effects. Figure 3 shows the effect of film temperature on absorption for two different films.

These studies of BaO films confirm the fact that the optical absorption threshold coincides with the threshold for photoconductivity[1] at about 3.8 ev. The magnitude of the absorption constant is so large that the absorption process cannot be attributed to impurity centers in the crystal lattice. Temperature variation of the absorption constant from room temperature down to about $-150°C$ is small but appears to indicate a slight accenting of the structure in the absorption constant curve near 2900A. The absorption constant does not change appreciably for variation of light intensity by a factor of 20.

The author is indebted to Professor Robert L. Sproull, who directed the research, and to Dr. Arnold R. Moore for valuable discussions. The work has been assisted by the ONR and the Research Corporation.

* Charles A. Coffin Fellow, 1948–49.
[1] W. W. Tyler, Phys. Rev. **76**, 179 (1949).

Beta-Spectrum of Praeseodymium 143

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PRAESEODYMIUM 143, a radioactive daughter substance of Ce^{143} which has a half-life of 33 hr., can be produced either by ordinary nuclear reactions,[1] such as $Ce^{142}(d, p)Ce^{143}$ and $Ce^{142}(n, \gamma)Ce^{143}$, or by nuclear fission process. Pr^{143} emits beta-particles with half-life determinations varying from 12.7 to 14.2 days,[1] and it does not emit gamma-rays. The beta-spectrum end point, investigated by means of aluminum absorption methods and estimated by Feather's empirical method, has been reported in the range between 0.83 and 1.0 Mev.[1] Recent spectrometer measurements[2] with sources containing a mixture of Ce^{141} and Pr^{143} yield straight line Fermi plots of the beta-spectrum from 565 kev, the end point of the Ce^{141} spectrum, to the end point of the Pr^{143} spectrum. The upper limit to the energy of the Pr^{143} spectrum is reported as 920 ± 10 kev by Ter-Pogossian *et al.* and as 930 ± 20 kev by Shepherd.[2]

Recently, a strong source of Pr^{143} of very high specific activity was obtained from the Isotopes Branch of the AEC at Oak Ridge in the form of a PrCl solution. This high specific activity material is suitable for beta-spectrum investigation in a beta-ray spectrometer. The Pr^{143} source was prepared by depositing, on a collodion film of 10 $\mu g/cm^2$ thickness, a drop of PrCl solution to which an extremely small quantity of detergent (Anotrox X) had been added. The total amount of solid contained in the source is around 20 μg and is spread over a circular area of 0.5 cm^2.

The Columbia solenoid magnetic spectrometer was used in this investigation. The resolution used was three percent defined as the full width at half-intensity. Both Nylon and collodion window counters were used to cover the upper and lower energy range of

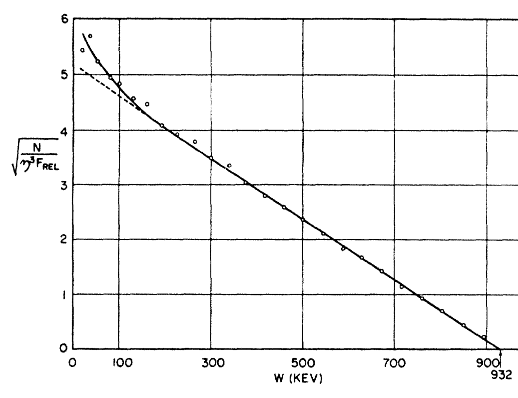

FIG. 1. Fermi plot of Pr^{143} beta-spectrum.

the spectrum. In plotting the Fermi plot, the explicit form[3] of the relativistic Coulomb factor

$$F(Z,\epsilon)\approx\frac{2\pi\delta}{1-e^{-2\pi\delta}}\left[\epsilon^2(1+4\gamma^2)-1\right]^S,$$

where $S=(1-\gamma^2)^{\frac{1}{2}}-1$, $\gamma=Z\alpha=Z/137$, $\delta=\gamma(\epsilon/\eta)$ was used.

This approximation is accurate to about 0.5 percent in this case. The Fermi plot thus obtained gives a straight line from the upper energy limit down to 170 kev (Fig. 1). Below 170 kev, the Fermi plot starts to deviate upward very gradually, which could be attributed to local variations in source thickness due to non-uniformity. The upper energy limit given by the intercept of the straight line in the Fermi plot is 932 ± 2 kev. This spectrum was investigated in the spectrometer many times, using sources from two different shipments. The results were reproducible and consistent.

Other Pr^{143} sources were made from the same solutions, and the half-life was continuously followed in a G-M counter over a period of ten weeks. The decay curve (Fig. 2) is definitely a straight line on a semilogarithmic plot and gives a value of 13.7 ± 0.1 days for the half-life.

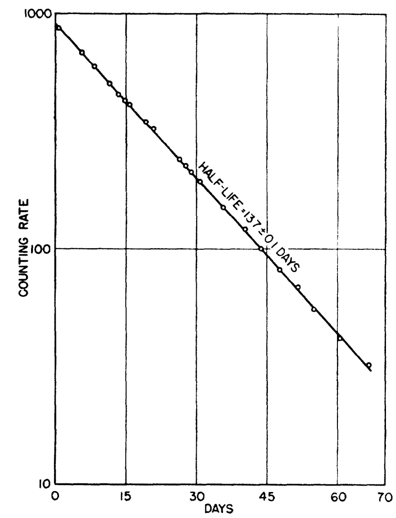

FIG. 2. Decay curve of Pr^{143}.

The *ft* value calculated is 1.3×10^7. For such a high atomic number ($Z=59$), the beta-radiation from Pr^{143} should be classified empirically into the group of first- or second-forbidden transitions. Nevertheless, the shape of the spectrum follows the allowed shape as in the many other cases where the *ft* value indicates a highly forbidden transition.

We should like to thank the United States AEC which aided materially in the performance of this research.

[1] G. T. Seaborg and I. Perlman, Rev. Mod. Phys. **20**, 622 (1948); C. E. Mandeville and E. Shapiro, Phys. Rev. **75**, 1834 (1949).
[2] L. R. Shepherd, Research **1**, 67 (1948); Ter-Pogossian, Cook, Goddard, and Robinson, Phys. Rev. **76**, 909 (1949).
[3] H. Bethe and R. F. Bacher, Rev. Mod. Phys. **8**, 194 (1936).

The Beta-Spectrum of $_{61}Pm^{147}$

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HIGH specific activity Pm^{147} has recently become available from the Isotopes Division of the AEC at Oak Ridge where it is made as a fission product. This high specific activity material, when used in the high transmission solenoidal focusing β-ray spectrometer, makes it possible to investigate its beta-spectrum using sources less than 30 $\mu g/cm^2$ thick.

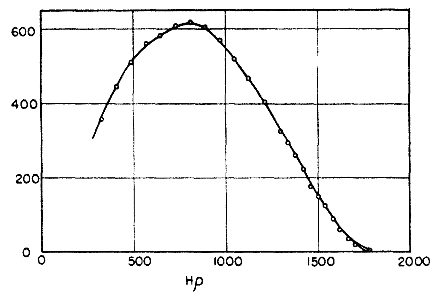

FIG. 1. $_{61}Pm^{147}$ spectrum corrected to constant sensitivity.

The Pm^{147}, received as $Pm^{147}Cl_3$ in 0.1 N HCl was evaporated to dryness and then redissolved in distilled water to which a small amount of wetting agent (Antorox) was added. A 0.01-ml drop placed on a collodion backing ($\sim$10 μg/cm²) formed a uniform source spread over a circular area of about 0.5 cm².

Several runs were made with the resolution set at 3 percent yielding results of which Figs. 1 and 2 are typical. Bethe's explicit

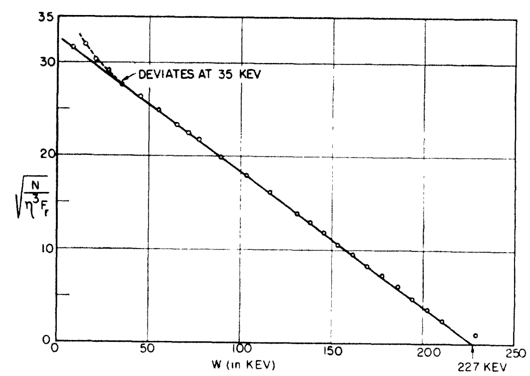

FIG. 2. Fermi plot of the beta-spectrum of $_{61}Pm^{147}$.

form of the relativistic Coulomb factor[1] was used in making the Fermi plot. The end point obtained was 227±1 kev. The plot was straight from the end point down to at least 35 kev. Below this energy, the curve deviated slightly upward and then again downward in a manner which could be attributed to finite source thickness and window absorption (40–50 μg/cm² collodion).

The above end point in conjunction with the reported value of the half-life (3.7 years)[2] yielded an *ft* value for the transition of 1.2×10^7 which for an element with a *Z* of 61 indicates a first- or second-forbidden spectrum. Although the curve has an allowed shape this is not a contradiction since, for certain interactions, a forbidden transition may exhibit an allowed shape.

We should like to thank the United States AEC which aided materially in the performance of this research.

[1] H. A. Bethe and R. F. Bacher, Rev. Mod. Phys. **8**, 194 (1936).
[2] G. T. Seaborg and I. Perlman, Rev. Mod. Phys. **20**, 623 (1948).

On the Low Energy Spectrum of Primary Cosmic Radiation and the Sun's Magnetic Dipole Moment*

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FOR various reasons which will be discussed in detail later,[1] it was deemed important to compare directly the vertical primary cosmic-ray intensity at Swarthmore, Pennsylvania (52° N geomagnetic latitude) with that at Fort Churchill, Manitoba (69° N geomagnetic latitude), both with and without a lead absorber.

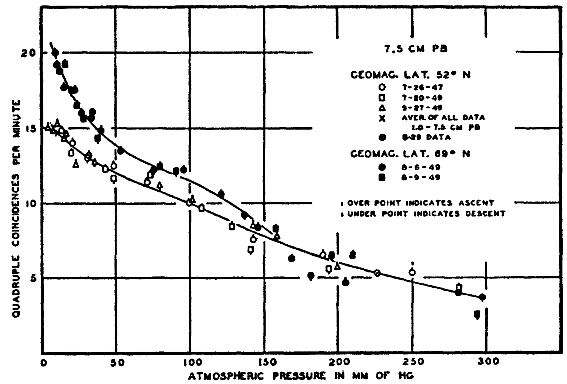

FIG. 1. Intensity *vs.* altitude curves for cosmic rays arriving vertically and capable of penetrating 7.5 cm of Pb at λ=52° N and at 69° N. The increase in the primary intensity at high latitudes is clearly evident. The reproducibility of the data should be noted.

The measurements were obtained with standard quadruple-coincidence counter trains identical with those used earlier.[2] Typical results are shown in Figs. 1 and 2. The records of other balloon flights have not yet been analyzed, although spot checks have shown good agreement with the points plotted here. A total of 13 flights was conducted at Fort Churchill, most of them in the morning.

The ratio of the vertical intensities with no lead absorber extrapolated to the top of the atmosphere is found to be $I(69°)/I(52°)=1.46$.

From this figure, and assuming that the change of intensity is a pure geomagnetic effect, one may easily calculate, using the same method of analysis outlined in a previous paper,[3] that this ratio

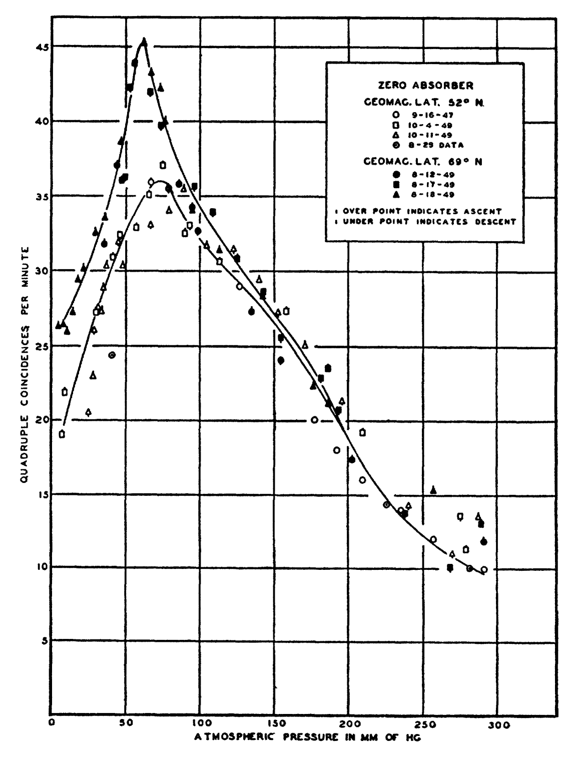

FIG. 2. Intensity *vs.* altitude curves with no lead absorber for cosmic rays arriving vertically at λ=52° N and at 69° N. Similar data were obtained with lead absorbers of intermediate thicknesses.