were identified, in addition to a group X, scattered from an unknown contaminant of high atomic number which amounted to less than one percent of the target material.

In order to look for an alpha-group corresponding to a level in Be^7 at 205 kev, the bombarding energy was decreased to 1.600 Mev, and the results are shown in the lowest curve of Fig. 1. At region A, corresponding to a level at 205 ± 70 kev, no alpha-group was detected with an intensity greater than 3 percent of the intensity of the ground-state alpha-group. The entire region B, corresponding to a 745-kev level in Be^7, was not surveyed because the target was destroyed before the completion of the results; however, in the region surveyed, no alpha-group was found of intensity greater than 2 percent of the ground-state alpha-group. The position of the elastically scattered proton groups is shown. No attempt was made at this lower bombarding voltage to detect the alpha-group corresponding to the 430-kev level because of the presence of protons elastically scattered from B^{10} and C^{12}.

Using fresh targets of B^{10} evaporated onto platinum, the Q-values of the two alpha-groups were determined to be 1.152 ± 0.004 and 0.721 ± 0.006 Mev, corresponding to the ground state of Be^7 and an excited state at 431 ± 5 kev. After a correction of 18 kev for surface contamination was added to the Q-values measured from the B^{10} Formvar target, these values agreed with those from the fresh targets. This correction was made by a comparison of the energies of the proton groups elastically scattered from B^{10} and C^{12}. The errors given on the Q-values do not include any estimate of the effect of surface contamination; however, it is believed that this is less than the stated errors. The results are in agreement with the Q-values reported by Brown *et al.*[1] of 1.148 ± 0.006 and 0.714 ± 0.008 Mev. The position of the excited state of Be^7 agrees with the two most accurate published values of[1] 435 ± 5 and[2] 429 ± 5 kev.

The observation of the proton group elastically scattered from the B^{10} on Formvar at 1.790-Mev bombarding energy permits the estimation of the relative yields of the $B^{10}(p,\alpha)Be^7$, $B^{10}(p,\alpha)Be^{7*}$, and $B^{10}(p,p)B^{10}$ groups which were in the ratio 1.0:0.4:10. Since the $B^{10}(p,p)B^{10}$ and $B^{10}(p,\alpha)Be^{7*}$ groups occurred at the same field setting, the relative intensity of these groups is considered to be the most accurate, reliable to 30 percent. In addition, if Rutherford scattering is assumed at 90 degrees for the 1.790-Mev protons from B^{10}, it is possible to estimate the absolute differential cross sections for the $B^{10}(p,\alpha)Be^7$, $B^{10}(p,\alpha)Be^{7*}$ alpha-groups to be 4.1 and 1.8 millibarns/atom/steradian. The accuracy of the differential cross sections calculated by this method cannot be stated since the validity of assuming Rutherford scattering is not known. This assumption leads to an estimate of 4 percent of Si^{28} in the enriched B^{10} material instead of less than 2 percent, as given by the Oak Ridge analysis. This indicates that the scattering of 1.790-Mev protons at 90 degrees from boron may be at least a factor of 2 lower than predicted by Rutherford scattering.

From these results, it may be concluded that there is no indication that levels in Be^7 at 205 and 745 kev are excited by the $B^{10}(p,\alpha)Be^7$ reaction at the bombarding energies used.

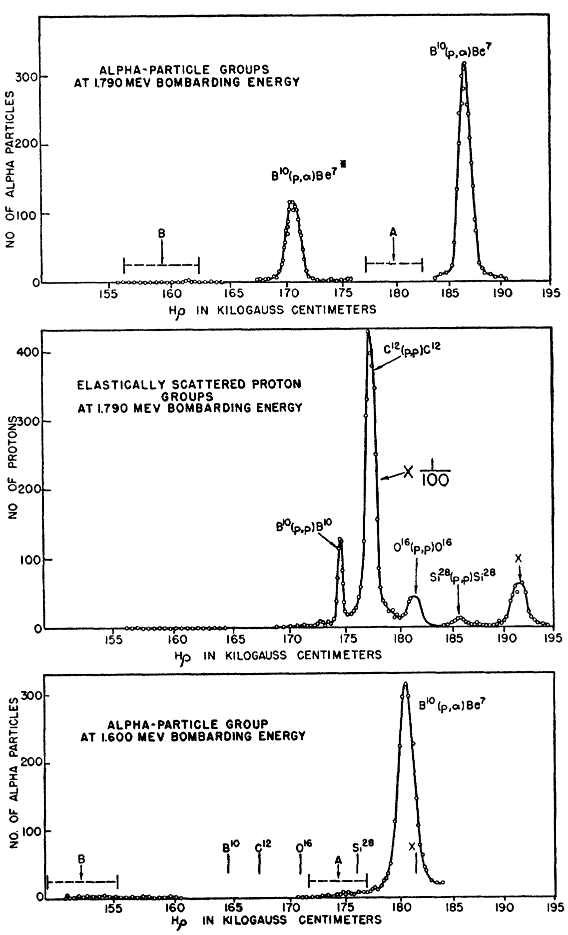

FIG. 1. Proton and alpha-particle groups from a thin target of enriched B^{10} on Formvar bombarded by protons.

* This work was assisted by the joint program of the ONR and AEC.
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Radiations of Krypton^{85}

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A LONG-LIVED krypton activity was found among the products of uranium fission by Hoagland and Sugarman.[1] From aluminum absorption measurements they concluded that this krypton emitted beta-radiation with a maximum energy of 0.74 Mev and no gamma-radiation. Later Thode[2] using mass spectrometer measurements assigned this krypton to mass 85 and gave 9.4 yr. as the half-life.

In the course of work in which gaseous activities were separated by elution with helium from a charcoal column, gamma-radiation was found associated with the long-lived krypton activity after extensive purification. A more detailed study of the beta- and gamma-radiations of Kr^{85} was therefore made and is reported below.

In measurements of beta-spectra of gaseous activities a major problem is the source container which should have a low mass in order to reduce distortion of the spectra from absorbed and scattered radiation. In this work the gas was contained in a 6-mm diameter bulb with a thickness of 0.7 mg/cm^2 which was blown on the end of a quartz capillary tube 0.8 mm o.d. and 0.4 mm i.d. Experimental data obtained with gaseous activities contained in this bulb indicated that there was very little distortion of beta-spectra at energies above 150 kev.

The experimental beta-energy distribution of Kr^{85} obtained with a thin lens spectrometer is shown in Fig. 1 as a Kurie plot for an allowed transition. Because of the curvature shown in Fig. 1, the data have been replotted in Fig. 2 on the assumption that the transition is first forbidden with a spin change of two and a parity change. The fact that Fig. 2 is a straight line indicates the validity of the above assumption, which is consistent with the Mayer[3] theory of nuclear shell structure. Extrapolation of the

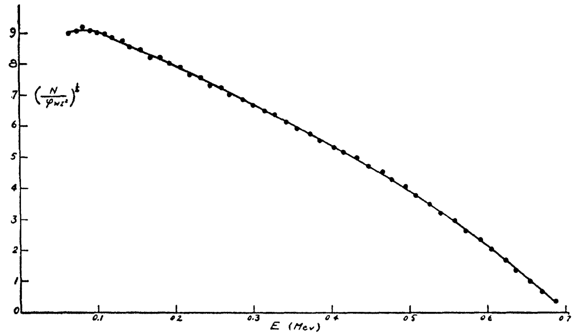

FIG. 1. Allowed Kurie plot of Kr^{85} beta-spectrum.

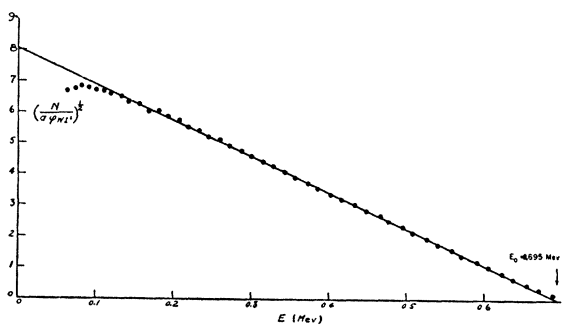

FIG. 2. Kr^{85} beta-spectrum plotted as a first-forbidden transition with $\Delta J=2$.

straight line yields a maximum energy for the beta-transition of 0.695±0.005 Mev. The value of log (*ft*) is 9 which is in agreement with *ft*-values computed by Nordheim[4] for other first-forbidden transitions with a spin change of two.

Scintillation spectrometer and lead absorption measurements of the gamma-radiation of long-lived fission krypton both indicate that the energy is 0.54±0.02 Mev. Coincidence absorption data show that the gamma-ray is in coincidence with a 0.15±0.02 Mev maximum energy beta-ray. Since extensive purification precludes the presence of another element and since the sum of the energies of the coincident beta- and gamma-rays is the same within experimental error as the energy of the more abundant beta-group of Kr^{85}, these radiations are almost certainly associated with Kr^{85}.

The branching ratio in the decay of Kr^{85} was calculated from the coincidence data and the calibrated detection efficiency of the coincidence gamma-counter. It was found that Kr^{85} decays by emission of a 0.15-Mev beta-ray in coincidence with a 0.54-Mev gamma-ray in 0.65±0.15 percent of the disintegrations.

We would like to thank G. W. Parker for the sample of fission product gases used in this work.

* This document is based on work performed for the Atomic Energy Project at Oak Ridge National Laboratory.

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[2] H. G. Thode, CR-PRG-37 (November, 1946), unpublished.
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Argon[39] Beta-Spectrum

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A LONG-LIVED gaseous activity has been removed from several different potassium salts after bombardments in nuclear reactors. Reaction with calcium vapor has shown that the radiations are from a rare gas isotope. This activity is eluted from a charcoal column by helium in the same way as A^{41}. Since the noble gases are readily separated by this procedure the activity is associated with an isotope of argon. This new long-lived argon isotope is presumably A^{39} formed by an (*n*, *p*) reaction on K^{39}. An attempt to find the 4-min. activity previously assigned to A^{39} was unsuccessful.

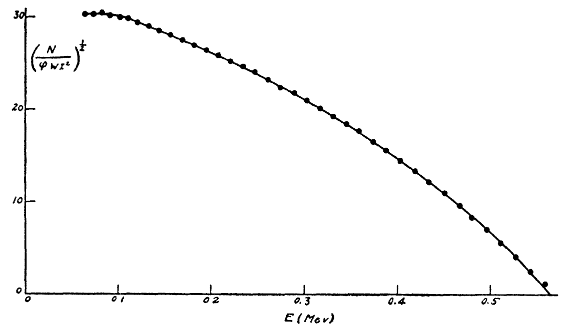

FIG. 1. Allowed Kurie plot of A^{39} beta-spectrum.

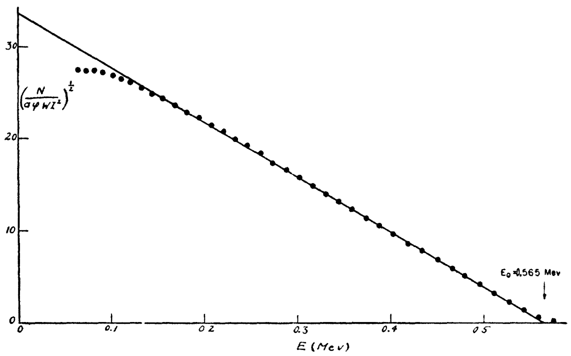

FIG. 2. A^{39} beta-spectrum plotted as a first-forbidden transition with $\Delta J=2$.

A sample of long-lived argon has been counted in a proportional counter for about one year. Since no definite decrease in activity was observed, it is concluded that the half-life is longer than 15 yr. Further work is being done to establish the mass assignment and the half-life.

When a 0.1-mc source of long-lived argon was counted with enough absorber to remove beta-radiation, no gamma-rays with energies higher than the secondary radiation were detected with a thallium activated NaI scintillation counter. This indicates less than 0.1 percent branching with gamma-radiation more energetic than 300 kev.

The beta-energy distribution of long-lived argon has been measured with a thin lens spectrometer using the same source container that was used in the Kr^{85} measurements.[1] The beta-energy distribution of A^{39} was also found to be that of a forbidden transition. Kurie plots for an allowed and for a first-forbidden transition with a spin change of two are shown in Figs. 1 and 2, respectively. On the assumption of a first-forbidden transition with a spin change of two the maximum energy is 0.565±0.005 Mev. This assumption is consistent with the Mayer[2] shell theory of nuclear structure. Since only a minimum value for the half-life is known, only a minimum value of log(*ft*) can be given. This is 8.7 which is in the region given by Nordheim[3] for transitions of the type assumed.

We would like to thank T. W. DeWitt for his help in this work.

* This document is based on work performed for the Atomic Energy Project at Oak Ridge National Laboratory.

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[2] M. G. Mayer, Phys. Rev. **78**, 16 (1950).
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