

UCRL1514

UNCLASSIFIED

UNIVERSITY OF CALIFORNIA - BERKELEY

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*

RADIATION LABORATORY

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.

UCRL-1514
Unclassified-Chemistry Distribution

UNCLASSIFIED

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

L ELECTRON CAPTURE AND ALPHA DECAY IN Np^{235}

Ralph A. James, Albert Ghiorso, and Donald Orth

October 24, 1951

Berkeley, California

L ELECTRON CAPTURE AND ALPHA DECAY IN Np²³⁵

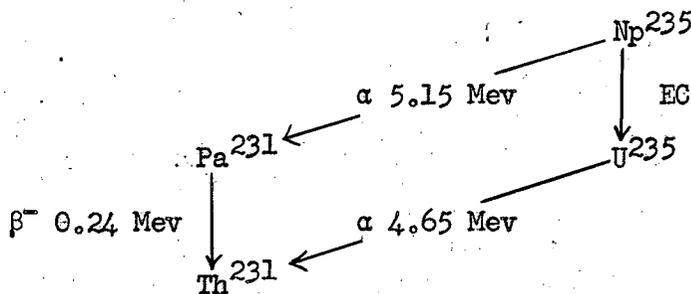
Ralph A. James*, Albert Ghiorso, and Donald Orth**
Radiation Laboratory
University of California, Berkeley, California

October 24, 1951

The isotope Np²³⁵ has previously been reported¹ to decay by orbital electron capture with a half-life of approximately 400 days. By the bombardment of 10 grams of enriched U²³⁵ (95 percent U²³⁵) with 20 Mev deuterons in the 60-inch Crocker Laboratory cyclotron, a much larger sample has been prepared and more accurate measurements made on the radiations of Np²³⁵.

After allowing the bombarded target to decay for several months so that all short-lived activities had completely decayed, a very pure neptunium fraction was isolated. This sample, in addition to the x-rays accompanying electron capture, emitted a small number of alpha particles having an energy of 5.06 ± 0.02 Mev. (disintegration energy 5.15 Mev). The decay of these alpha particles and the x-rays have now been followed for a little more than 2 years and both give a half-life of 410 ± 10 days, showing that both originate from decay of Np²³⁵.

The disintegration energy for the reaction $Np^{235} + e^- = U^{235}$ can be calculated using the closed cycle system and the disintegration energies shown below.



* Present address: Department of Chemistry, University of California, Los Angeles, California.

** Present address: Oak Ridge National Laboratory, Oak Ridge, Tennessee.

These values give $5.15 - (4.65 + 0.24) = 0.26$ Mev as the energy available for capture of a free electron. After subtracting the orbital electron binding energies, 0.14 Mev and 0.24 Mev are the energies available for K electron capture and L electron capture respectively. This very low disintegration energy and the high nuclear charge are expected² to give a high ratio of L electron captures to K electron captures, particularly in the case of forbidden transitions.

In agreement with this prediction, a large excess of L x-rays over the number of K x-rays has been observed corresponding to greater than 90 percent L electron capture and less than 10 percent K electron capture. This conclusion was first reached from absorption curves using the best available estimates of the counting efficiencies of these K and L x-rays and has since been confirmed by the use of xenon filled proportional counters connected through a linear amplifier to a 48 channel pulse analyzer in an arrangement similar to that of Hanna, et al.³ This last method also gives evidence that most of the L x-rays arise from vacancies in the L_{II} and L_{III} levels. These vacancies can be created either by (1) capture of electrons from the L_{II} and L_{III} levels or (2) capture of an electron from the L_I level followed by a transition of the Coster-Kronig type to the L_{III} level. The available data do not seem to warrant an estimate of the relative numbers of captures from the various L levels but do warrant the conclusion that at least 90 percent of the electrons captured are from the L levels.

Figure 1 shows a typical curve obtained on the sample with settings of counter tube voltage and grid bias voltage corresponding to an energy range of about 7-27 kev. The observed curve (solid line) has the general shape

expected from the L x-rays arising from the L_{II} and L_{III} levels while the dotted line shows the general shape expected if they originated in the L_I level.

Table I summarizes the approximate amount of the various modes of decay and the calculated partial half-lives for each.

Table I
Branching Ratios and Partial Half-lives for Various Modes
of Decay in Np²³⁵

Mode of decay	Branching Ratio (% of Total Disintegrations)	Partial Half-life
Alpha	0.005%	2 x 10 ⁴ yrs
K capture	<10	>12 yrs
L capture	>90	<450 days
Total	100	410 days

The authors are indebted to Professor Glenn T. Seaborg under whose direction this problem was undertaken, and to G. B. Rossi and the 60-inch cyclotron crew for the excellent U²³⁵ bombardment.

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

Figure 1. Pulse analysis curve of L x-rays emitted by Np^{235} . Dashed curve is general form of curve expected for transitions from the L_I level.

REFERENCES

1. R. A. James, A. E. Florin, H. H. Hopkins, Jr., and A. Ghiorso, National Nuclear Energy Series, Plutonium Project Record Volume 14B, Paper Number 22.8 (McGraw-Hill Book Co., Inc., New York, 1949).
2. R. E. Marshak, Phys. Rev. 61, 431 (1942).
3. G. C. Hanna, D. H. W. Kirkwood, and B. Pontecorvo, Phys. Rev. 75, 985 (1949).

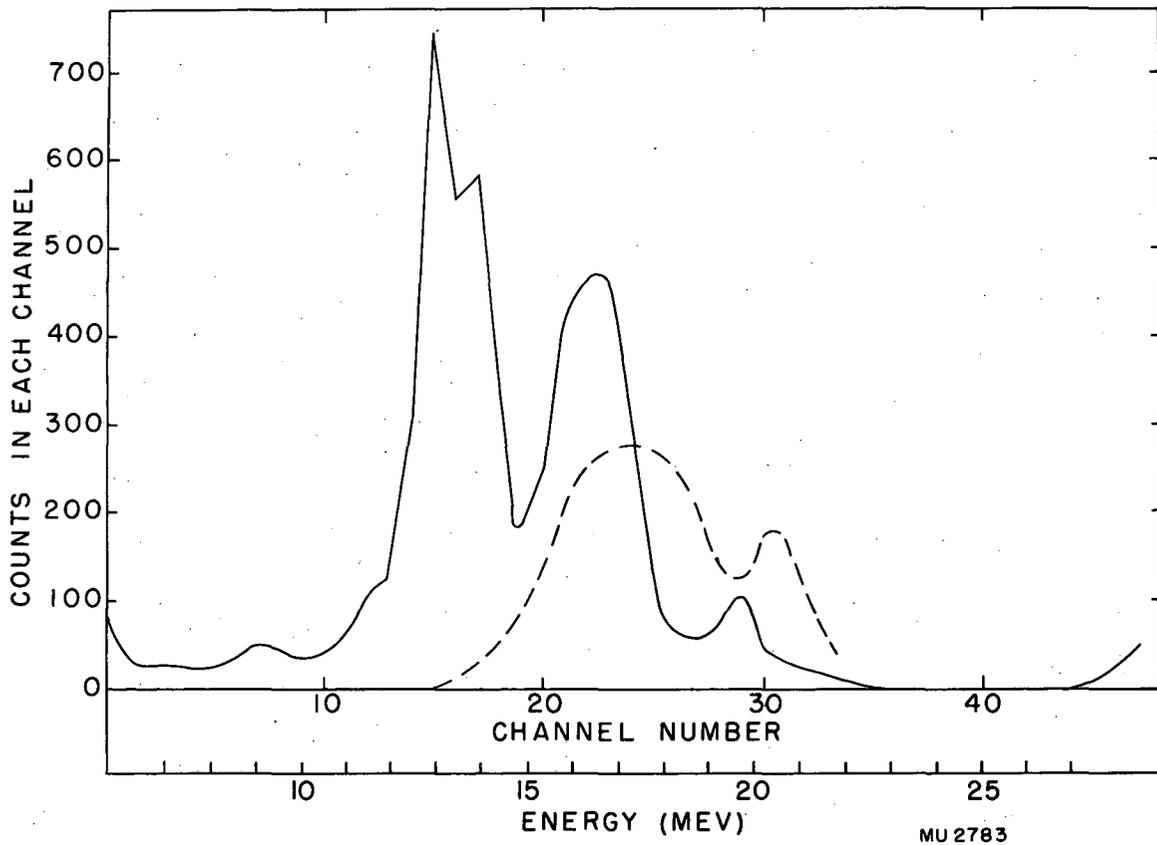


Fig. 1