{\S\&}$	α	$I(\gamma+ce)^a$	Comments
147.67 3	652.089	0.0132 12	[E2]		3.08		$I\gamma$: From Ice(L2)=0.0170 15 and α (L2)=1.292 19. The authors give Ice(L2)=0.027 10 and Ice(L3) $\leq$ 0.011. The evaluator has used the L2/L3 theory value for E2 of 1.85 4 to deduce Ice(L2) $\leq$ 0.020 and thus Ice(L2)=0.017 to 0.020. The evaluator adopts Ice(L2)=0.0185 15 which, in the evaluators' units, becomes 0.0170 15. Mult.: K:L1:L2:L3= $\leq$ 0.33: $\leq$ 0.01:0.027 10: $\leq$ 0.011.
151.4# 4	623.10	$\approx$ 0.02	[E1]		0.199		
164.8# 2	205.883	0.44 9	[E1]		0.1635		
165.049 8	636.861	3.0 2	M1+E2	0.21 3	6.75 12	20.2 8	Mult.: K:L1:L2:L3:M1:M2:N1:N2:O1:P1= 14.0 7:2.95 15:0.49 3:0.068 19: 0.75 6: 0.14 6:0.20 2:0.044 9: 0.07 2: $\leq$ 0.04. $I(\gamma+ce), \alpha$: $I(\gamma+ce)$ is from a sum of Ice and $I\gamma$. δ gives α =6.75 12, which, along with $I\gamma$, gives $I(\gamma+ce)$ =23.2 16, compared with the experimental sum of 20.2 7. Similarly as for the 132 γ , α (K)exp(165 γ) is smaller than the theoretical value, in this case by 15% 7. See the authors' comment on this discrepancy.
180.277 8	652.089	0.48 4	M1(+E2)	<0.25	5.31 14		Mult.: K:L1:M1=2.09 11:0.42 2:0.104 15.
205.879 13	205.883	2.70 15	E1		0.0980		Mult.: K:L1::L2=22 2:0.031 5:0.015 5.
265.922 12	471.810	0.40 4	[E1] [@]		0.0552	2.6 2	Mult.: K:L1:L2:L3:M1:M2=1.74 18: 0.35 3:0.15 3: $\leq$ 0.02:0.12 2:0.023 14. $I(\gamma+ce)$: From sum of Ice and $I\gamma$.
298.57 5	504.448	0.08 2	[E1] [@]		0.0429	0.14 4	$I(\gamma+ce)$: From sum of Ice and $I\gamma$.
410.8 1	504.448	0.087 9	[E2]		0.0910		
417.24 4	623.10	0.66 4	E2		0.0874		Mult.: Ice(K)=0.040 16. α (K)exp=0.056 23 gives mult=E2(+M1) with $\delta>3.1$. The placement in the level scheme requires $\Delta J=2$.
430 1	636.861	$\approx$ 0.04	[E1]		0.0200		
430.634 20	471.810	4.10 20	E2		0.0805		Mult.: K:L1=0.208 13:0.034 8. α (K)exp=0.047 4.
447.35 4	653.23	0.120 15	M1+E2	<0.77	0.37 7		Mult.: α (K)exp=0.30 8.
463.273 20	504.448	1.24 8	M1+E2 [@]		0.23 17	1.52 13	$I(\gamma+ce)$: From sum of Ice and $I\gamma$. Mult.: K:L1=0.242 18:0.035 8.
464.36# 8	670.24	0.086 14	M1+E2	1.5 +17-5	0.17 8		Mult.: α (K)exp=0.12 6.
471.805 20	471.810	72 3	M1+E2 [@]		0.22 16	87 5	Mult.: K:L1:L2:L3:M1:M2:N1:N2:N3:O1= 13.1 4:1.91 9:0.38 2: $\leq$ 0.08: 0.46 3:0.14 3:0.135 12: $\leq$ 0.005:0.052 15. $I(\gamma+ce)$: From sum of Ice and $I\gamma$.

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²⁴¹Cm ε Decay 1974Po08 (continued)

γ(²⁴¹Am) (continued)

Eγ [†]	E(level)	Iγ ^{‡a}	Mult. [§]	δ ^{&}	α	I(γ+ce) ^a	Comments
504.45 3	504.448	0.60 4	M1+E2 [@]		0.18 13	0.67 4	I(γ+ce): From sum of Ice and Iγ.
595.8 3	636.861	0.015 3	[E2]		0.0373		
623.1 3	623.10	0.012 3	[M2]		0.433		
636.88 3	636.861	1.55 11	M1+E2	0.59 18	0.133 16		δ: From α(K)exp. α(L1)exp gives δ=0.60 46. Mult.: K:L1=0.176 18:0.030 8.
652.1 4	652.089	0.04 1	[E2]		0.0306		
653.2 2	653.23	0.15 1	[E1]		0.00898		
670.2 2	670.24	0.58 4	[E1]		0.00856		

[†] From 1974Po08.

[‡] From 1974Po08, except where calculated from ce data as noted.

[§] From subshell ratios and α data of 1974Po08 as reanalyzed by the evaluator using the "frozen orbital hole" internal conversion coefficient calculations of 2008Ki07. The authors' Ice data have been normalized to the Iγ data by requiring Iγ for the 132.4, 165.0, and 205.9 transitions to equal the Iγ calculated from the ce data. The 132.4 and 165.0 keV K lines were not used in the normalization due to apparent disparities in the α (see author's explanation in 1974Po08. Multi-polarities and mixing ratios for these transitions have been deduced from subshell ratios. The ce data given below are the authors' values from their Table II. In their analysis, these are intensities per 100 ε decays, as are the Iγ values from their Table I, adopted here. The evaluator's reanalysis requires that the ce intensities be lowered by the factor 1/1.09 in order to remain as intensities per 100 decays. Where the ce data have been used to obtain α values, Iγ values, or summed to obtain total intensities, they have been lowered by this factor.

[#] Transition observed only in γγ coincidence.

[@] Probable anomalous conversion. See 1974Po08 for discussion and for calculation of penetration effects.

[&] If no value given it was assumed δ=1.00 for E2/M1.

^a For absolute intensity per 100 decays, multiply by 0.990 1.

Decay Scheme

Intensities: I(γ+ce) per 100 parent decays

²⁴⁵Bk α Decay 1975Ba25,1974Po08

Parent ²⁴⁵Bk: E=0.0; J π =3/2-; T_{1/2}=4.95 d 3; Q(g.s.)=6454.5 14; % α decay=0.12 1.

²⁴⁵Bk-J, T_{1/2}: From Adopted Levels in ²⁴⁵Bk.

²⁴⁵Bk-Q(α): From 2012Wa38.

1975Ba25:²⁴⁵Bk produced from ²⁴³Am(α ,2n) reaction was radio-chemically separated and chemically prepared for α measurements using a magnetic α spectrograph.

1974Po08: α particles measured with Au-Si surface barrier detector.

1966Ah02: γ rays following the α decay was investigated by γ singles and $\gamma\alpha$ -coin using Ge(Li) detectors.

1956Ch77: Measured $\gamma\alpha$ -coin, from decay of ²⁴⁵Bk. Measured E γ , I γ , E α and I α .

1951Hu39: measured properties of ²⁴⁵Bk and reported half-life, α -decay energies and its intensities and branching ratio.

²⁴¹Am Levels

E(level) [†]	J π [‡]	Comments
0.0	5/2-	
41.176 3	7/2-	
93.70 10	9/2-	
157.50 18	11/2-	
205.883 10	5/2+	
235.2 5	7/2+	
239		E(level): From 1975Ba25.
270		E(level): From 1975Ba25.
273.2 5	9/2+	
319.8 10	11/2+	
381.1? 1	13/2+	
459?		E(level): From 1975Ba25.
471.810 9	3/2-	
495		E(level): From 1975Ba25.
504.449 9	5/2-	
543?		E(level): From 1975Ba25.
550.4 4	7/2-	

[†] From Adopted Levels except as noted.

[‡] From Adopted Levels.

α radiations

E α [†]	E(level)	I α [‡] #	HF [§]	Comments
5796	550.4	0.9 1	17.9 25	E α ,I α : E is from 1975Ba25. They report I α <1.3. 1974Po08 report I α =0.9 1 for E α =5811 3. The evaluator assumes that the two references are seeing the same α transition.
5814@	543?			E α : From 1975Ba25. Not reported by 1974Po08. No I α is given since the peak is obscured by an impurity.
5852 2	504.449	1.4	20	E α ,I α : From 1975Ba25. I α <3.7 (1975Ba25). 1974Po08 report I α =4.1 2 for E α =5856 3. The evaluator assumes that this peak is the unresolved sum of the 5861 and 5852 peaks reported by 1975Ba25. This assumption leads to I α (5852 α)=1.4.
5861 2	495	2.7	12	E α ,I α : From 1975Ba25. See comment on 5852 α .
5886 2	471.810	21.5 5	1.96 17	E α : E α =5888 3 (1974Po08). I α =25 (1975Ba25).
5897@	459?			E α : From 1975Ba25. Not reported by 1974Po08. No I α is given since the peak is obscured by an impurity.
5983@ 3	381.1?	0.08 2	1560 420	E α ,I α : From 1974Po08. Not reported by 1975Ba25.
6035 2	319.8	0.55 8	466 79	E α : E α =6035 4 (1974Po08). I α <4.6 (1975Ba25).
6079	273.2			E α : From 1975Ba25. Not reported by 1974Po08. No I α is given since the peak is obscured by an impurity.
6085 2	270	6.2 3	74 8	E α : E α =6085 3 (1974Po08). I α =6.7 (1975Ba25).
6113	239	5.2	125	E α ,I α : From 1975Ba25. Not observed by 1974Po08.
6118 2	235.2	10.0 5	68 7	E α : E α =6122 4 (1974Po08). No I α is reported by 1975Ba25 since the peak is obscured by the calibration line. The value of 15.2 5 reported by 1974Po08 is assumed by the evaluator to include I α (6113 α), a peak reported only by 1975Ba25, and has been lowered to 10.0 to correct for the presence of this close-lying 6113 α .
6147 2	205.883	18.3 5	52 5	E α : E α =6150 4 (1974Po08). I α =20.7 (1975Ba25).
6193 2	157.50	1.2 1	1360 170	E α : E α =6198 5 (1974Po08). I α not given by 1975Ba25. Peak obscured by an impurity line.

Continued on next page (footnotes at end of table)

^{245}Bk α Decay 1975Ba25,1974Po08 (continued) **α radiations (continued)**

$E\alpha^\dagger$	E(level)	$I\alpha^\ddagger\#$	HF §	Comments
6258 2	93.70	1.5 1	2210 240	$E\alpha$: $E\alpha=6263$ 5 (1974Po08). $I\alpha<2.7$ (1975Ba25).
6308 2	41.176	15.0 5	393 36	$E\alpha$: $E\alpha=6315$ 5 (1974Po08). $I\alpha=12.2$ (1975Ba25).
6348 2	0.0	15.5 5	593 54	$E\alpha$: $E\alpha=6354$ 5 (1974Po08). $I\alpha=15.1$ (1975Ba25).

† From 1975Ba25. The resolution of this work is about 4 keV. The authors do not quote uncertainties; however, based on other work of the first author, and given an uncertainty of 0.5 keV in the calibration peak, the evaluator has assigned an uncertainty of 2 keV. 1974Po08 have also reported $E\alpha$ values. The resolution of their detector system is about 20–25 keV. Energies of 1974Po08 are given in comments. Their values have been increased by the evaluator using the recommendations by 1991Ry01 to correct for changes in the calibration energies used by the authors (1974Po08). The correction increased from +3 keV to +6 keV for 5.808 α up to the 6.348 α Others: 1951Hu39, 1956Ch77, 1956Ma32.

‡ The intensities per 100 α decays are from 1974Po08. 1975Ba25 report intensities without uncertainties. Values of these authors are given in comments.

§ $r_0(^{241}\text{Am})=1.4966$ 8 average of $r_0(^{240}\text{Pu})=1.4979$ 7 and $r_0(^{242}\text{Cm})=1.4953$ 9, is used in the calculations as given in 1998Ak04.

$\#$ For α intensity per 100 decays, multiply by 0.0012 1.

$@$ Existence of this branch is questionable.

 $\gamma(^{241}\text{Am})$

For $\alpha\gamma$ coin data see 1966Ah02, 1956Ch77.

$E\gamma^\ddagger$	E(level)	$I\gamma^\ddagger\#$	Mult.#	δ^b	α	$I(\gamma+ce)^\dagger$	Comments
41.176 3	41.176		M1+E2	0.486 23	295 17		$E\gamma$: From Adopted Gammas.
165.5 5	205.883	7.0 15	[E1]		0.162 3		
195 1	235.2	=1	[E1]		0.1110 21		
207.4 5	205.883	33 5	E1		0.0964 15		$E\gamma$: The adopted $E\gamma$ is 205.879 13 from ϵ decay.
(265.922@ 12)	471.810	0.12 3	[E1] ^a		0.0552		$I\gamma$: From $I\gamma/I\gamma(472\gamma)=0.0056$ 6 in ϵ decay. $I(\gamma+ce)$: From $I(\gamma+ce)/I\gamma=6.6$ 6 in ϵ decay.
(430.634@ 20)	471.810	1.25 25	E2		0.0805		$I\gamma$: From $I\gamma/I\gamma(472\gamma)=0.057$ 4 in ϵ decay.
471.8& 3	471.810	22& 4	[M1+E2] ^a		0.22 16	31 5	$I(\gamma+ce)$: From $I\gamma$ and $I(\gamma+ce)/I\gamma=1.208$ 86 in ϵ decay.

† For absolute intensity per 100 decays, multiply by 0.0012 1.

‡ From 1966Ah02, except where noted otherwise.

§ From 1966Ah02, except where noted otherwise. Intensities are per 100 α decays. Other: 1956Ch77.

$\#$ From adopted gammas. Values in square brackets are based on the level scheme.

$@$ From ^{241}Cm ϵ decay. Not observed in ^{245}Bk α decay.

$\&$ From 1976Ah03.

^a Anomalous E1 transition. See ^{241}Cm ϵ decay.

^b If no value given it was assumed $\delta=1.00$ for E2/M1, $\delta=1.00$ for E3/M2 and $\delta=0.10$ for the other multipolarities.

^{245}Bk α Decay 1975Ba25,1974Po08 (continued) **$^{240}\text{Pu}(\alpha, t)$ 1975Er01**

1975Er01: 29 MeV beams of α particles from the University of Minnesota MP tandem Van de Graaff accelerator was used to bombard ^{240}Pu targets. The reaction products were studied with an Enge split-pole magnetic spectrograph. Absolute cross sections were determined using two silicon monitor detectors.

 ^{241}Am Levels

E(level)	$J\pi^\dagger$	$(d\sigma_{\text{exp}}/d\Omega)/(2J+1)\sigma$ (DWBA) ‡	Comments
95\$	9/2-	0.66 5	
158\$ 2	11/2-	0.027 4	
235\$ 5	7/2+	0.037 20	
272\$ 2	9/2+	0.070 10	
323\$ 4	11/2+	0.084 20	
380\$ 1	13/2+	0.35 2	
475@ 4	3/2-	0.11 5	
504@ 3	5/2-	0.14 5	
549@ 1	7/2-	0.60 5	
625& 3	(1/2+)		
653& 4	(3/2+, 5/2+)		
682@ 3	(11/2-)		
732 ^a 4	(11/2+)		$J\pi$: Assignment considered by the authors (1975Er01) from the expected energy for the band member.
822 ^a 4	(13/2+)	0.24 3	
884 4			
1020 4			
1064 4			
1106 4			
1132 5			
1163 ^b 3	(9/2-)		
1227 3			

Footnotes continued on next page

²⁴⁰Pu(α,t) ¹⁹⁷⁵Er01 (continued)

²⁴¹Am Levels (continued)

† Spin and orbital assignments were made by 1975Er01 based on a comparison with theory of the experimental spectroscopic factors, fit to rotational bands, and previous assignments known from ²⁴⁵Bk α decay. These assignments are consistent with the adopted values.

‡ See 1975Er01 for theoretical spectroscopic factors calculated with Coriolis mixing and pairing effects.

§ (A): 5/2[523] band.

(B): 5/2[624] band.

@ (C): 3/2[521] band.

& (D): Possibly 1/2[400] band?

a (E): Probably 7/2[633] band.

b (F): 7/2[514] band?

²⁴¹Am(²⁰⁹Bi, ²⁰⁹Bi'γ) 2004Ab16, 2002AbZV

2004Ab16, 2002AbZV: ²⁰⁹Bi beam with E=1450 MeV which is about 10–15% above the Coulomb barrier was produced at the ATLAS superconducting linear accelerator at Argonne National Laboratory The ²⁰⁹Bi beam was used to bombard a 110 μg/cm² thick ²⁴¹Am target to study high spin states in ²⁴¹Am. Measured E_γ, I_γ and γγ-coin γγ-coin with the gamma-sphere array of 101 Compton-suppressed Ge spectrometers.

²⁴¹Am Levels

E(level) [†]	Jπ [‡]	E(level) [†]	Jπ [‡]	E(level) [†]	Jπ [‡]
0.0 #	5/2-	1062.2 @ 4	27/2-	2795.1 # 8	45/2-
41.176 @ 3	7/2-	1085.1 b 8	19/2-	2977.7 c 12	41/2-
94.4 # 4	9/2-	1118.0 a 6	27/2+	3035.6 @ 9	47/2-
157.65 @ 20	11/2-	1219.7 # 4	29/2-	3036.8 a 11	47/2+
206.19 & 15	5/2+	1231.4 c 8	21/2-	3157.2 & 12	49/2+
234.3 # 4	13/2-	1236.4 & 5	29/2+	3175.3 b 13	43/2-
235.2 a 5	7/2+	1345.6 b 9	23/2-	3267.3 # 10	49/2-
273.8 & 6	9/2+	1388.0 @ 5	31/2-	3424.8 c 13	45/2-
320.0 a 10	11/2+	1426.9 a 6	31/2+	3521.3 a 12	51/2+
320.1 @ 3	15/2-	1510.8 c 9	25/2-	3525.6 @ 11	51/2-
381.7 & 5	13/2+	1551.7 & 6	33/2+	3634.0 & 13	53/2+
418.7 # 4	17/2-	1563.0 # 5	33/2-	3635.7 § b 14	47/2-
453.5 a 9	15/2+	1643.2 b 9	27/2-	3768.1 # 11	53/2-
472.7 b 4	3/2-	1749.8 @ 5	35/2-	3903.0 c 14	(49/2-)
505.2 c 5	5/2-	1775.7 a 7	35/2+	4034.9 a 13	55/2+
526.1 @ 3	19/2-	1827.5 c 9	29/2-	4043.7 @ 12	55/2-
531.3 & 5	17/2+	1904.0 & 8	37/2+	4123.1 b 14	51/2-
550.8 b 4	7/2-	1941.1 # 5	37/2-	4138.1 & 14	57/2+
625.9 c 6	9/2-	1976.4 b 10	31/2-	4295.3 # 12	57/2-
630.2 a 8	19/2+	2145.9 @ 6	39/2-	4576.1 @ 13	59/2-
645.4 # 4	21/2-	2162.1 a 8	39/2+	4577.5 a 14	(59/2+)
682.6 b 6	11/2-	2178.5 c 10	33/2-	4669.9 & 15	61/2+
724.3 & 5	21/2+	2290.2 & 9	41/2+	4846.3 # 13	61/2-
774.3 @ 4	23/2-	2344.5 b 10	35/2-	5117.7 @ 14	63/2-
787.9 c 7	13/2-	2352.6 # 6	41/2-	5229.4 & 15	65/2+
851.7 a 5	23/2+	2562.0 c 11	37/2-	5408.3 # 14	65/2-
864.4 b 7	15/2-	2575.1 @ 8	43/2-	5816.8 & 16	(69/2+)
913.1 # 4	25/2-	2583.2 a 9	43/2+	5980.9 # 14	(69/2-)
959.8 & 5	25/2+	2708.5 & 10	45/2+		
989.7 c 7	17/2-	2744.4 b 11	39/2-		

† From a least-squares fit to the E_γ data, with the energy of the 41-keV level and the 95-keV level taken from adopted levels and held fixed.

‡ From 2004Ab16.

§ 4636.0 listed in Table II of 2004Ab16 should be 3636.0.

(A): 5/2[523] band, α=+1/2.

@ (B): 5/2[523] band, α=-1/2.

& (C): 5/2[642] band, α=+1/2.

a (D): 5/2[642] band, α=-1/2.

b (E): 3/2[521] band, α=-1/2.

c (F): 3/2[521] band, α=+1/2.

$^{241}\text{Am}(^{209}\text{Bi}, ^{209}\text{Bi}'\gamma)$ 2004Ab16,2002AbZV (continued) $\gamma(^{241}\text{Am})$

$E\gamma^{\ddagger}$	E(level)	$I\gamma^{\S}$	Comments
41.176 3	41.176		E γ : From Adopted gammas. The transition is not observed in this reaction due to the large internal conversion coefficient and the low efficiency of the gamma-sphere array at this low energy.
77.0@ 5	550.8	0.18# 17	
91.3@ 5	1085.1	0.3# 3	E γ : The energy fit is poor. The least-squares adjustment gives 95.4 5.
98.0 5	418.7	16# 5	
106.2@ 5	787.9	0.10# 9	
107.2 2	526.1	129# 49	
108.0† 5	381.7	14# 7	
108.1 5	959.8	0.7# 4	
113.7@ 5	1345.6	0.30# 28	
116.4 2	157.65	97# 36	
118.3 5	1236.4	1.0# 4	
120.3 5	645.4	22# 7	
120.8 5	625.9	0.7# 7	
124.5 5	989.7	0.13# 11	
124.8 5	1551.7	0.53# 23	
127.3 5	851.7	2.0# 10	
129.1 2	774.3	172 65	
131.7 5	682.6	1.8# 17	
132.9 5	1643.2	0.16# 8	
133.3 5	453.5	3.7# 18	
139.1 5	913.1	29# 9	
139.9 2	234.3	260# 110	
147.2 5	1231.4	0.18# 15	
147.6 5	381.7	1.4# 7	
148.2 5	1976.4	0.11# 6	
149.6 5	1062.2	23 6	
149.9 5	531.3	18# 9	
157.3 5	1219.7	39 12	
158.2 5	1118.0	29 15	
162.0 5	787.9	1.0# 9	
162.4 2	320.1	1.4 $\times 10^3$ 6	
164.9 5	1510.8	0.15# 13	
165.1 2	206.19	137# 57	
166.2 5	2344.5	0.11# 5	
168.6 5	1388.0	13 4	
174.3 5	1236.4	1.0# 4	
175.1 5	1563.0	22 7	
176.7 5	630.2	5.0# 24	
179.5 5	273.8	14# 6	
181.7 5	864.4	2.3# 22	
184.4 2	418.7	350 150	
184.5 5	1827.5	0.17# 10	
185.6 5	959.8	0.7# 4	
186.6 5	1749.8	11 5	
190.5 5	1426.9	3.8 19	
191.1 5	1941.1	11 4	
193.0 5	724.3	24 12	
194.0 5	235.2	2.8# 14	
198.0 5	724.3	2.4# 12	
201.9 5	989.7	1.3# 12	
204.9 5	2145.9	8# 4	
206.0 2	526.1	1020 160	
206.1 2	206.19	102# 16	
207.1 5	2352.6	8.5# 3	
211.0 5	531.3	1.8# 9	
221.5 5	851.7	7# 3	
	1085.1	3.1 30	
224.0 5	1775.7	0.9 15	
226.9 2	645.4	540 230	
235.5 5	959.8	7 4	
241.0 5	1231.4	1.8 15	

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$^{241}\text{Am}(^{209}\text{Bi}, ^{209}\text{Bi}'\gamma)$ 2004Ab16, 2002AbZV (continued) $\gamma(^{241}\text{Am})$ (continued)

$E\gamma^{\ddagger}$	E(level)	$I\gamma^{\S}$	$E\gamma^{\ddagger}$	E(level)	$I\gamma^{\S}$
247.9 2	774.3	380 160	430.9 5	3175.3	0.36 17
258.1 5	2162.1	1.8 14	442.5 5	2795.1	22 4
260.3 5	1345.6	3.0 27	447.1 5	3424.8	0.18 19
266.3 5	1118.0	9 4	448.7 5	3157.2	1.0 6
267.8 2	913.1	178 38	453.6 5	3036.8	0.7 5
276.5 5	1236.4	10 4	455.9 5	550.8	0.18# 17
279.5 5	1510.8	1.5 13	460.4 5	3635.7	0.15 8
287.8 2	1062.2	63 14	460.5 5	3035.6	18 5
297.8 5	1643.2	1.6 8	472.0@ 5	472.7	0.18# 17
306.6 2	1219.7	128 28	472.2 5	3267.3	8.0 25
308.8 5	1426.9	3.7 17	476.8 5	3634.0	0.28 18
315.3 5	1551.7	5.3 23	479.3@ 5	3903.0	0.13# 14
316.1 5	1827.5	1.7 10	484.5 5	3521.3	0.32 20
325.8 5	1388.0	68 15	487.4 5	4123.1	0.06 4
333.6 5	1976.4	1.1 6	490.0 5	3525.6	4.1 15
343.3 2	1563.0	100 3	500.8 5	3768.1	1.5 5
348.8 5	1775.7	4.3 17	504.1 5	4138.1	0.10 7
351.3 5	2178.5	0.6 6	505.3 5	505.2	0.5# 5
352.3 5	1904.0	1.8 9	510.0 5	550.8	0.18# 17
361.9 2	1749.8	64 14	513.6 5	4034.9	0.24# 15
367.8 5	2344.5	1.1 5	518.1 5	4043.7	0.68 30
378.0 2	1941.1	78 17	527.2 5	4295.3	0.27 12
383.5 5	2562.0	0.4 4	531.8 5	4669.9	0.039 30
386.2 5	2290.2	3.6 19	532.4 5	4576.1	0.35 16
386.4 5	2162.1	4.5 30	541.6 5	5117.7	0.30 15
396.3 5	2145.9	47 11	542.8†@ 5	4577.5	0.18# 11
399.9 5	2744.4	0.40 14	551.0 5	4846.3	0.17 12
411.2 5	2352.6	53 12	559.5 5	5229.4	0.029# 22
415.7 5	2977.7	0.18 20	562.0 5	5408.3	0.13# 9
418.3 5	2708.5	1.4 7	573.0†@ 5	5980.9	0.10# 7
421.1 5	2583.2	1.0 5	587.6†@ 5	5816.8	0.022# 16
429.2 5	2575.1	31 7			

† The tentative placement assigned to this transition results from the observation of a weak transition at this energy in sums of coincidence spectra double gated on transitions between high-spin levels in the g.s. band.

‡ From 2004Ab16. The authors state that the uncertainties are 0.2 keV for the strongest transitions and 0.5 keV for the weakest transitions. Transitions listed as questionable placed are seen clearly only in sums of gated coincidence spectra.

§ Relative intensities in arbitrary units from 2002AbZV.

Value given is an upper limit.

@ Placement of transition in the level scheme is uncertain.

 $^{243}\text{Am}(\text{p}, \text{t})$ 1974Fr01

1974Fr01: Proton beam with $E=16.5$ MeV from the Argonne FN tandem bombarded a 50–150 $\mu\text{g}/\text{cm}^2$ ^{243}Am target. Measurements were done with the Enge split-pole magnetic spectrograph. Cross section were measured between 15° – 60° . Determined L from angular distribution, and Q value. Interpreted cross section measurements with DWBA calculation using the code TWOPAR.

$Q(\text{p}, \text{t}) = -3407$ 15 (1974Fr01).

$J\pi(\text{target}) = 5/2^-$.

 ^{241}Am Levels

E(level)	$J\pi$	$L^{\S}$	$\sigma(\text{exp})_{60^\circ}/\sigma(\text{DWBA})$
0.0	5/2-	0	3.05
42 2	7/2-†	2	
94 2	9/2-†	(2, 4)	
158.0 15	11/2-†	4	
234.0 13	(13/2-)‡	4	
952 1	5/2-	0	0.55

Continued on next page (footnotes at end of table)

 $^{243}\text{Am}(\text{p,t})$ **1974Fr01 (continued)**

 ^{241}Am Levels (continued)

<u>E(level)</u>	<u>Jπ</u>	<u>L§</u>	<u>$\sigma(\text{exp})_{60^\circ}/\sigma(\text{DWBA})$</u>
982 2			
1136 3			
1550 4	(5/2-)	(0)	0.35

† From l and comparisons to $J\pi$ in Adopted Levels.

‡ From l and fits to the rotational bands sequence.

§ From $\sigma(\theta)$.

Adopted Levels, Gammas

Q(β⁻)=-2330 SY; S(n)=6093.3 21; S(p)=5097 14; Q(α)=6185.2 6 2012Wa38.
Δ(Q(β⁻))=-200 (syst, 2012Wa38).

²⁴¹Cm Levels

Cross Reference (XREF) Flags

A ²⁴⁵Cf α Decay
B ²⁴¹Bk ε Decay

E(level)	Jπ	XREF	T _{1/2}	Comments
0.0 §	1/2+	AB	32.8 d 2	%ε=99.0 1; %α=1.0 1. %α: Iα/(Iα+Iε)=0.010 1 from a measurement of Ice(145.536γ) in ²³⁷ Pu following α decay of ²⁴¹ Cm (1974Po08). Other: %α=0.96 9 from absolute counting (1960Gl01). T _{1/2} : From least squares decay analyses of the 471.8 keV γ using a Ge(Li) detector. Others: 35 d (1952Hi11), 37 d (1967Ba42). Jπ: HF=2.5 3 for α decay to the 1/2+ 145.54 level in ²³⁷ Pu with configuration 1/2[631]. E(level): From α decay.
5.5 §	(3/2+) †	AB		
57.1 §	(5/2+) †	AB		
81?	(7/2+)	A		E(level),Jπ: Possible 7/2+ member of the 1/2[631] band, but see the evaluator's comment in the ²⁴⁵ Cf α decay dataset.
163?	(9/2+)	A		E(level),Jπ: Possible 9/2+ member of the 1/2[631] band, but see the evaluator's comment in the ²⁴⁵ Cf α decay dataset.
267.8	(5/2+) ‡	B		Configuration=5/2+[622] (2003As01).
420.2	(7/2+) ‡	B		Configuration=7/2+[624] (2003As01).
≈2300			15.3 ns 10	%SF=100. %SF: Only SF decay observed. From calculations of T _{1/2} for SF and for T _{1/2} for γ decay (1972We09) one predicts the isomeric decay branch to be 1.3×10 ⁻⁵ %. E(level): From a fit to the ²³⁹ Pu(α,2n) excitation function, reported values are 2.3 MeV 2 (1971Br39) and 2.6 MeV 2 (1972Vy07). 1972We09 calculate 2.11 MeV. T _{1/2} : measured values and production methods: 20 ns ²³⁹ Pu(α,2n) (1969Me11); 19 ns 8 ²⁴¹ Am(d,n) (1970Po01); 25 ns 15 ²⁴³ Am(p,3n) (1971Re11); 15.3 ns 10 ²³⁹ Pu(α,2n) (1971Br39); 20 ns ²³⁹ Pu(α,2n) (1972Ga42); 10 ns 1 ²³⁹ Pu(α,2n) (1974SpZS). For theoretical calculations of T _{1/2} (SF) see, for example, 1978Po09, 1985Lo17, and 1990Bh02. ²³⁹ Pu(a,2nf): fission fragment angular distributions were measured; spin and configuration assignments were proposed by 1974SpZS, 1974GaZD. See also 1975Kh06 for possible spins deduced from angular-distribution measurements of 1974SpZS. (³ He,tF): fission probability was obtained from measured fission counts (singles) and the observed coincidences between fission fragments; barrier heights were deduced by 1976Ga11. Barrier parameters were also deduced by 1981Re06 from analysis of fission probability data of 1976Ga11. See 1972We09, 1980Ku14 and 1984Ku05 for calculated barrier parameters. ²³⁸ Pu(α,nF): Γ(n)/Γ(f) was deduced, compared with theory including pairing by 1973Me23.

† The following arguments are based on those given by 1996Ma72 in their ²⁴⁵Cf α decay paper. On the basis of the observation of 56.1 and 50.6 gammas in coincidence with the 7083α, and the absence of any gammas in coincidence with the 7138α, the authors propose the existence of excited levels at 5.6 and 56.1. From systematics, the g.s. configuration for ²⁴⁵Cf is expected to be 5/2[622] or 1/2[631]. HF(7138α)<4 identifies the 7138α as the favored transition connecting states of the same configuration, and HF(7083α)=20 suggests that the 7083α and 7138α feed members of the same band. If the configuration of ²⁴⁵Cf is 5/2[622], then the 7138 and 7083 α's must feed the 5/2+ and 7/2+ members of this band in the daughter ²⁴⁵Cm; however, the deduced rotational parameters do not agree with systematics for this configuration. The evaluator notes that these systematics lead to an expected 7/2 - 5/2 separation of 44 keV rather than 56 keV. On the other hand, if the parent configuration is 1/2[631], then the 7138 α feeds the g.s., and the assumption that the 5.6 and 56.1 levels are the 3/2+ and 5/2+ members of this band gives rotational parameters consistent with systematics for the 1/2[631] band. The evaluator adopts these assignments.

‡ 2003As01 suggest that the ε decay proceeds from the parent 7/2[633] state to the 7/2[624] state in ²⁴¹Cm, expected to lie at ≈420 keV. They point out that the inverse transition in ²⁴³Pu β⁻ decay has log ft=5.5, and the similar transitions from 5/2[642] to 5/2[633] in ²³²Np, ²³³Np, ²³⁵Pu, and ²³⁶Am ε decays have log ft values in the range 4.8 to 5.4. For the 420 level, a log ft of 5.0 to 5.5 lead to a deduced T_{1/2}(²⁴¹Bk) of 4.4 to 14 minutes, consistent with the measured T_{1/2}. The authors further suggest that the three transitions they observe in ε decay can be assigned as decay from the 7/2[624] level to the 5/2[622] band head, followed by transitions to the 3/2 and 5/2 members of the 1/2[631] g.s. band. The energy of the 3/2+ member of the 1/2[631] has been determined in ²⁴⁵Cf α decay.

§ (A): 1/2+[631] band.

Adopted Levels, Gammas (continued)
 $\gamma(^{241}\text{Cm})$

E(level)	E γ	Comments
57.1	51.6	E γ : From E γ (262.3 1)-(210.7 2) from the 268 level in ϵ decay E=50.6 is reported in α decay.
	57.1	E γ : From E γ (262.3 1) from the 268 level in ϵ decay and E(5.5 level) from α decay. E=56.1 is reported in α decay.
(A) 1/2+[631] band	(A) 1/2+[631] band	(A) 1/2+[631] band

$^{241}_{96}\text{Cm}_{145}$

 ^{241}Bk ϵ Decay 2003As01,2003AsZY

Parent ^{241}Bk : E=0; J π =(7/2+); T $_{1/2}$ =4.6 min 4; Q(g.s.)=2330 syst; % ϵ +% β^+ decay=?

^{241}Bk -Q(ϵ): 2330 200(sys, 2012Wa38).

^{241}Bk -T $_{1/2}$: From decay curves of Cm K $_{\alpha 1}$, K $_{\alpha 1}$ and L $_{\alpha}$ x-rays in ^{241}Bk (2003As01).

^{241}Bk -J: From Adopted Levels in ^{241}Bk .

2003As01,2003AsZY: ^{241}Bk was produced in the $^{239}\text{Pu}(^6\text{Li},4n)$ reaction at the JAERI tandem accelerator facility. The ϵ decay was studied using the gas-jet coupled JAERI-ISOL. γ -singles, $\gamma\gamma$ -coin and X-rays associated with the decay were measured with Ge detectors.

The decay scheme is given explicitly in 2003AsZY, otherwise, the two references contain the same data.

 ^{241}Cm Levels

E(level) †	J π	Comments
0.0 ‡	1/2+	
5.5 ‡	(3/2+)	E(level): From ^{245}Cf α decay.
57.1 ‡	(5/2+)	
267.8	(5/2+)	Configuration=5/2[622].
420.2	(7/2+)	Configuration=7/2[624].

† From Adopted Levels.

‡ (A): 1/2[631] band.

 $\gamma(^{241}\text{Cm})$

E γ	E(level)	I $\gamma^{\dagger}$
152.4 1	420.2	6 2
210.7 1	267.8	6 2
262.3 2	267.8	10 3

† The authors point out that the intensities are tentative since the coincidence summing effect cannot be corrected for without knowing the decay scheme.

^{241}Bk ϵ Decay 2003As01,2003AsZY (continued) **^{245}Cf α Decay 1996Ma72**

Parent ^{245}Cf : $E=0$; $J\pi=1/2+$; $T_{1/2}=45.0$ min 13; $Q(\text{g.s.})=7258.5$ 18; $\% \alpha$ decay=35.3 25.

^{245}Cf - $Q(\alpha)$: From 2012Wa38.

^{245}Cf - J : From Adopted Levels in ^{245}Cf (2011Br03).

^{245}Cf - $T_{1/2}$: From Adopted Levels in ^{245}Cf which is the unweighted average of 43.6 min 8 (1967Fi04) and 46.4 min 3 (1996Ma32). Other measurement: 44 min (1956Ch43).

^{245}Cf - $\% \alpha$ decay: From Adopted Levels of ^{245}Cf in 2011Br03 who used a corrected value for $I_\gamma(253)=30.6$ from ^{245}Bk ϵ decay (1996Ma27).

2004He28: α and γ decay studies of $^{253}\text{No} \rightarrow ^{249}\text{Fm} \rightarrow ^{245}\text{Cm}$ were performed at GSI, Darmstadt. α -decays were measured with the position sensitive 16 strips PIPS detector and γ -rays with a clover detector consisting of four Ge detectors.

Determined $E\alpha$, $I\alpha$ and branching ratio and $t_{1/2}$ of ^{245}Cf .

1996Ma27: ^{245}Cf produced by the $^{238}\text{U}(^{12}\text{C},5n)$ reaction which was then followed by radiochemical separation. The α decay, X-ray and γ rays were measured using a Si-surface barrier detector, a low energy photon detector and a HpGe detector, respectively.

1967Fi04: Properties of ^{245}Cf observed using the A pulse analysis.

 ^{241}Cm Levels

E(level)	$J\pi$	Comments
0.0 [†]	1/2+	
5.5 [†]	(3/2+)	E(level): From energy difference of transitions from the 56.1 level.
56.1 [†]	(5/2+)	
81? [†]	(7/2+)	
124?	(7/2+)	
163? [†]	(9/2+)	

[†] (A): 1/2[631].

 α radiations

$E\alpha^{\dagger\#}$	E(level)	$I\alpha^{\S\#@}$	$HF^{\dagger}$	Comments
6978&	163?	0.31	138	
7016&	124?	0.31	198	
7058&	81?	0.68	134	
7084 10	56.1	7.0	16	$E\alpha$: From 2004He28. 1996Ma72 report 7083 with no uncertainty. $I\alpha$: Other: 7.8 (2004He28).
7137.9 19	0.0	91.7	2.1	$E\alpha$: Weighted average of 7136.8 20 (1967Fi04) and 7145 5 (1996Ma72). The published value of 1967Fi04 has been adjusted by 1991Ry01 to account for changes in the calibration energies. The uncertainty in the value of 1996Ma72 has been taken from 2012Wa38. The authors do not give an uncertainty in their publication. Other: 7142 5, with an additional systematic uncertainty of 10 keV (2004He28). $I\alpha$: Others: 91.3% (2004He28).

[†] $r_0(^{241}\text{Cm})=1.4952$ 64 average of $r_0(^{241}\text{Cm})=1.495$ 12 and $r_0(^{242}\text{Cm})=1.4953$ 9, is used in the calculations as given in 1998Ak04.

Footnotes continued on next page

²⁴⁵Cf α Decay 1996Ma72 (continued)

α radiations (continued)

‡ From 1996Ma72, except as noted for the branches to the g.s. and 56 keV level. The authors' values, relative to their value of 7145 for the g.s. branch, have been lowered by 7 keV to account for the adopted value of 7137.9 for the g.s. branch.

§ From 1996Ma72.

The data for ²⁴⁵Cf α decay are not consistent with systematics. Other nuclides with configuration=1/2[631] whose α decay have been studied are ²³⁹Pu and ²⁴¹Cm, both with N=145. For ²⁴⁵Cf α decay, the levels that are expected to be fed, given the sensitivity of the work of 1996Ma72 are the members of the 1/2[631] g.s. band whose feeding in ²³⁹Pu α decay give hindrance factors of 2.76, 9.49, 7.76, 765, and 1260 (2014Br17) for the 1/2, 3/2, 5/2, and 7/2 members, respectively. In ²⁴¹Cm α decay the values are 2.5 3, 8.2 9, 7.5 8, 490 19, and ≈370, consistent with, but not as precisely known as for ²³⁹Pu decay. From the energies of the 1/2+, 3/2+, and 5/2+ observed members of the g.s. 1/2[631] band, the authors calculate the 7/2+ member to be at 69 keV and the 9/2+ member to be at 160 keV. Using the hindrance factors from ²³⁹Pu α decay, one gets predicted intensities for branches to the 1/2+ to 9/2+ levels of about 70%, 18%, 15%, 0.08%, and 0.04%, respectively. The branches to the 1/2+ and 3/2+ members would of course not be resolved. The authors suggest that the 81 keV level, defined by their 7058 α branch, is the band head of the 5/2[622] band; however, it has been shown in ²⁴⁵Bk ε decay that this band head lies at 267.8 keV, and from a hindrance factor of 3300 for the branch to this level in ²³⁹Pu α decay, one expects Iα=0.003% for this branch in ²⁴⁵Cf α decay, too small to have been seen. The 7058α may correspond to the 7/2+ member of the g.s. band instead; however, its intensity is much larger than expected, as is the branch to the probable 9/2+ member. The 7016α may be spurious since no level is expected at 122 keV, especially with such a hindrance factor.

@ For α intensity per 100 decays, multiply by 0.353 25.

& Existence of this branch is questionable.

γ(²⁴¹Cm)

<u>Eγ[†]</u>	<u>E(level)</u>
50.6	56.1
56.1	56.1

† From 1996Ma72.

Decay Scheme

Adopted Levels

Q(β^-)=-3290 SY; S(n)=7700 SY; S(p)=2980 SY; Q(α)=7040 SY 2012Wa38.

Δ (Q(β^-))=260, Δ (S(n))=250, Δ (S(p))=200 and Δ (Q(α))=210 (syst, 2012Wa38).

Experimental Studies:

2003As01, 2001AsZY: ²⁴¹Bk was produced and identified from ²³⁹Pu(⁶Li,4n) at the JAERI tandem accelerator facility.

The ions were mass separated using the gas-jet couple online separator. Observed Cm K, and L x-rays associated with ²⁴¹Bk ϵ through x- γ ray coin.

1989Ha27, 1973Es01, 1967Mi06: Alphas from the decay of ²⁴⁵Es were measured with Si(Au) surface detectors.

Theoretical/Systematical Studies:

2011Sh13: Calculation of cluster radioactivity half-life.

2004Be10: Calculated single-quasiparticle level energies using the self-consistent microscopic calculations with Gogny force.

2004Pa40: Calculated deformation parameters and the proton one quasiparticle states of heaviest nuclei using the macroscopic-microscopic approach.

²⁴¹Bk Levels

E(level) [†]	J π [‡]	T _{1/2}	Comments
0.0 [§]	(7/2+)	4.6 min 4	% α =?; % ϵ +% β^+ =?. T _{1/2} : From decay curves of Cm K _{α1} , K _{α1} and L _{α} x-rays in ²⁴¹ Bk as measured by 2003As01.
51 [#] 4	(3/2-)		
82 [#] 6	(5/2-)		
128 [#] 7	(7/2-)		

[†] Excited levels are reported only in ²⁴⁵Es α decay.

[‡] Systematics suggests that the g.s. has configuration 7/2[633] or 3/2[521]. On the basis of the hindrance factors for the α branches to levels at 51, 82 and 128 keV, these levels are assigned to a rotational band, and based on the energy spacing, this band is probably 3/2[521] with the level at 51 keV being the band head. The g.s. is thus probably 7/2[633].

[§] (A): 7/2[633] state.

[#] (B): 3/2[521] band.

²⁴⁵Es α Decay 1989Ha27

Parent ²⁴⁵Es: E=0.0; J π =(3/2-); T_{1/2}=1.1 min 1; Q(g.s.)=7909 3; % α decay=40 10.

²⁴⁵Es-Q(α): From 2012Wa38.

²⁴⁵Es-J, T_{1/2}: From Adopted Levels in ²⁴⁵Es.

1989Ha27: ²⁴⁵Es produced by ²³⁸U(¹⁴N,7n) and ²³⁷Np(¹²C,4n) reactions. Alphas were measured with Si(Au) surface detectors with FWHM =17-20 keV for the 5.486 MeV ²⁴¹Am α group.

1973Es01: ²⁴⁵Es produced by (HI, α xn) reaction. Measured E α using a Si-Au surface barrier detector.

1967Mi06: ²⁴⁵Es produced by ²³⁸U(¹⁴N,7n) JINR cyclotron facility. Measured E α using a Si surface barrier detector.

²⁴¹Bk Levels

E(level)	J π	T _{1/2}
0.0	(7/2+)	4.6 min 4
51 4	(3/2-)	
82 6	(5/2-)	
128 7	(7/2-)	

α radiations

E α [†]	E(level)	I α [‡] #	HF [§]
7654 6	128	3 1	53 23
7699 5	82	13 4	18 8
7730 1	51	79 6	3.8 11
7780 3	0.0	5 1	90 30

[†] From 1989Ha27. Others: 1973Es01, 1967Mi06.

[‡] Intensity per 100 α decays from 1989Ha27.

[§] r₀(²⁴¹Bk)=1.50 average of r₀(²⁴⁰Cm)=1.495 12 and r₀(²⁴²Cf)=1.5 extrapolated from systematics, is used in the calculations as given in 1998Ak04.

[#] For α intensity per 100 decays, multiply by 0.40 10.

Adopted Levels

$Q(\beta^-)=-4540$ SY; $S(n)=6740$ SY; $S(p)=3630$ SY; $Q(\alpha)=7660$ SY 2012Wa38.

$\Delta(Q(\beta^-))=280$, $\Delta(S(n))=170$, $\Delta(S(p))=220$ and $\Delta(Q(\alpha))=150$ (syst, 2012Wa38).

Experimental Studies:

2010AsZX: Determined $t_{1/2}$ of ^{241}Cf from decay curve analysis.

1970Si19: ^{241}Cf identified through $^{234}\text{U},(^{12}\text{C},5n)$. Alpha spectrum was measured with a Si(Au) detector.

1967Nu01: Studied alpha decay of ^{245}Fm .

Theoretical/Systematical Studies:

2013IS13: Prediction of spins from systematic studies of preformation probability for α decay and the neutron number of parent.

 ^{241}Cf Levels

E(level)	J π	$T_{1/2}$	Comments
0.0	(7/2-)	3.78 min 70	$\% \alpha \approx 25$; $\% \epsilon + \% \beta^+ \approx 75$. The electron-capture branch has not been observed. The 7342α from ^{241}Cf is assumed by the evaluator to be a favored transition with HF=2.0. This gives $\% \alpha \approx 25$ and thus $\% \epsilon + \% \beta^+ \approx 75$. $T_{1/2}$: From 1970Si19. Others: 2.35 m 18 (2010AsZX). J π : An analogy to ^{235}U and ^{237}Pu , both with 143 neutrons, suggest the configuration 7/2[743].
≈ 155	(1/2+)		J π : the HF for α decay from ^{245}Fm determines the configuration to be the same as that of the ^{245}Fm g.s. If configuration=1/2[631] for ^{245}Fm , in analogy to ^{241}Cm , ^{239}Pu , and ^{237}U with 145 neutrons, then that configuration applies also to this level.

 ^{245}Fm α Decay 1967Nu01

Parent ^{245}Fm : E=0.0; J π =?; $T_{1/2}=4.2$ s 13; $Q(\text{g.s.})=8440$ syst; $\% \alpha$ decay ≤ 100 .

$^{245}\text{Fm}-Q(\alpha)$: 8440 100 (syst, 2012Wa38).

$^{245}\text{Fm}-T_{1/2}$: From Adopted Levels in ^{245}Fm .

$^{245}\text{Fm}-\% \alpha$ decay: From Adopted Levels in ^{245}Fm .

1967Nu01: Measured E α from decay of ^{245}Fm that was produced via the $^{233}\text{U}(^{16}\text{O},4n)$ reaction.

 ^{241}Cf Levels

E(level)	Comments
0.0	
≈ 155	E(level): From $Q(\alpha)(^{245}\text{Fm})=8440$ 100,syst and E $\alpha=8150$ 20, with the uncertainty in $Q(\alpha)$ being a systematics value, one gets E=155 102.

 α radiations

E α	E(level)	Comments
8150 20	≈ 155	E α : From 1967Nu01.

Adopted Levels

$Q(\beta^-) = -5260$; $S(n) = 8410$ SY; $S(p) = 1420$ SY; $Q(\alpha) = 8250$ SY 2012Wa38.

$\Delta(Q(\beta^-)) = 370$, $\Delta(S(n)) = 460$, $\Delta(S(p)) = 230$ and $\Delta(Q(\alpha)) = 210$ (syst, 2012Wa38). The measured $E\alpha$ group of 8113 20 gives $Q(\alpha) = 8250$ 20 with the α group being a g.s. to g.s transition.

Experimental Studies:

1996Ni06: Alpha decay properties measured from the decay of ²⁴⁵Md.

Theoretical/Systematical Studies:

2010Do08: Calculated half-life for the isomeric state in ²⁴¹Es using the WKB approximation and Royer's formula.

²⁴¹Es Levels

E(level) [†]	T _{1/2}	Comments
0.0	8 s +6-5	% α =?; % ϵ +% β^+ =?. T _{1/2} : From 1996Ni09. J π : Systematics (see 1972El21) suggests that the g.s. has the configuration 3/2[521] or 7/2[623].
0+x x+41		E(level): the uncertainty in the E=41 component of the energy is 28 keV.

[†] Two α groups are reported in ²⁴⁵Md α decay, with $\Delta Q(\alpha) = 41$ 28. These two groups define levels at E=x and E=x+41 28. If the highest-energy group feeds the g.s., then x=0.

²⁴⁵Md α Decay 1996Ni09

Parent ²⁴⁵Md: E=300; J π =(7/2); T_{1/2}=0.35 s +23-16; Q(g.s.)=8980 syst; % α decay=?

²⁴⁵Md-T_{1/2}: From 1996Ni08.

²⁴⁵Md-E,J: From Adopted Levels in ²⁴⁵Md. See 1996Ni09 for details.

²⁴⁵Md-Q(α): 8980 210 (syst 2012Wa38).

1996Ni06: Alpha decay from ²⁴⁵Md produced from ²⁰⁹Bi(⁴⁰Ar,X) fusion reaction. ⁴⁰Ar beam with E=5.12 MeV/nucleon from the UNILAC accelerator at GSI, Darmstadt irradiated 395-590 $\mu\text{g}/\text{cm}^2$ Bi targets. Measured (evaporation residue)- α - α correlations using the PIPS 16 strips detector.

²⁴¹Es Levels

E(level) [†]	Comments
0+x x+41	E(level): The uncertainty in the E=41 component of E(level) is 28 keV.

[†] If the 8680 α feeds the g.s., then X=0.

α radiations

E α	E(level)
8635 20	x+41
8680 20	0+x

Adopted Levels

$S(p)=2360$ SY; $Q(\alpha)=8760$ SY 2012Wa38.
 $\Delta(S(p))=500$ and $\Delta(Q(\alpha))=310$ (syst, 2012Wa38).

Experimental Studies:

2008Kh10: ^{241}Fm produced and identified via the fusion evaporation reaction $^{204}\text{Pb}(^{40}\text{Ar}, 3n)$. ^{40}Ar beam with $E=187\text{--}206$ MeV from the UNILAC linear at GSI, Darmstadt bombarded a ^{204}Pb target. ^{241}Fm underwent spontaneous fission, and the evaporation residues were selected using the SHIP velocity filter and studied with a 16-strip Si detector, two time-of-flight detectors and an HPGe Clover detector. Measured Er-SF and Er- α correlated event (Er=evaporation residue), half-life and and fission branching. No isomers were found in this study.

Theoretical/Systematical Studies:

2011Ad15: Calculated energies of low lying one-quasiparticle states with the microscopic-macroscopic two-center shell model approach(TCSM) the WKB approximation and Royer's formula.

^{241}Fm Levels

E(level)	$T_{1/2}$	Comments
0.0	0.73 ms 6	$\%SF>78$ (2008Kh10); $\%\alpha<14$ (2008Kh10); $\%\varepsilon<12$ (2008Kh10). $T_{1/2}$: From 145 Er-SF correlated events (2008Kh01). $J\pi$: 1/2- predicted in 1997Mo25 calculations.

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