Title

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Publication Date

1954-01-08

UCRL 2450

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

BERKELEY, CALIFORNIA

UCRL-2450
Unclassified - Physics Distribution

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Contract No. W-7405-eng-48

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The principal aim of this note is to show the close similarity in the alpha spectra of Am^{243} and Am^{241} insofar as comparison is possible and to suggest an interpretation for some of the observed levels. In earlier publications[1, 2] the similarities in the spectra of even-even alpha emitters were demonstrated and it now appears that alpha emitters with odd nucleons have points of similarity with each other but have a distinctly different pattern than the even-even nuclei.

The alpha-emitter Am^{243} was first prepared[3] through neutron capture by Am^{242} and its presence detected by observing the growth of Np^{239}. From mass spectrographic analysis of the americium and the amount of Np^{239} which grew, the half-life was estimated to be $\sim 10^4$ years.[3] The neutron irradiation of plutonium containing Pu^{242} creates Am^{243} through the intermediary Pu^{243} which is short-lived β^--emitter[4] and sufficient Am^{243} relative to Am^{241} could be produced in this way to measure the alpha-particle energy (5.27 Mev) with an ionization chamber.[5]

The sample of Am^{243} used for magnetic analysis in the present study was prepared by plutonium (Pu^{239}) irradiation. Only about 2 percent of the alpha activity was due to Am^{243} and the rest was Am^{241}.[7] Nevertheless, the more prominent features of the Am^{243} alpha spectrum could be measured. From the resolved alpha spectra and the isotopic abundance of Am^{243} in the sample, the half-life was calculated to be $7._6 \times 10^3$ years. The magnetic spectrograph has been described in earlier publications.[8, 9]

Three alpha groups attributable to Am^{243} were observed with energies and abundances as indicated in Fig. 1. The alpha groups of Am^{241} were used as energy standards.[9] In comparing the spectrum with that of Am^{241}, it will be noted that the main group of Am^{241} (84 percent abundance) populates a state 60 kev above the ground state[10]

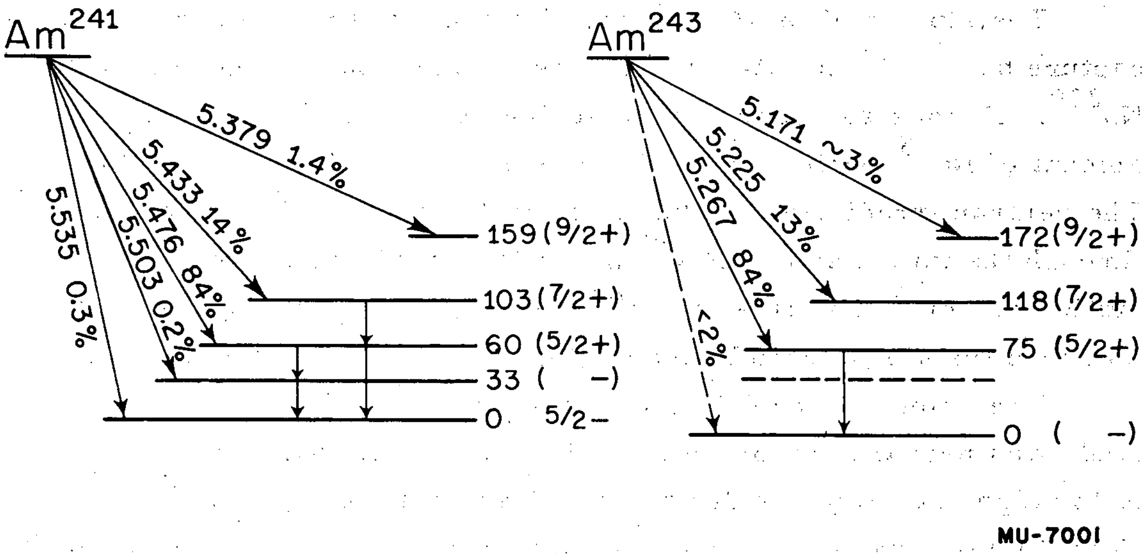

Fig. 1

Partial decay schemes for Am^{241} and Am^{243}.

and the main group of Am^{243} (84 percent abundance) leads to an excited state of 75 kev. The alpha-gamma coincidence measurements which established this decay sequence will be mentioned presently. Each alpha emitter has a transition in about 14 percent abundance of some 40 kev lower energy than the main alpha transition and each has a low intensity group of about 55 kev still lower energy. It is seen that the parallelism is close for those transitions which can be compared.

The ground state alpha transition for Am^{243} was not observed, but the limit of detection was 2.5 percent and it will be noted that the corresponding transition for Am^{241} is found in only 0.3 percent abundance. Similarly, if there is a low abundance transition (energy level shown as a broken line) corresponding to that populating the 33-kev state of Np^{237} from Am^{241} decay, it would not have been seen. Purer and more intense sources of Am^{243} will be required to see if this state exists.

A small amount of a sample was available which had about twice as much Am^{243} activity as Am^{241} and this was used for a gamma-ray study. A scintillation spectrometer triggered by coincident alpha particles was employed in order to obtain the gamma-ray energies and abundances. A single prominent peak was obtained at 75 kev which showed a hump on the low energy side presumably due to the 60-kev gamma ray of Am^{241}. Since the Am^{241} content was known, its contribution to the gamma-ray peak could be subtracted. The result was that the 75-kev gamma-ray was found to accompany 80 percent of the total Am^{243} alpha particles. This means that the conversion coefficient cannot be greater than 0.25 and fixes this transition as E1 just as is the case for the 60-kev transition of Am^{241}.[11] (The conversion coefficients of 75-kev M1 and E2 transitions should be 10 or greater.)[12]

If we consider those components of the Am^{243} spectrum which lead to the 75-kev state and to the next two higher states, we note a marked resemblance to the ground state and first two excited states of an even-even alpha emitter like Cm^{242}.[13] The similarity includes energy level spacings and the intensities of the alpha groups. In the case of an even-even nucleus this type of spectrum has been interpreted as a rotational band comprising the states 0+, 2+, and 4+.[13]

According to the theory of Bohr and Mottelson,[14] the rotational states of an odd nucleon case should have the following energy and spin sequence:

$$E_I = \frac{\hbar^2}{2\tau}\left[I(I+1) - I_o(I_o+1)\right];\ I = I_o,\ I_o+1,\ I_o+2,\ \ldots\ldots$$

I_o is the spin of the lowest state in the band.

If one has three adjacent states belonging to a rotational band it should be possible to calculate I_o (and therefore $I_o + 1$ and $I_o + 2$) as well as the quantum of rotation, $\hbar^2/2\tau$. On this basis the spins of the states reached by $Am^{241}\alpha_{60}$ and $Am^{243}\alpha_{75}$ were calculated to be 2.3 and 2.8, respectively. Since the spins must be half integral, the closest value is 5/2. This same treatment of Am^{241} data was made by Rasmussen[15] who arrived at similar conclusions for the spin numbers of the excited states. It should be mentioned that the calculated spin number is sensitive to the accuracy of the energies of the states. If the measured energy difference between $Am^{241}\alpha_{60}$ and α_{103} were 44 kev instead of 43 kev, the value obtained for I_o would have been 2.8 instead of 2.3.

From shell model considerations, the ground states of Np^{237} and Np^{239} are assigned odd parity. Since the 60 kev and 75 kev transitions are E1, the levels belonging to the rotational band have even parity. The spin and parity assignments made on this basis are shown in Fig. 1. The spin number 5/2 for the ground state of Np^{237} is a measured value.[16]

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