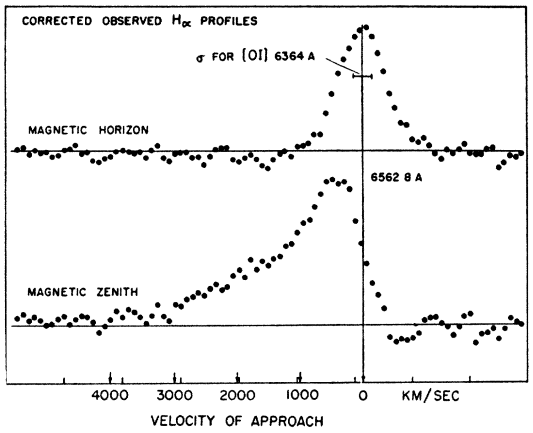

FIG. 1. Corrected observed profiles for Hα in the auroral spectrum for two magnetic orientations.

showed Hα in considerable intensity. A spectrum of a flaming feature which did not show Hα in appreciable intensity was used as a comparison for the effect of the first positive bands of N_2 that are adjacent to Hα.

Previous observations by Vegard,[1] Gartlein,[2] and others, of diffuse hydrogen emissions had been interpreted as scattering of rapidly moving incident protons. No Doppler displacement, however, was established. The current spectra, obtained with respect to the geomagnetic coordinates, have enabled an unambiguous evaluation of the nature of auroral hydrogen. The profile of Hα observed from the magnetic zenith is very asymmetrical, with the entire line shifted to the violet. The profile of Hα in the magnetic horizon is symmetrical but broadened. Figure 1 shows the mean of four separate microphotometer traces for each magnetic orientation after correction for the first positive bands of N_2.

The velocity profile of Hα in the zenith cannot indicate a real velocity spread of the incident protons because of their nearly simultaneous arrival in the auroral zone. The profile, therefore, must be a consequence of the loss of energy of the protons upon entering the upper atmosphere. The violet wing indicates that the velocity of the protons before entering the atmosphere is greater than 3300 km/sec., corresponding to an energy of 57 kev. This velocity is considerably greater than has been deduced from indirect correlations.

It has been pointed out by J. R. Platt[3] that protons moving with these velocities have a small probability of emitting Hα-radiation through electron capture. The probability increases to a maximum when the velocity of the proton is equal to the Bohr orbital velocity for the 3*s* shell (730 km/sec.). As a consequence, it would be difficult to detect protons moving with much higher velocities than those currently observed; hence, the velocity of 3300 km/sec. represents only a lower limit to the velocity of the auroral protons.

[1] Vegard, report to the Gassiot Comm., Phys. Soc. London, p. 82 (1948).
[2] Gartlein, Trans. Am. Geophys. Union **31**, No. 1, 7 (1950).
[3] J. R. Platt, private communication.

Radioactivity of F^{17}

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October 23, 1950

FLUORINE[17] has long been known to be a positron emitter. Early cloud-chamber investigations by Kurie, Richardson, and Paxton[1] showed that the maximum energy of the transition was approximately 2.1 Mev. An excess of positrons at the low energy end of the spectrum was interpreted by Bethe, Hoyle,

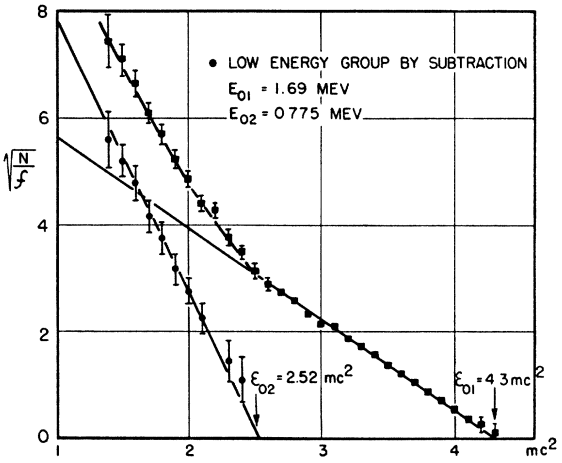

FIG. 1. β-spectrum of F^{17}.

and Peierls[2] as possibly being due to a low energy beta-group followed by a gamma-ray of approximately 900-kev energy.

The beta-ray spectrum of F^{17} has recently been investigated in this laboratory, using the technique of bombarding gases in the cyclotron and transporting them by a circulating pump to the source chamber of a semicircular focusing spectrometer as described previously.[3] The F^{17} was produced by a (d, n) reaction on O^{16}. A Fermi plot of the spectrum (Fig. 1) shows that it is of the allowed shape down to 2.5 mc^2, where it deviates considerably from linearity. The end-point energy (average of several such runs and corrected for window absorption) is $E_{01}=4.35\ mc^2$ which corresponds to a maximum energy of 1.72±0.03 Mev. On subtracting the high energy spectrum a low energy group of the allowed shape is obtained, having an end-point energy of $E_{02}=0.78$ Mev.

The relative intensity of the two groups was calculated from the intercepts of the two Fermi plot lines on the vertical and horizontal axes. The data obtained indicate that the low energy group is 33±5 percent as intense as the high energy group. The partial lives for the two transitions are found to be $t_1=93$ sec. and $t_2=285$ sec. (based on an observed half-life[4] of 70.0 sec.) with the corresponding Ft values $Ft_1=3240$ sec. and $Ft_2=350$ sec.

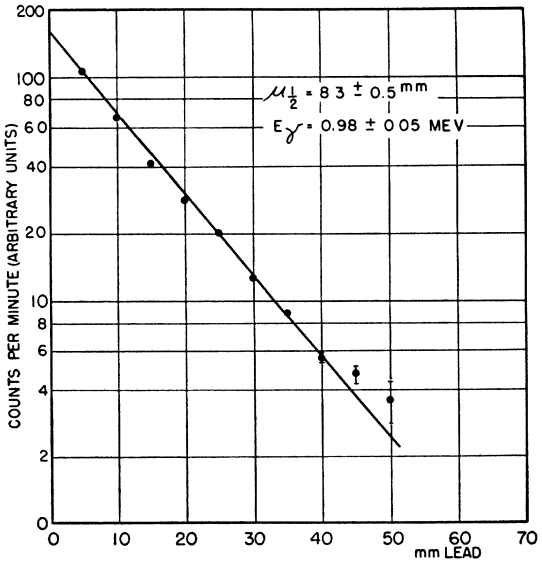

FIG. 2. F^{17} γ-ray absorption curve in lead.

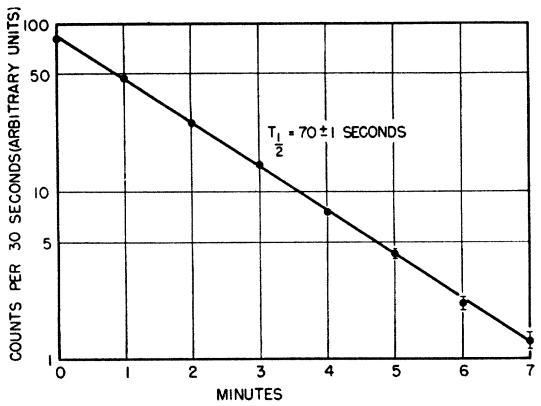

FIG. 3. Half-life of F^{17} gamma-ray.

The energy of the gamma-ray which presumably accompanies the low energy transition was measured. Figure 2 shows an absorption curve in lead of the gamma-rays from F^{17}. A photomultiplier tube with an anthracene crystal was used as detector. The 0.51-Mev annihilation radiation is not seen on this curve since the discriminator was set to detect only the larger pulses produced by the higher energy gamma-rays. The half-thickness for absorption shows that the energy of this gamma-ray is 0.98 $\pm$0.05 Mev.

A decay curve of the gamma-ray (Fig. 3), taken with the same geometry and discriminator setting shows that its half-life is 70$\pm$1 sec., in good agreement with the half-life for the β^+ decay.

We wish to thank Professor W. W. Havens for his constant help and encouragement. Our thanks are also due to the AEC which aided materially in the performance of this research.

* Assisted by the AEC.

[1] Kurie, Richardson, and Paxton, Phys. Rev. **49**, 368 (1936).
[2] Bethe, Hoyle, and Peierls, Nature **143**, 200 (1939).
[3] H. Brown and V. Perez-Mendez, Phys. Rev. **78**, 649 (1950).
[4] H. W. Newson, Phys. Rev. **48**, 790 (1935).

Preparation of Th^{235} and Pa^{235}

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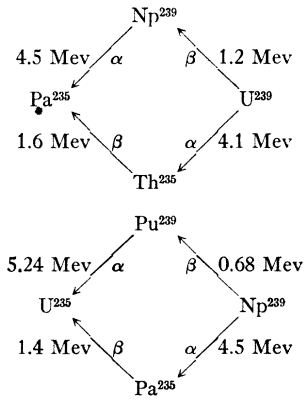
BY the method of decay cycles[1] it is possible to predict the disintegration energies of nuclides which have never been observed. In the present experiment, the β-disintegration energies of Th^{235} and Pa^{235} were calculated from the following cycles:



The α-disintegration energies for Np^{239} and U^{239} were obtained by extrapolation of the appropriate lines on an α-disintegration energy *vs.* mass number plot (see reference 1, Fig. 1). In this way, the β-disintegration energies of Th^{235} and Pa^{235} were calculated to be 1.6 Mev and 1.4 Mev, respectively. It was expected that these energies would lead to β-decay half-lives of about a minute and half an hour, respectively.

Therefore, it seemed possible that Pa^{235} could be obtained by a short irradiation of Th^{234} (UX_1) at a high neutron flux in the NRX pile, followed by a rapid chemical separation of Pa.

In the meantime, Pa^{235} was prepared by Meinke and Seaborg[2] by the reactions $U^{238}(d, \alpha n)$ and $U^{238}(p, \alpha)$, and shown to decay by β-emission with an energy of 1.4 Mev and a half-life of 23.7 $\pm$0.5 min.

Th^{234} was separated from about 1 kg of uranium by aqueous extraction of a solution of pure uranyl nitrate in ether followed by co-precipitation with ferric hydroxide. Traces of uranium were finally removed by four precipitations of the Th^{234} with a carrier of lanthanum fluoride. Great care was taken to avoid recontamination of the Th^{234} with uranium, which would have produced confusing fission product activities during the pile irradiation.

The Th^{234} was finally dissolved in 6 M nitric acid and Pa isotopes were removed by three extractions with di-isopropyl ketone.[3] The Th^{234} solution was immediately evaporated in a small silica tube, sealed, and irradiated for 45 min. in a thermal neutron flux of 6×10^{13} neutrons/cm^2/sec. in the NRX pile. The preliminary removal of Pa isotopes reduced the contamination of the Pa^{235} by 6.7-hr. Pa^{234}.

After the irradiation, the silica tube was smashed, and Pa extracted as before with di-isopropyl ketone to separate it from the Th^{234} and La^{140}. The Pa was further purified from La^{140}, Th^{234}, and any traces of uranium fission products by washing the di-isopropyl ketone solution twice with equal volumes of a solution of 1 M nitric acid and 3 M ammonium nitrate. The Pa was then extracted back into 0.1 M nitric acid. A half-volume of concentrated nitric acid was added to the aqueous solution, and Pa was finally purified by extracting it into an equal volume of 0.4 M

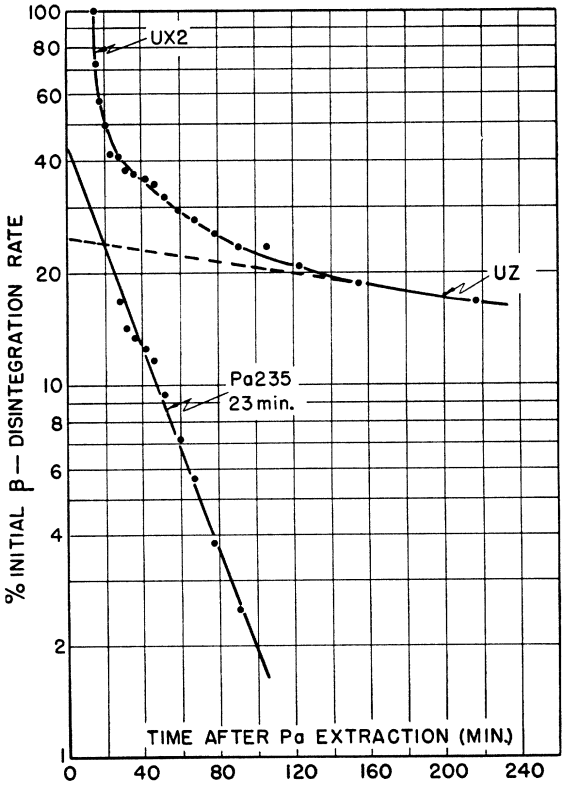


FIG. 1. Decay of Pa fraction from neutron-irradiated UX_1.