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Radiation Laboratory
Berkeley, California

Contract No. W-7405-eng-48

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May 10, 1955

Printed for the U. S. Atomic Energy Commission

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The neutron capture cross section of $Cm^{242}(n, \gamma)Cm^{243}$ is difficult to measure directly because of the difficulty of detecting the relatively long-lived Cm^{243} produced. Previous indirect measurements range from 10 to 95 barns.[1]

In this work the total (capture and fission) neutron cross section was determined by measuring the destruction of Cm^{242} in high intensity neutron bombardments in the Materials Testing Reactor.

The Cm^{242} used was purified from the Pu^{238} daughter, and from Am^{241}, by ion-exchange methods. The Am^{241} content was estimated to be <0.01 percent by weight. The pure Cm^{242} was then vaporized on to thin aluminum foils. The amount of Cm^{242} on each foil was measured by alpha counting in a high-stability, low-solid angle ($4\pi/829$) counter. The amount of Cm^{242} on each foil was initially $\sim 10^{-3}$ μg. The foils were then sealed in quartz capsules and irradiated. After irradiation, the foils were recounted to determine the amount of Cm^{242} remaining. Corrections were made for the Pu^{238} contribution to the total alpha activity.

Pure Pu^{238} vaporized on thin aluminum foils was used as a flux monitor. The amount of Pu^{238} destroyed was measured by determining the decrease in the alpha counting rate, using a 52 percent alpha counter. The total neutron cross section for Pu^{238} was taken to be 470 barns.

The total neutron cross section of Cm^{242} can be calculated from the relationship

$$A_o/A = \exp(\sigma\phi t + \lambda t)$$

where A_o = the activity of Cm^{242} immediately before bombardment

A = the activity of Cm^{242} immediately following bombardment

σ = the total neutron cross section

ϕ = the average flux in neutrons cm^{-2} day^{-1}

λ = the decay constant of Cm^{242} = 4.27×10^{-3} day^{-1}

t = the time of bombardment in days .

The experimental results are summarized in Table I.

Table I

Experiment	$2.303 \log_{10}(A_o/A)$	t (days)	$t\phi \times 10^{-20}$ (neutrons/cm^2)	λt	total cross section (barns)
1	0.324 ± 0.003	72.5	8.9	0.310	16 ± 3
	[0.326 ± 0.004]				[19 ± 4]
2	0.784 ± 0.005	174	24.3	0.743	17 ± 2

The bracketed terms in experiment 1 represent the results obtained by recounting the foil four months after bombardment, at which time the β^- activity on the foil was reduced by a factor of ~10.

The error quoted in the total cross section is the standard deviation based on the number of alpha counts recorded. It does not include errors in the flux determination due to errors in the value of the Pu^{238} cross section, or to other experimental causes.

The fission cross section of Cm^{242} is reported to be <5 barns.[2] Hence the capture cross section must be between 12 and 17 barns.

A rough relationship between the total neutron cross section and the ingoing neutron binding energy has been noted.[3] Cm^{242} and Cm^{244} have nearly the same neutron binding energy, and the total neutron cross section of Cm^{244} is 25 ± 10 barns.[4] According to reference 3 a value of ~100 barns is expected for these two isotopes. The low values observed may be related to a possible subshell at 96 protons,[5] although the total neutron cross section of Cm^{246} appears to be normal.

We would like to acknowledge the use of the pile facilities and aid of the personnel of the Materials Testing Reactor. It is a pleasure to acknowledge helpful discussions with Albert Ghiorso. It is a priviledge to acknowledge the continued interest of Professor Glenn T. Seaborg.

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

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[1] S. G. Thompson and R. J. Barrett, unpublished work, this laboratory.

[2] Hanna, Harvey, Moss, and Tunnicliffe, Phys. Rev. 81, 893 (1951).

[3] B. G. Harvey, Phys. Rev., to be published.

[4] C. M. Stevens, M. H. Studier, P. R. Fields, J. F. Mech, P. A. Sellers, A. M. Friedman, H. Diamond, and J. R. Huizenga, Phys. Rev. 94, 974 (1954).

[5] G. T. Seaborg, Phys. Rev. 92, 1074 (1953).