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Radiation Laboratory

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# BETA DECAY ENERGY OF $Ac^{226}$

K. L. Hall and D. H. Templeton

October 20, 1950

Berkeley, California

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# BETA DECAY ENERGY OF $Ac^{226}$

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October 20, 1950

In order to extend the energy surface in the heavy region by closing alpha-beta cycles, some alpha energies must be estimated from a plot of alpha disintegration energy vs. mass number. By combining these estimations with experimentally determined values, one may calculate beta decay energies in those cases in which no beta transition has been observed. Thus, in the 4n+2 series the alpha systematics are extended from $Pb^{210}$ to $Cm^{238}$ as shown. (The numbers are decay energies in Mev; e stands for estimations from alpha systematics,[1] c means calculated by closing decay cycles, the other values are experimental.)

$$\begin{array}{ccccccccccccccc}
Pb^{210} & \underline{<7.83} & Po^{214} & \underline{<7.25} & Em^{218} & \underline{<6.64} & Ra^{222} & \underline{<6.41} & Th^{226} & \underline{<5.96} & U^{230} & \underline{<6.26} & Pu^{234} & \underline{<6.61} & Cm^{238} \\
\uparrow & 5.37^{c} & \uparrow & 3.15 & \uparrow & 2.73^{c} & \uparrow & 2.09^{c} & \uparrow & 1.05^{c} & \uparrow & 0.54^{c} & \downarrow & 0.42^{c} & \downarrow \; 0.98^{c} \\
Tl^{210} & \underline{<5.61} & Bi^{214} & \underline{<6.83} & At^{218} & \underline{<6.00^{e}} & Fr^{222} & \underline{<5.37^{e}} & Ac^{226} & \underline{<5.45^{e}} & Pa^{230} & \underline{<5.30^{e}} & Np^{234} & \underline{<6.05^{e}} & Am^{238}
\end{array}$$

To lend more credence to the estimated and calculated values in the region of $Cm^{238}$, an experimental check on one of the values can be made. $Ac^{226}$ was chosen for this purpose. $Ac^{226}$ was first observed in alpha bombardments of uranium. The isotope was assigned by milking the 30.1-minute $Th^{226}$ daughter from a pure actinium fraction.[2] Later experiments on the direct observation of the decay of the $Th^{226}$ alpha group in equilibrium with its parent gave 29±2 hours[3] for the half-life of $Ac^{226}$.

Thorium foil was bombarded with 350 Mev protons to produce $Ac^{226}$. The foil was then dissolved in concentrated HCl containing a trace of $F^{-}$. The bulk of the

thorium was removed by extraction into 1M TTA in benzene at a pH of 1.0-2.0. The rare earths and actinium were then extracted into the benzene phase at pH of 6.0-7.0, and finally into 0.1M HCl. Two methods were employed to separate the actinium from the rare earths. In the first method, the rare earths were extracted away using 3M TTA at pH of 3.0-3.2 and actinium subsequently extracted into 0.15M TTA at a pH of 6.0-7.0. The second method consisted of transferring the activities onto a resin column of Dowex-50 ($NH_4^+$ form) and eluting with "5 percent citrate" at a pH of 4.0. The rare earth fraction was located by its beta activity, and the actinium by the alpha peak.

Aluminium absorption curves were taken at various times, so that the decay could be followed through each absorber. From each of these decay curves was resolved a 10-day line ($Bi^{213}$ in equilibrium with $Ac^{225}$). The resulting $Ac^{226}$ line varied in slope from 24 to 39 hours (averaging 32 hours), fitting in also the 6-hour $Ac^{228}$ line. The activity of the $Ac^{226}$ was then read at a certain time on all decay curves, and these activities were plotted as an aluminum absorption curve. The resulting curves, together with their Feather analyses, are shown for two experiments. Two lines of limiting slope were drawn through the absorption points of each experiment, and Feather analyses made accordingly. The end points give an average of $1.17 \pm 0.07$ Mev. The error quoted is seen to be the result of statistical fluctuations and does not include indeterminant errors, such as small amounts of radiochemical impurities, etc.

As a further check on the beta energy, a column-separated sample was run on the bender, and a crude Kurie plot made. The end point determined in this manner fell within the above limits.

It is to be noted that there is no observable gamma tail in the absorption curves, indicating that $Ac^{226}$ is nearly a pure beta emitter. The decay energy

is thus assigned to 1.17 ± 0.10 Mev, and this value is seen to compare closely to the calculated value of 1.05 Mev.

This work was performed under the auspices of the U. S. Atomic Energy Commission.

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[1]Perlman, Ghiorso, and Seaborg, Phys. Rev. 77, 26 (1950).

[2]G. T. Seaborg and I. Perlman, Rev. Mod. Phys. 20, 585 (1948).

[3]K. Street, Jr., Private Communication.

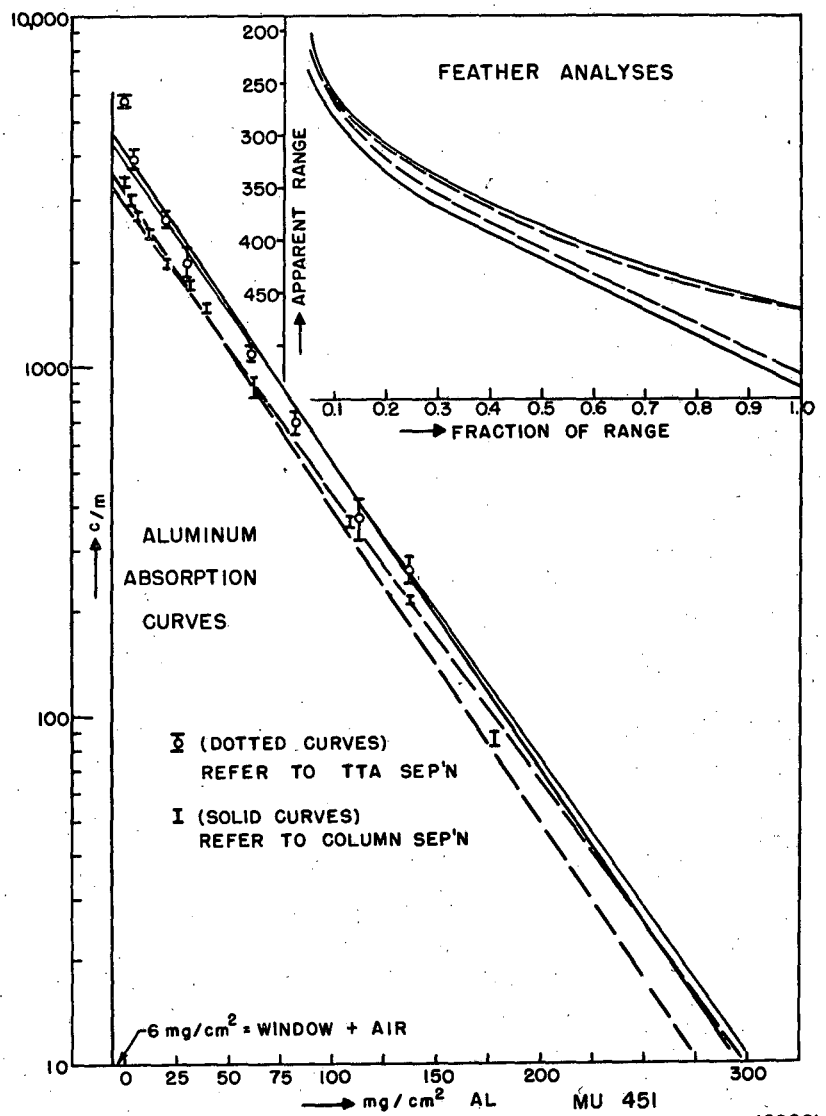
FEATHER ANALYSES
APPARENT RANGE
FRACTION OF RANGE
ALUMINUM
ABSORPTION
CURVES
c/m
(DOTTED CURVES)
REFER TO TTA SEP'N
(SOLID CURVES)
REFER TO COLUMN SEP'N
6 mg/cm² = WINDOW + AIR
mg/cm² AL
MU 451
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FIG. 1