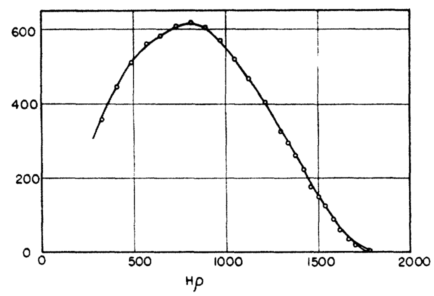

FIG. 1. $_{61}Pm^{147}$ spectrum corrected to constant sensitivity.

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

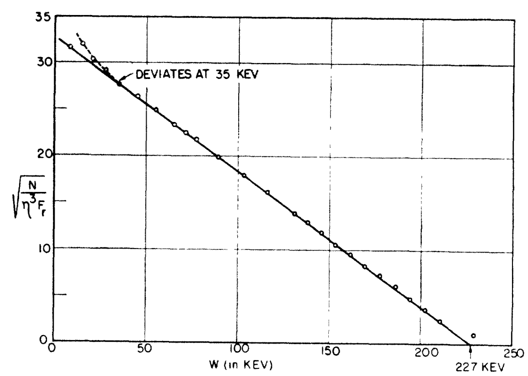

FIG. 2. Fermi plot of the beta-spectrum of $_{61}Pm^{147}$.

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.

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

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November 7, 1949

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.

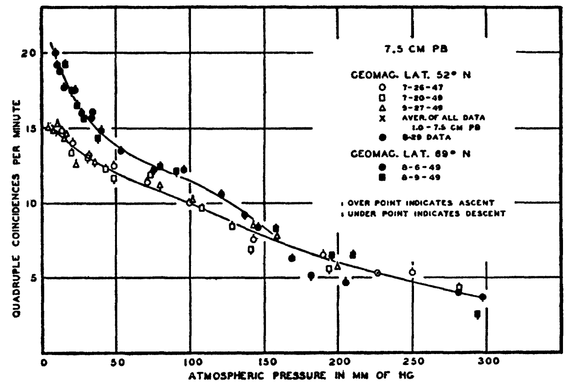

FIG. 1. Intensity *vs.* altitude curves for cosmic rays arriving vertically and capable of penetrating 7.5 cm of Pb at λ=52° N and at 69° N. The increase in the primary intensity at high latitudes is clearly evident. The reproducibility of the data should be noted.

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

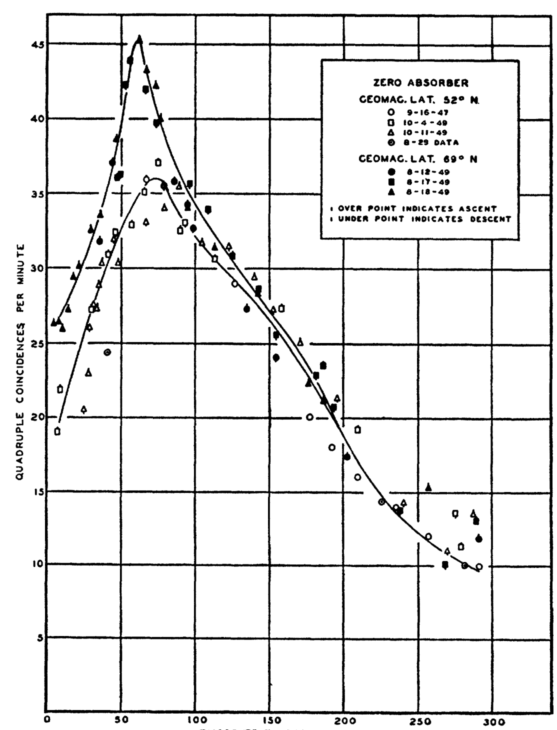

FIG. 2. Intensity *vs.* altitude curves with no lead absorber for cosmic rays arriving vertically at λ=52° N and at 69° N. Similar data were obtained with lead absorbers of intermediate thicknesses.

is consistent with a differential energy spectrum in the energy range from 0.1 to 1.6 Bev for protons of the form $(K/E^{1.14})dE$.

According to the calculations of Dwight,[4] one should expect an increase of at least five percent from 6 to 12 hr. local solar time at 69° N geomagnetic latitude and a decrease of about three percent in the same interval at 52°, on the assumption of a sun's permanent magnetic dipole moment[5] of 10^{34} gauss-cm^3, which is inconsistent with the observations reported here. Nor does it seem possible to account for these results by a shift in the latitude of the knee due to the diurnal variation of the vertical intensity. In point of fact, according to Dwight's calculations, one would expect a difference of vertical intensity between 52° and 69° of about seven percent with maximum in the early morning and decreasing towards noon local solar time. In particular, at 6 hr. the intensity at 52° should be seven percent greater than at 69°, contrary to observation.

This in turn means that the sun's magnetic dipole moment in August, 1949, was not 10^{34} gauss-cm^3 but at most 0.6×10^{33} gauss-cm^3, assuming that the knee on that date was at least at 75° N geomagnetic latitude. This raises the interesting possibility that the sun, like certain stars the magnetic fields of which have been measured by Babcock,[6] has a variable magnetic field and hence a magnetic dipole moment which varies as a function of time.[7] This possibility has far-reaching consequences as regards the mechanism for the acceleration of charged particles of all kinds up to cosmic-ray energies in the neighborhood of the sun. It would thus appear that systematic observations of the vertical intensity at high geomagnetic latitudes and at high altitude, over extended intervals of time, would be highly desirable as a means of studying the variation of the solar magnetic field with time.

One of us (M.A.P.) expresses his grateful appreciation to all those without whose cooperation these experiments could never have been performed, to the National Geographic Society, and to the Defense Research Board of Canada. It is a pleasure for the other author (M.S.V.) to thank Professor J. R. Oppenheimer and Dr. M. A. Tuve for their generous hospitality.

* Supported in part by the Joint Program of the ONR and the AEC.

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[6] H. W. Babcock, Publ. Astr. Soc. Pacific **59**, 260 (1947); Phys. Rev. **74**, 489 (1948).
[7] This suggestion arose from a conversation with Dr. S. E. Forbush.

PHYSICAL REVIEW VOLUME 76, NUMBER 12 DECEMBER 15, 1949

Proceedings of the American Physical Society

Minutes of the Meeting of the Ohio Section at Cleveland, November 5, 1949

The Ohio Section of the American Physical Society held its fall meeting in Cleveland at The Case Institute of Technology, on November 5, 1949. There was no business other than the programme of ten contributed papers (the abstracts of nine of which follow) and the invited talk by E. C. Gregg on the Case Institute betatron and plans for its use. Abstracts of these papers follow.

Leon E. Smith, *Secretary*
Denison University,
Granville, Ohio

Apparatus for Acoustical Measurements with Pulse-Modulated Ultrasonic Waves. Ernest Yeager, Hyman Chessin, John Bugosh, and Frank Hovorka, *Western Reserve University*.—A thousand-watt, pulse-modulated ultrasonic generator has been constructed for operation in the range 200 to 1200 kc at pulse repetition rates from 15 to 2500 sec.$^{-1}$ with pulse durations from 25 μsec. to one-half the repetition period. Acoustical output is stable within 0.4 db after an initial warm-up period of one hour. The ultrasonic generator consists of a pulse generator, r-f oscillator, pulse modulator, and four stages of Class C amplification using tetrodes with a final thousand-watt, push-pull stage. The transducer mounting, which accommodates 3-in., circular, x-cut, quartz crystals from 200 to 1200 kc, permits propagation directly into water in a glass thermostatic bath, 6 ft. in length. Investigations of electrochemical effects are normally carried on in an acoustical cell which is placed within the tank in such a fashion that the acoustical waves enter and leave the cell through rho-c rubber windows. Oscillograms are presented which indicate the ease with which this equipment can be used for investigations of electroacoustical effects.

[1] This research has been supported by the ONR.

A High Frequency Barium Titanate Hydrophone.* John Bugosh, Ernest Yeager, and Frank Hovorka, *Western Reserve University*.—A microphone has been constructed with a pressure-sensitive cylinder of radially polarized barium titanate, 0.125 in. long, 0.125 in. diameter, and a 0.012-in. wall.[1] Pyseal has been used to cap one end of the cylinder while the other end is fitted into a Monel tube, 20 in. long. The underwater calibration[2] of this unit indicates that the response is flat within ±3 db from 50 to 100 kc and from 200 to 500 kc at a level of -130 db re one volt/dyne/cm^2. It is non-directional within ±2 db through 300 kc and ±4 db through 750 kc. Several microphones of this type have performed very well with constant use for six months. A $\frac{1}{16}$-in. microphone of similar design has also been constructed and is under investigation.

* This research has been supported by the ONR.

[1] This type of ceramic cylinder was suggested by Mr. J. P. Arndt of the Brush Development Company of Cleveland.

[2] U.S.N. Underwater Sound Reference Laboratory, Orlando, Florida.