D. Decay of Neutron Deficient Am Isotopes

Our study of the decay of neutron deficient Am isotopes was undertaken in hopes of clarifying the nature of the reported short lived fission activities with half-lives of 1.4 and 2.6 minutes which were attributed to the decay of ^{232}Am and ^{234}Am, respectively.[13] While these activities were first supposed to be spontaneously fissioning shape isomers, further studies of half-life systematics for fission isomerism of the actinides indicated that fission isomers of ^{232}Am and ^{234}Am would be expected to have half-lives $\leq$1 msec.[14] Thus it has been suggested that the observed fission activities actually result from α delayed fission, i.e., electron capture of the ^{232}Am and ^{234}Am isotopes to levels above the fission barriers in the Pu daughter.

Since the isotopes ^{232}Am and ^{234}Am have not been observed in any other experiments, it was of interest to search for the α decay of those isotopes and to compare the lifetimes and excitation functions for production of those isotopes with the similar data for the fission activities to see whether the isotope assignments and interpretations of the isotopes as resulting from β delayed fission were consistent with the α decay data.

The reactions ^{4}He + ^{237}Np at energies of 70 to 110 MeV, ^{3}He + ^{237}Np at energies of 50 to 100 MeV and ^{10}B + ^{230}Th at energies of 85 to 100 MeV. In most of the experiments recoiling product nuclei were caught on a 200 $\mu g/cm^2$ Al leaf catcher and transferred in ~0.5 seconds to a shielded counting position where both solid state detectors were used to observe the emitted α particles and fission fragments. In some additional

Table I. Cross Sections for Long-Lived Fission Activities

Target	Beam	Energy	No. of Events Observed	Cross Section (nb) for $T_{1/2}$ (min) 1	1.4	2.6
^{237}Np	^{4}He	71.5	0	≤ 2.32	≤ 2.66	≤ 4.34
^{237}Np	^{4}He	75.0	0	≤ 0.109	≤ 0.115	≤ 0.151
^{237}Np	^{4}He	76.6	0	≤ 1.91	≤ 2.19	≤ 3.58
^{237}Np	^{4}He	85.0	0	≤ 0.23	≤ 0.25	≤ 0.382
^{230}Th	^{10}B	86.7	1	0.745	0.967	1.93
^{230}Th	^{10}B	92.5	4	0.45	0.70	1.18
^{230}Th	^{10}B	100.6	5	5.90	7.66	15.29

experiments dielectric track detectors were used to detect the fission fragments from recoiling nuclei decaying in flight. The thesis of J. K. Archer, based upon these experiments, is now in preparation. A summary of the more important results follows.

Fission Decay

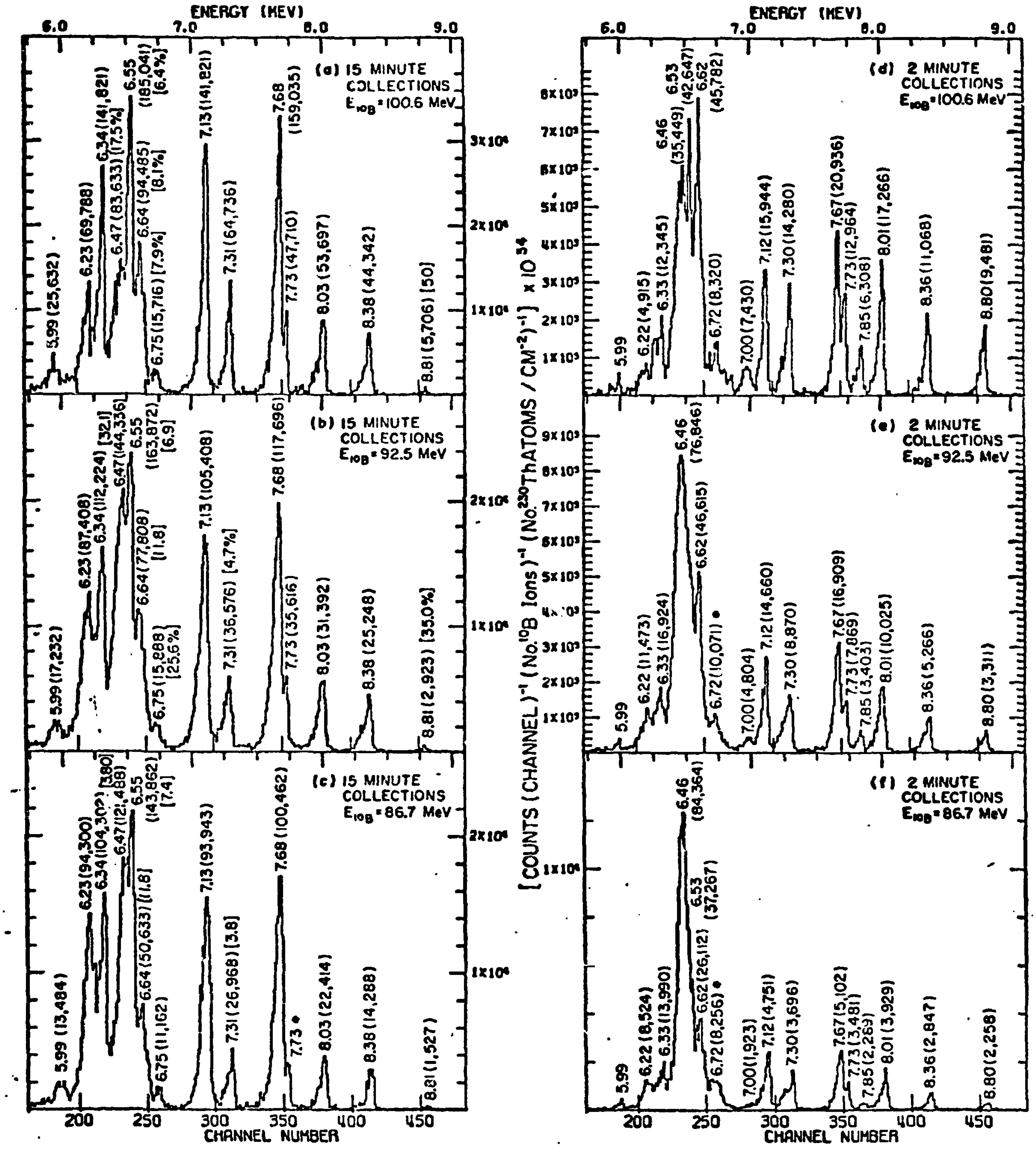
Cross sections or upper limits to cross sections obtained for the production of fissioning nuclei with lifetimes greater than ~1 sec are presented in Table I. Since in none of the experiments was there sufficient activity to allow a half-life determination, we have calculated cross sections assuming lifetimes of 1, 1.4 and 2.6 minutes. No long-lived fission activities were observed in the ^{4}He irradiations. In the original reports of a 1.4 minute fission activity of ^{232}Am produced in the reaction $^{10}B + ^{230}Th$, the excitation function was reported to peak at ≈90 MeV with a cross section ≈2 nanobarns. We find the cross section in that energy range to be 0.7±0.4 nb. At 100 MeV, the measured cross section for a 1.4 minute activity is 7.7±3.5 nb. Thus our results confirm the existence of long-lived fission activities produced in the $^{10}B + ^{230}Th$ reaction but the cross section for such activities appear to be higher at 100 MeV.

Alpha Decay

An α emitter with a half-life of 3.3±0.1 minutes and emitting a 6.46 MeV α particle has been observed in the ^{3}He, ^{4}He and ^{10}B irradiations and is assigned to the isotope ^{234}Am. The lifetime is in reasonable agreement with the 2.6 minute lifetime of the fission activity previously assigned to ^{234}Am.

An unknown α emitter with a lifetime of 2.0±0.1 minutes and an α particle energy of 7.30 MeV has been observed in the ^{10}B irradiations.

Figure 7 α-particle spectra for nuclei produced in the reaction of ^{10}B with ^{230}Th. Data is presented for 86.7, 92.5 and 100.6 MeV projectile energies. Spectra a-c represent experiments in which reaction recoils were collected for 15 minutes and the decay observed for 30 minutes. Spectra d-f represent experiments in which the collection period and the counting period were each 2 minutes. Energies are indicated. The numbers in parentheses and brackets represent peak areas and relative intensities.


ENERGY (MEV)
6.0
7.0
8.0
9.0
(a) 15 MINUTE COLLECTIONS E_{10B} = 100.6 MeV
(b) 15 MINUTE COLLECTIONS E_{10B} = 92.5 MeV
(c) 15 MINUTE COLLECTIONS E_{10B} = 86.7 MeV
(d) 2 MINUTE COLLECTIONS E_{10B} = 100.6 MeV
(e) 2 MINUTE COLLECTIONS E_{10B} = 92.5 MeV
(f) 2 MINUTE COLLECTIONS E_{10B} = 86.7 MeV
[COUNTS (CHANNEL)$^{-1}$ (No.^{10}B Ions)$^{-1}$ (No.^{230}ThATOMS / CM^{-2})$^{-1}$] x 10^{34}
CHANNEL NUMBER
200
250
300
350
400
450

While α energy systematics make it quite plausible that this activity could be assigned to ^{232}Am, the failure to observe the appropriate reported daughter activities which should be observed following either α decay or electron capture decay from the daughter ^{228}Np nucleus prevents us from firmly assigning this activity.

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