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The Radiation Characteristics of Cm^{240} and Cm^{241}

G. H. Higgins and K. Street, Jr.

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THE RADIATION CHARACTERISTICS OF Cm^{240} and Cm^{241}

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In an attempt to extend the earlier work on the neutron deficient curium isotopes,[1,2] the isotopes of mass numbers 242, 241, and 240 were produced in varying ratios by bombarding Pu^{239} with helium ions.

Carrier-free samples of curium which had been chemically purified by ion-exchange techniques were volatilized onto platinum counting disks for study. The decay of the alpha particles, and also the conversion and Auger electrons accompanying orbital electron capture, was followed on a windowless proportional counter. Decay of alpha particles of specific energies was followed on the 48 channel differential pulse analyzer.[3]

When the bombardment energy was between 30 and 40 Mev, activities with three different half-lives were observed. These were the 27 day 6.25 Mev alpha activity previously reported[1] and assigned to Cm^{240}, a 35 day 5.89 Mev alpha and electron capture activity, and the well known 162 day 6.08 Mev alpha activity of Cm^{242}.

Some of the samples which were proportionately richer in Cm^{240} were allowed to decay for known periods of time and any americium which might have grown into them was separated chemically. Samples were prepared and counted in the same manner as those of the curium. No activity other than a small amount of Am^{241} (about 0.001 percent of that present in the target material) which had followed the curium chemistry was detected.

Thus less than 0.5 percent of the Cm^{240} decayed by electron capture to produce the 52 hour activity of Am^{240}.

When the bombardment energy was between 25 and 28 Mev, only the 35 day and 162 day activities were observed. At this energy the (α,2n) reaction would be expected to predominate while the (α,3n) should be in such low incidence that products of it would not be dectected. For this reason the 35 day activity was assigned to Cm^{241}.

The ratio of the number of electron capture disintegrations to the number of alpha disintegrations in the 5.89 Mev group was calculated to be between 360 and 460. The number of electron capture disintegrations was determined by assuming the same counting efficiency for the radiations accompanying the electron capture disintegration process of Cm^{241} as for those of U^{231} and the number of alpha disintegrations was determined from geometrical considerations, assuming 100 percent counting efficiency. The values above indicate only the precision of the measurements and errors in the assumed counting efficiency could change the numbers by factors of two or more. The partial alpha half-lives calculated from these branching ratios are 35 and 45 years.

While the 5.89 Mev group apparently accounts for more than 75 percent of the observed alpha disintegrations which decay with a 35 day half-life, it is certain from the alpha systematics[5] that the ground state transition energy would be between that of Cm^{242} (6.08 Mev) and Cm^{240} (6.25 Mev), but particles in this energy range are as yet unobserved.

We wish to express our appreciation to Dr. Glenn T. Seaborg for his continuing interest in this work.

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