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RADIATION LABORATORY

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Contract No. W-7405-eng-48

DECAY OF Np^{236}

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March 2, 1951

Berkeley, California

DECAY OF Np^{236}*

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Recent work at this laboratory on the nuclear energy surface[1] in the heavy region has demonstrated the value of precise determinations of the transition energies in radioactive decay in these elements. As part of a program of such measurements, the beta decay energy of 22 hour Np^{236} came under consideration. The decay cycles involving this isotope of neptunium (Fig. 1)[2] showed that the experiment might be complicated by orbital electron capture decay to U^{236}, so an attempt has been made to establish the decay scheme of Np^{236}.

Samples of neptunium were prepared by bombardment of U^{235} with the deuteron beam from the 60-inch cyclotron at Crocker Radiation Laboratory. The electron spectrum of purified neptunium fractions was observed on a beta ray spectrometer employing the double focusing principle proposed by Svartholm and Siegbahn,[3] and Shull and Dennison.[4] The detector is a Geiger counter filled with 8.8 cm of 90 percent argon, 10 percent ethylene mixture, and has a 30 $\mu g/cm^2$ Formvar window supported on a mesh grid. Window absorption corrections are necessary only below about 30 kev and can be made with fair accuracy.

Samples of chemically separated Np^{236} were evaporated from concentrated hydrochloric acid solution on conducting Tygon films about 30 $\mu g/cm^2$ thick. Auger electrons, internal conversion electrons, and beta particles were seen. The beta spectrum is complex, and resolution of Fermi-Kurie plots of the data indicate beta energies of 0.51 Mev (59 percent) and 0.36 Mev (41 percent). A pair of internal conversion lines corresponding to the K and L conversion of a 150 kev gamma ray was also observed. This gamma ray is approximately 100 percent converted if it is assumed to follow the 0.36 Mev transition.

*This work was performed under the auspices of the U. S. AEC.

The measured intensities of the electrons from Auger conversion of the K and L x-rays were far in excess of the Auger electrons expected from K and L electron vacancies due to the observed internal conversion of the 150 kev gamma ray.

The radiations were resolved by beryllium and silver absorption into electrons, L x-rays, and K x-rays, and the relative abundance of each was determined. These were corrected for the counting efficiencies under the experimental conditions, and the L Auger conversion factor was assumed to be 0.5.[5] An estimate of the amount of K electron capture may be made if the K x-rays observed in the absorption experiments are corrected for the contribution from internal conversion of the gamma ray. If the L electron vacancies resulting from the K vacancies are subtracted from the total calculated from the absorption experiments, a further estimate of the amount of L electron capture is obtained. When these are related to the number of beta particles, a decay scheme may be postulated in which the relative abundances of beta decay and electron capture should be correct to ± 20 percent (Fig. 2).

Apparently there is a considerable amount of L electron capture, even at this large disintegration energy of about 1.2 Mev. However, other heavy nuclides such as Am^{242m}, U^{231}, and Np^{235} have demonstrated predominant capture of L electrons[6,7,8] at lower transition energies.

We wish to thank Professor G. T. Seaborg for his continued interest and advice.

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[1] Perlman, Ghiorso, and Seaborg, Phys. Rev. 77, 26 (1950).

[2] The alpha disintegration energy of U^{236} is from Ghiorso, Brittain, Manning, and Seaborg, Phys. Rev., to be published, and Jaffey, Diamond, Hirsch, and Mech, Phys. Rev., to be published. The alpha disintegration energies of Np^{236} and Pa^{232} were estimated as discussed by I. Perlman, et al., (reference 1). The other energies are based on the data reviewed by G. T. Seaborg and I. Perlman, Rev. Mod. Phys. 20, 585 (1948).

[3] N. Svartholm and K. Siegbahn, Arkiv. Mat. Astron. Fysik. 33A, No. 21 (1946); Hedgran, Siegbahn, and Svartholm, Proc. Phys. Soc. 63A, 960 (1950).

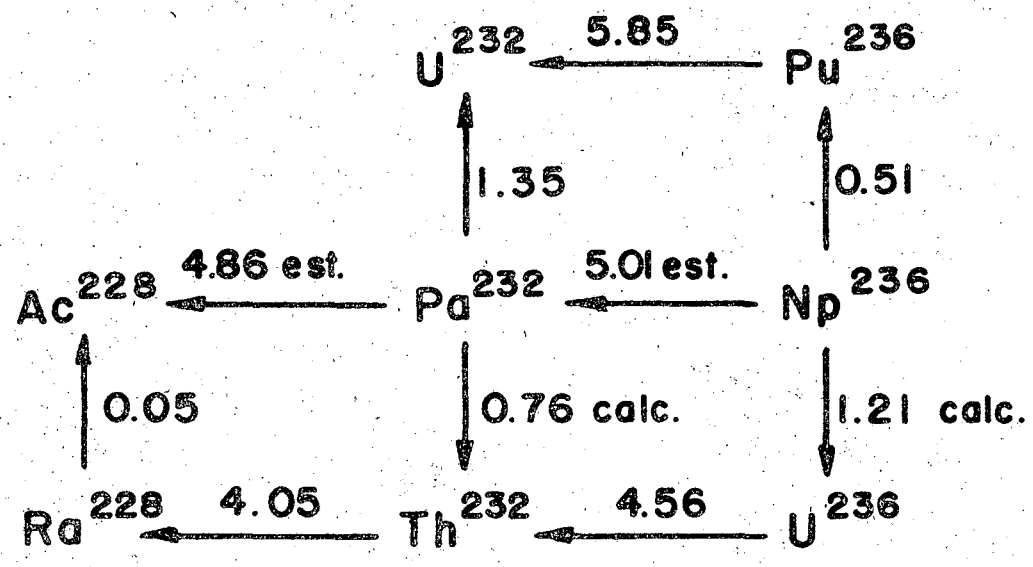
[4] F. Shull and D. Dennison, Phys. Rev. 71, 681 (1947); ibid., 72, 256 (1947).

[5] B. B. Kinsey, Can. J. Research A, 404 (1948).

[6] O'Kelley, Barton, Jr., Crane, and Perlman, Phys. Rev. 80, 293 (1950).

[7] Crane, Ghiorso, and Perlman, Phys. Rev., to be published.

[8] R. A. James and A. Ghiorso, Phys. Rev., to be published.


U232
5.85
Pu236
1.35
0.51
Ac228
4.86 est.
Pa232
5.01 est.
Np236
0.05
0.76 calc.
1.21 calc.
Ra228
4.05
Th232
4.56
U236

MU 1520

Fig. 1

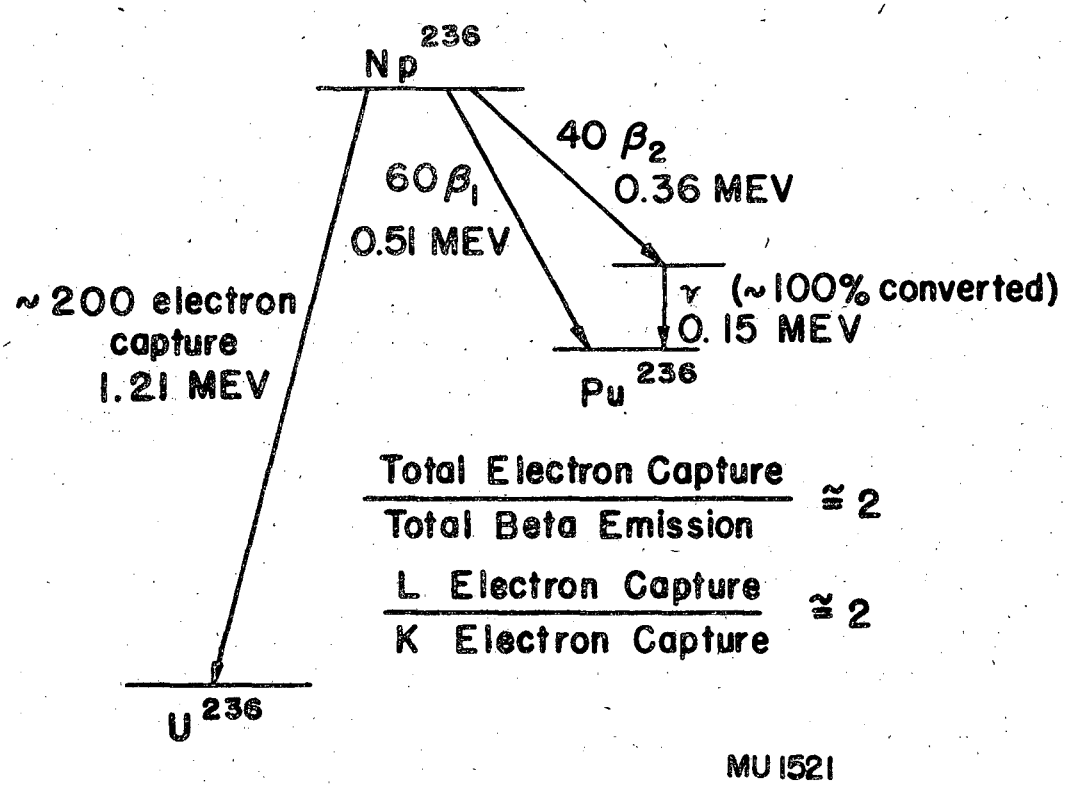

Np 236
40 β2
0.36 MEV
60 β1
0.51 MEV
γ (~100% converted)
0.15 MEV
~200 electron
capture
1.21 MEV
Pu 236
Total Electron Capture / Total Beta Emission ≅ 2
L Electron Capture / K Electron Capture ≅ 2
U 236
MU 1521

Fig. 2