

UCRL 2984

UCRL 2984

APL
~~FR~~

UNIVERSITY OF
CALIFORNIA

*Radiation
Laboratory*

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks.
For a personal retention copy, call
Tech. Info. Division, Ext. 5545*

BERKELEY, CALIFORNIA

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

UNCLASSIFIED

UNIVERSITY OF CALIFORNIA

Radiation Laboratory
Berkeley, California

Contract No. W-7405-eng-48

NEUTRON CROSS SECTION OF Cm²⁴²

J. P. Surls and B. G. Harvey

May 10, 1955

Neutron Cross Section of Cm²⁴²

J. P. Surls and B. G. Harvey
Radiation Laboratory and Department of Chemistry
University of California, Berkeley, California

May 10, 1955

The neutron capture cross section of Cm²⁴² (n, γ) Cm²⁴³ is difficult to measure directly because of the difficulty of detecting the relatively long-lived Cm²⁴³ 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 Cm²⁴² in high intensity neutron bombardments in the Materials Testing Reactor.

The Cm²⁴² used was purified from the Pu²³⁸ daughter, and from Am²⁴¹, by ion-exchange methods. The Am²⁴¹ content was estimated to be <0.01 percent by weight. The pure Cm²⁴² was then vaporized on to thin aluminum foils. The amount of Cm²⁴² on each foil was measured by alpha counting in a high-stability, low-solid angle (4 π /629) counter. The amount of Cm²⁴² on each foil was initially $\sim 10^{-3}$ μ g. The foils were then sealed in quartz capsules and irradiated. After irradiation, the foils were recounted to determine the amount of Cm²⁴² remaining. Corrections were made for the Pu²³⁸ contribution to the total alpha activity.

Pure Pu²³⁸ vaporized on thin aluminum foils was used as a flux monitor. The amount of Pu²³⁸ destroyed was measured by determining the decrease in the alpha counting rate, using a 52 percent alpha counter. The total neutron cross section for Pu²³⁸ was taken to be 470 barns.

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

$$A_0/A = \exp(\sigma\beta t + \lambda t)$$

where A_0 = the activity of Cm^{242} immediately before bombardment

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

σ = the total neutron cross section

β = the average flux in neutrons $\text{cm}^{-2} \text{day}^{-1}$

λ = the decay constant of $\text{Cm}^{242} = 4.27 \times 10^{-3} \text{day}^{-1}$

t = the time of bombardment in days .

The experimental results are summarized in Table I.

Table I

Experiment	$2.303 \log_{10}(A_0/A)$	t (days)	$t\beta \times 10^{-20}$ (neutrons/cm ²)	λt	total cross section (barns)
1	0.324 ± 0.003 [0.326 ± 0.004]	72.5	8.9	0.310	16 ± 3 [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 privilege to acknowledge the continued interest of Professor Glenn T. Seaborg.

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

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

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

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

⁴C. 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).

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