Positron Emission from Np^{234}†

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An investigation of Np^{234} with a trochoidal analyzer revealed the presence of positrons having an end-point energy of approximately 0.8 Mev. The ratio of positron emission to electron capture was found to be $(4.6\pm1.0)\times10^{-4}$.

A URANIUM-235 target was bombarded with 21-Mev deuterons in the Argonne National Laboratory 60-in. cyclotron. The neptunium fraction was chemically isolated, and the decay followed with scintillation, internal and external beta proportional and 4π counters. The 4.4-day activity[1,2] of Np^{234} [1,2] was detected as well as the 22-hour activity of Np^{236}.

The gamma and electron spectra of Np^{234} were examined (before and after decay of most of the Np^{236}) with NaI(Tl) and trans-stilbene crystals in conjunction with a 10-channel analyzer and coincidence circuit. Numerous gamma rays decaying with a 4.4 day half-life and presumably belonging to Np^{234} were found. Further purification of the Np sample resulted in no visible change in the gamma spectra. A detailed report of these studies will be published later after the decay of the electromagnetic radiations has been further verified and corrections for any contribution from Np^{235} have been made.

The Np^{234} was also investigated on our trochoidal analyzer[3] which makes use of a semicircular fringing magnetic field to separate positrons from negatrons. Four inches of lead are interposed between the detector (a methane proportional counter) and the sample which are ten inches apart. One can count either negatrons or positrons depending on the field orientation. When counting positrons the discrimination against both negatrons and gamma rays is exceedingly good. A sample of Sr^{90}-Y^{90} containing approximately 1.8×10^7 disintegrations per minute gives only 6 counts per minute above the normal background of 10.5 counts per minute. A sample of 1.2-Mev gamma rays emitting 1.2×10^6 dis/min gives no detectable counts above the normal background. The efficiency of counting positrons using the external probe is 5 ± 1 percent. An Np^{234} sample of 2.6×10^7 dis/min (determined from coincidence and internal beta measurements) gave 600 positron counts per minute above background which corresponds to a branching ratio of $(4.6\pm1.0)\times10^{-4}$. A total background of 14.9 counts per minute was obtained by absorbing out the negatrons and positrons. An aluminum absorption curve was run on the positrons and the half-thickness compared directly with the half-thickness obtained on the same instrument for Na^{22} ($\beta^+=0.54$ Mev). The Np^{234} positron was found to have an end-point energy of approximately 0.8 Mev, which sets a lower limit of 1.8 on the disintegration energy of the nuclide. The decay of the positron was followed for several days and gave a half-life of (4.4 ± 0.1) days which is in excellent agreement with the published value.[2]

This is believed to be the first observation of the emission of positrons by a nuclide of atomic number higher than 80.[4]

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