the air. Some of the flares were followed by minor but distinct magnetic storms. For example, a flare of importance 2 occurred at 0002 local time October 26 and was followed by a magnetic storm with sudden commencement at 0430 local time October 27.[1,2] The flight course covered only a small range of longitudes, and corrections were made for this from earlier measurements of the longitude effect. (At $\lambda = 40°$ this correction is -8.3 counts per minute per degree longitude near 112° W.)

The results of the measurements are shown in Fig. 1 with

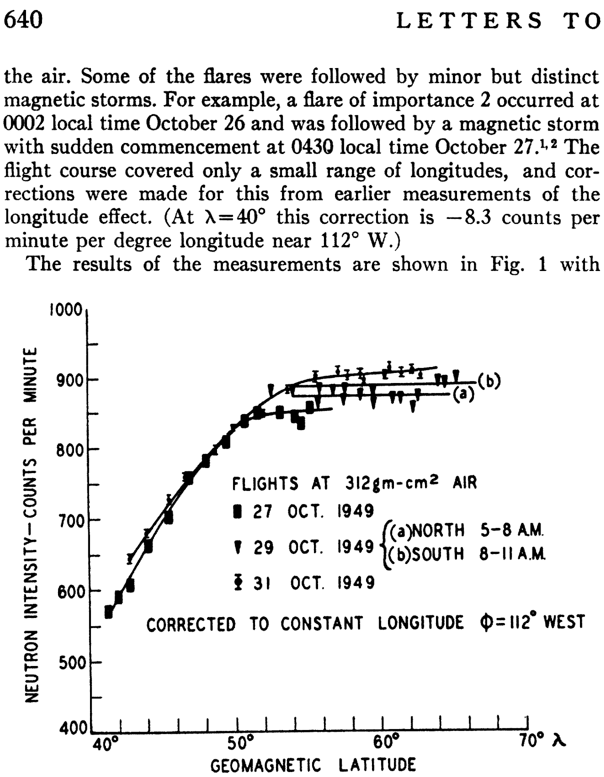

FIG. 1. The change of fast neutron intensity with geomagnetic latitude during solar activity and a magnetic storm. The maximum intensity on a quiet day is 660 events per minute. Counting rates for both quiet and disturbed day values were normalized at the geomagnetic equator.

standard deviations indicated for each point. These fast neutron intensity curves have five characteristics which are of interest in relation to the solar activity:

(1) The measured intensities above $\lambda = 53°$ are all approximately 30 percent above the intensity of 660 events per minute observed on undisturbed days.[3] Also, the intensity increases with time during the period of the flights. Thus, the observations represent a continuing increase above normal quiet day intensity and not the recovery of the cosmic-ray intensity to normal which commonly occurs during a magnetic storm.

(2) If the "knee" of the latitude curve is arbitrarily defined as the intersection of the tangents to the approximately straight line portions of the latitude curve, it is seen that a northward shift of the knee takes place between October 27 and 31. This shift is 3° and lies outside the experimental errors. On undisturbed days this knee[3] is located at $\sim 50°$.

(3) Below $\lambda = 51°$ there is no change or, at most, only a negligible change of intensity during the time interval 27 to 31 October. Due to the nature of the longitude corrections, the difference of intensity shown in the region of 42° may not be real.

(4) Above $\lambda = 51°$ the intensity curves still appear to have positive slopes.

(5) Any assumed diurnal effect at 30,000 feet during the four day period was negligible, since in Fig. 1, (a) represents measurements in the local time interval 0500 to 0730 and (b) represents measurements from 0900 to 1130 local time.

The use of the neutron component as a sensitive indicator of changes in primary particle intensity and a comparison of neutron and charged particle intensity measurements will be published later.

The measurements in Fig. 1 show that beginning on October 27, additional primary particles with momenta lower than permitted by the apparent quiet day cut-off value at $\lambda \approx 50°$ arrive at the top of the atmosphere and that by October 31, particles, if singly charged, arrive with momenta as low as ~ 1 Bev/c corresponding to a cut off at $\lambda = 56°$.

Either: (*I*) These low energy primaries are normally part of the cosmic radiation spectrum and a geo- or heliomagnetic field decreased during the period following solar activity to admit these particles, or (*II*) the low energy particles are added to the normal cosmic-ray flux during the disturbed period and are produced in the solar system.

The present measurements do not distinguish between these extreme alternatives. However, the absence of a pronounced shift in neutron intensity observed for $\lambda < 50°$ N with time and the recent evidence against a strong helio dipole field make it difficult to support alternative (I). On the other hand, the approximate 30 percent increase of intensity above normal and the shift of the knee of the latitude curve northward are evidence for alternative (II).

The absence of a significant diurnal effect at 30,000 feet and the observed latitude dependence for the low energy primary particles arriving between $\lambda = 51°$ and $\lambda = 56°$ indicate that these low energy particles may be approximately isotropically distributed in space and are mostly charged particles.

The writer wishes to thank E. Hungerford for recording the data and to thank Major W. Gustafson, the officers, and crew of the Air Forces B-29 for their cooperation and skill in flying the aircraft.

† Reported at meeting Am. Phys. Soc. June, 1950, Phys. Rev. 80, 135 (1950).
* Assisted by the joint program of the ONR and AEC.
[1] Data kindly compiled and supplied by A. H. Shapley of the Central Radio Propagation Laboratory, National Bureau of Standards.
[2] J. Geophys. Research 55, 94 (1950).
[3] J. A. Simpson, Jr., Proc. of the Echo Lake Conference on Cosmic Rays, 1949.

The High Energy Beta-Spectrum of Sc^{46}

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IN a recent study[1] of the disintegration of Ti^{45} a small amount of Sc^{46} was found as an impurity. A cloud-chamber histogram of the beta-particle radiations from this impurity clearly showed the lower energy group but failed to identify the higher energy group previously reported by Peacock and Wilkinson.[2] This has led to the further investigation of the disintegration of Sc^{46} herein described.

For this study three beta-ray spectrometer sources were prepared from an Oak Ridge sample of Sc^{46}. One was prepared as received with no further chemical separation. The second was separated chemically in accordance with the procedures outlined by Noyes and Bray[3] with special precautions being made to remove the scandium from any possible phosphorus or strontium

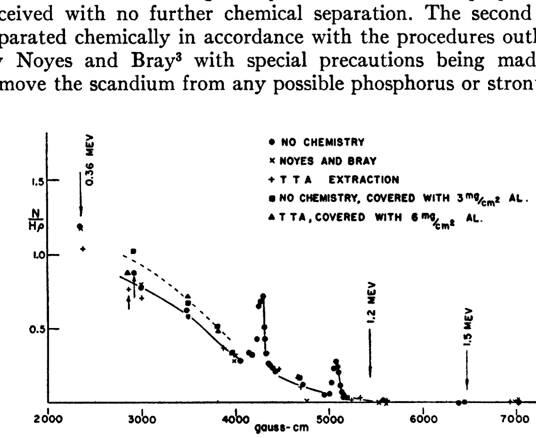

FIG. 1. Momentum spectrum of electrons, from sources of Sc^{46}, whose energies lie in the region higher than the high intensity, low energy beta-ray group. The solid line represents the best fit for the bare sources. Dashed line represents best fit when sources are covered with an aluminum foil whose surface density (in mg/cm²) is approximately equal to that of the source. The significance of this experiment is discussed in the text. The two peaks are the internal conversion lines for the 0.89- and the 1.12-Mev gamma-rays.

impurities. The third source was prepared by means of a thenoyl trifluoracetone (TTA) extraction[4] of scandium. Sources were deposited upon a cellophane foil 0.001 inch thick.

The results of the spectrometer studies are given by the momentum spectrum in Fig. 1. Since only the high energy spectrum is of interest, the low energy group of Sc^{46} is not shown. However, normalization of the three sources was made by comparing counting rates across the peak of this low energy, high intensity group. Statistical errors are no larger than the size of the marker which indicates the position of the experimental point. The arrows indicate experimental data taken 72 days and 112 days after initiation of the study with appropriate normalization by means of the peak counting rate of the lower energy beta-spectrum. This indicates that the higher energy group decays with the same half-life as does the lower energy group, this being 84 days, in good agreement with the accepted value for Sc^{46}. Since there is little difference in the shapes of the spectra obtained from all three sources and since the half-life is the same as that associated with Sc^{46}, it would appear that the recorded electrons are not produced by an impurity.

The results are not in agreement with those previously reported by Peacock and Wilkinson.[2] The maximum energy appears here to be about 1.2 ± 0.1 Mev. Nothing above background counting could be observed at energies higher than 1.2 Mev. A Fermi-Kurie plot of the data shows a convexity toward the energy axis. This was expected since a thick source (3–6 mg/cm²) was necessary in order to obtain an appreciable counting rate over background for the higher energy group. Since it is conceivable that the radiation observed could be caused by Compton electrons ejected as secondary electrons from the source by the 0.89- and 1.12-Mev gamma-rays, it was decided to cover the source with an aluminum foil having a thickness approximately equal to that of the source. If the higher energy electrons were purely secondary Compton electrons one would expect an increase in counting rate over the higher energy group of approximately fifty percent. Although the spectrum in Fig. 1 does show a definite increase in counting rate when the source is covered, it amounts only to about 15 percent. It would therefore appear that, although part of the electron radiation is caused by secondary electrons ejected from the source by the Compton process, at least a part really belong to a high energy beta-group. This real group of higher energy beta-particles appears not to exceed 0.5 percent of the total number of such particles from Sc^{46}.

The authors wish to thank Mr. J. Hudis who performed the necessary chemical separations.

* Assisted by the joint program of the ONR and AEC.

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[2] C. L. Peacock and R. G. Wilkinson, Phys. Rev. **74**, 297 (1948).
[3] Noyes and Bray, *A System of Qualitative Analysis for the Rare Elements* (The Macmillan Company, New York, 1927), pp. 207–208, 221.
[4] A Broido, AECD-2616 (1949); W. W. Meinke, AECD-2738 (1949), p. 28, unpublished.

Q-Values for (α, p) Reactions on Aluminum and Boron by Means of Photographic Emulsions

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In the earlier experiments with natural α-particle sources the results of different authors were often inconsistent, partly because of the spread of the energy of the particles and partly because of the poor geometry. So far, photographic emulsions have been used in connection with (α, p) reactions mainly for recording the number of protons and measuring the energy of these protons. We have used the emulsions also for determining the directions of the different protons and from that the directions of the corresponding α-particles, thus improving the geometry.

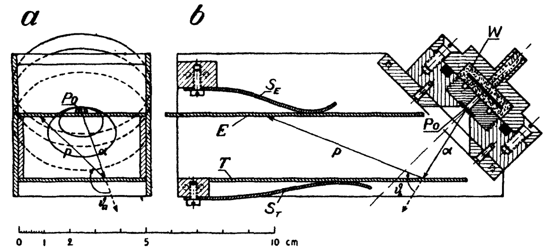

FIG. 1. Experimental arrangement for investigating proton tracks from different targets T, bombarded with α-particles from a polonium source Po. E is the photographic plate.

Figure 1 shows two sections of the apparatus employed. E is the photographic plate, T the target, and Po a polonium sample (about 12 mc). No direct α-particles from the polonium source can reach the emulsion on the plate E. A mica window of 0.67 mg/cm² thickness was placed before the source to prevent contamination of the walls and surfaces in the chamber when this was evacuated. The most frequent energy value of the α-particles was 4.80 Mev, and the half-width of the distribution 0.40 Mev. The positions of p and α in Fig. 1 were computed from the direction of the track in the emulsion. The proton energy was determined from the length of the track and the Q-values computed from the well-known formula. Figure 2 shows the Q-values found for the Al(α, p)Si-reaction. The figure gives the result for 100 tracks. Each Q-value is represented by a vertical line. If each Q-value is represented by a triangle of the shape marked to the right on the figure (the half-width of the triangle is the same as for the energy distribution of the α-particles), and the triangles integrated, we get the curves in the figure. The Q-values found belong to the groups -1.24, 0.14, and 2.30 Mev.

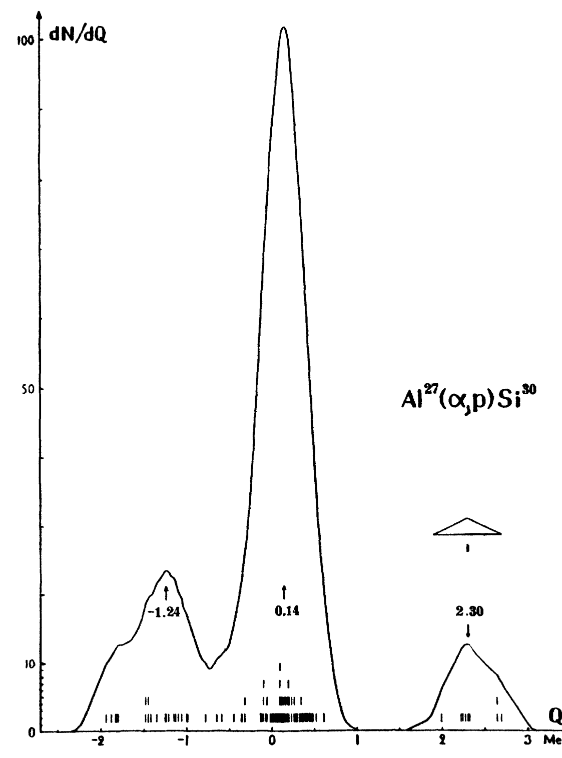

FIG. 2. The most probable Q-values for the Al(α, p)Si reaction, computed from the Q-values obtained from 100 proton tracks.