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# THE NUCLIDE $99^{254}$

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The nuclide $99^{254}$ has previously been reported[1, 2] and found to decay[2, 3] with a half-life of 36 hours by emission of $\beta^-$ particles. Further investigation has revealed the existence of another isomer of $99^{254}$ which decays almost entirely by emission of alpha particles. The 36-hour isomer has been found to exhibit electron-capture branching to produce $Cf^{254}$.

1. The long-lived isomer --Samples of the 20-day 6.6-Mev alpha emitting $99^{253}$ subjected to neutron bombardment were shown by alpha pulse analysis to contain a nuclide emitting $6.44 \pm 0.01$ Mev alpha particles. This new alpha radioactivity showed no decrease in intensity during 3 months, so that the nuclide responsible for it must have a half-life longer than about 2 years.

Chemical purification of the $99^{253}$ by the method of ion-exchange elution, using Dowex-50 cation resin and ammonium α-hydroxy-isobutyrate as eluant[4] showed that the 6.44-Mev alpha emitter could not be separated from element 99.

Its assignment, based on the systematics of alpha radioactivity,[5, 6] was most logically to mass 254. This assignment was confirmed by collecting recoil nuclei from a very thin sample of the new alpha emitter. These daughter nuclei were shown to decay, by emission of

$\beta^-$ particles, with a half-life of approximately 3 hours. This radiation is characteristic of $Bk^{250}$.[7]

The absence of any 7.2-Mev alpha particles of $100^{254}$ [1, 2, 3, 8] in equilibrium with this long-lived isomer of $99^{254}$ shows that the partial half-lives of the latter species for both $\beta^-$ decay and isomeric transition to the 36-hour isomer are more than 100 times longer than the alpha half-life. It is perhaps more likely that the 36-hour isomer is the metastable state, and it will be convenient provisionally to refer to it as $99^{254m}$.

2. Electron capture in $99^{254m}$. --Preliminary experiments[9] showed that a californium isotope decaying by spontaneous fission, with no detectable emission of alpha particles, grew into very carefully purified samples containing $99^{253}$, $99^{254}$, $99^{254m}$, and $99^{255}$. The californium exhibited a half-life of 85 ± 15 days. This observation has since been repeated and confirmed with much larger amounts of activity.

The californium isotope responsible for such a short-lived spontaneous fission decay is most likely of even mass, and is therefore probably $Cf^{254}$, since $Cf^{250}$ and $Cf^{252}$ are already known.[7, 10, 11] Some $Cf^{256}$ might have been formed by electron capture decay of the (unknown) nuclide $99^{256}$, which might have been present in the sample. However, $99^{256}$ is expected to be short-lived,[12] and any $Cf^{246}$ produced by its electron-capture decay would have been removed in the initial purification of the 99 sample. Samples containing only $99^{253}$ and $99^{254}$ exhibit only a very small spontaneous fission activity. The $Cf^{254}$ must therefore grow from the 36-hour $99^{254m}$, by the electron-capture process, and not from the $99^{254}$. The amount of $Cf^{254}$ produced by a known amount of $99^{254m}$ gave a value of 1000 for the ratio of $\beta^-$ decay to electron capture.

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