UNCLASSIFIED

UNCLASSIFIED

[redacted]

Non-CCRP
JLW 7/7/80

UNCLASSIFIED

L A REPORT 21

[redacted]

August 31, 1943.

This document contains 6 pages

FISSION CROSS SECTION OF 94^{239} FOR 220 KEV NEUTRONS AND Ra PLUS Be NEUTRONS

WORK DONE BY:

C. Wiegand

REPORT WRITTEN BY:

E. Segre

C. Wiegand

[redacted]

Physics - Fission

UNCLASSIFIED

[redacted]

UNCLASSIFIED

[redacted]

ABSTRACT

The fission cross section of 49 and 25 for 220 Kev neutrons have a ratio of 1.14. For radium-plus-beryllium neutrons the fission cross sections of 28, 24 and 49 are respectively 0.32, 0.7 and 1.57 times that of 25.

[redacted]

[redacted]

FISSION CROSS SECTION OF 94^{239} FOR 220 KEV NEUTRONS AND Ra PLUS Be NEUTRONS

In an earlier investigation [1] we have measured the fission cross section of 25 using a photoneutron source giving 220 Kev neutrons, and it is interesting to measure also the fission cross section of 49 for this energy. The experimental problem is however considerably more difficult because of the high specific activity of the material. If we use one of our ordinary air-filled ionization chambers and linear amplifiers and try to put in it a sample of about 10 micrograms of 49, serious difficulties are encountered, caused by the fluctuations and superposition of the alpha background.

This difficulty can be overcome by using a coincidence chamber with a sample mounted on a thin film, taking advantage of the fact that the fission fragments fly apart in opposite directions. However, in attempting to use this method we lost too much neutron intensity and another way of attacking the problem was found much more satisfactory. Introducing tank nitrogen in the chamber and collecting negative ions we found, as is well known, that the sharpness of the pulses is increased very much and, provided the amplifier has an adequate frequency response (our apparatus has a practically constant gain up to at least 70 Kcycles/sec), it is easy to count fissions even in presence of 10^6 alphas/minute in the chamber. As a matter of

[redacted]

1) Chamberlain, Kennedy and Segre, A-449

[redacted]

fact with 1.3×10^6 alphas/minute in the chamber we could not detect any spurious pulses that would trip our counters in several hours and under such conditions of bias that all fissions are recorded.

In our experiments the cross section of 49 was compared with that of 25 and the final result is $\sigma_{49}/\sigma_{25} = 1.14 \pm 0.13$ for a neutron energy of 220 Kev (0.13 is the standard deviation based upon statistics).

A sample of enriched uranium containing 35.5 μg of 25, prepared by the Berkeley method, was used as a standard, and a sample containing 16.8 μg of 49 as determined by its alpha activity ($T_{\frac{1}{2}}$ = 21,300 years[2]) was used for the determination of σ_{49}.

The two samples were put successively in the ionization chamber, the chamber was filled with nitrogen, and an yttrium-plus-beryllium source was put in a standard position above the chamber. The beryllium block had the form of a cube with 4 cm side and the yttrium was located on an axis of the cube near the bottom face. The radium equivalent of the yttrium was about 600 mgr of radium (measured through 1.2 cm of lead). The whole ionization chamber, source and amplifier were located on a rack supported by wires coming from the ceiling, to avoid any slowing down of the neutrons. We checked that cadmium screens did not affect the fission counting rate.

The counting rate with the 25 sample was 18.2 ± 0.85 c/hr; the counting rate with the 49 sample was 9.65 ± 0.45 c/hr; from these

2) Compton, A.H., CN-419

[redacted]

numbers one can deduce the ratio of the cross sections at 220 Kev

$$\frac{\sigma_{49}}{\sigma_{25}} = \frac{R_{49}}{R_{25}} \; \frac{M_{25}}{M_{49}} \; \frac{239}{235} = 1.14 \pm 0.13$$

Since thickness of the samples or inequality in their distribution is always a possible cause of error in measurements of this type we checked that our samples give the accepted value of σ_{49}/σ_{25} for thermal neutrons. This was done by surrounding the whole apparatus with a thick paraffin layer and measuring cadmium differences.

In these experiments we had a net counting rate of 172.5 $\pm$ 8 c/hr for the 25 sample and 139 $\pm$ 8 c/hr for the 49 sample. With these numbers we find at thermal energies $\sigma_{49}/\sigma_{25} = 1.74 \pm 0.2$, to be compared with the value 1.87 $\pm$ 0.14 [3]. Naturally one can obtain the ratio of the ratios of the cross sections at 220 Kev and at thermal energies in a manner independent both of the mass measurements of the samples and also of possible irregularities of the layer, by combining the measurements at thermal energies with the ones at 220 Kev. One obtains

$$\left(\sigma_{49}/\sigma_{25}\right)_{220} \Big/ \left(\sigma_{49}/\sigma_{25}\right)_{th} = \frac{1.14 \pm 0.1}{1.74 \pm 0.2} = 0.655 \pm 0.1$$

and if we assume that the correct value of $\left(\sigma_{49}/\sigma_{25}\right)_{th}$ is 1.87, we obtain

$$\left(\sigma_{49}/\sigma_{25}\right)_{220} = 1.22 \pm 0.2$$

[redacted]

3) Chamberlain, Kennedy, Segre, Wahl. CN-469

 [redacted]

We thought it also worth while to measure σ_{28}, σ_{25}, σ_{24} and σ_{49} for radium-plus-beryllium neutrons although some of these cross sections have been previously measured[4]. The experimental set-up used was the same as described above, with the exception of the neutron source. Since 28, 25 and 24 undergo fission with radium-plus-beryllium neutrons, one has to operate with a set of enriched samples in order to obtain the separate contributions of the various isotopes: we used a sample containing 955 μg of 28, 0.2 μg of 25 and 0.002 μg of 24; a sample containing 77 μg of 28, 129 μg of 25, 1.03 μg of 24 prepared and analysed in Berkeley and a sample of 24 containing 13.4 μg of pure 24, kindly loaned by Professor Latimer.

If we take σ_f of 25 as unity, we find $\sigma_{28} = 0.323 \pm 0.015$; $\sigma_{24} = 0.7 \pm 0.15$ and $\sigma_{49} = 1.57 \pm 0.16$.

[redacted]

---

4) Goffman, Duffield, Blanchard and Seaborg, CF-392