Cosmic-Ray Neutron Intensity Increase Associated with Solar Flare of February 23, 1956*

J. A. Lockwood, H. E. Yingst, A. R. Calawa, and G. Sarmaniote
University of New Hampshire, Durham, New Hampshire

(Received March 5, 1956)

An increase of 35-fold in the cosmic-ray intensity was observed with a neutron detector located at Durham, New Hampshire (geomagnetic latitude $\lambda = 54°$ N), during the solar flare which began at 0330 UT, February 23, 1956. For several days prior to the onset of the flare a large decrease in the daily average neutron intensity was recorded.

A LARGE increase in the neutron intensity of cosmic radiation was observed to begin between 0345 and 0400 UT, February 23, presumably associated with the giant flare observed at this time. The neutron intensity was measured by lead-paraffin pile monitors located at Durham (geomagnetic latitude $\lambda = 54°$ N, longitude $\phi = 71°$ W, elevation sea level), and Mt. Washington, ($\lambda = 55.5°$ N, $\phi = 71°$ W, elevation 6262 ft). The lead-paraffin pile at Mt. Washington is of standard design for the International Geophysical Year[1] and the pile at Durham, although not of standard design, has a similar energy response to the nucleonic component of cosmic radiation. The neutron counting rates of these two detectors are ~2600 and 200 min^{-1}, respectively.

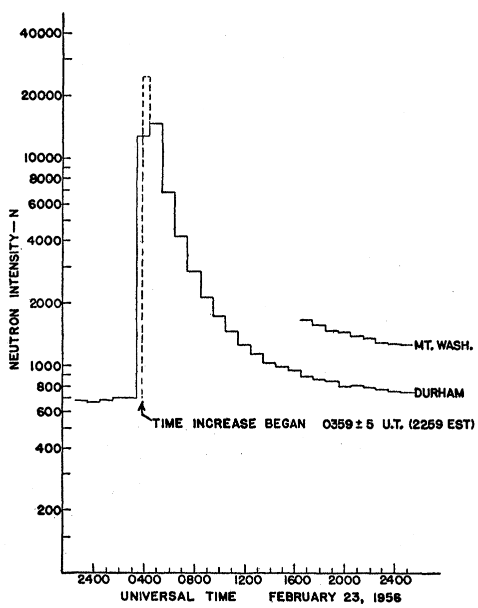

Fig. 1. Hourly average neutron intensity, N, in counts per hour at Durham and Mt. Washington, New Hampshire, for February 23, 1956. Scaling factors of 8 and 64, respectively, were used.

In Fig. 1 is shown the hourly average counting rates corrected for barometric pressure ($\alpha = -9.7\%$/cm Hg) at Durham during the solar flare. Operation difficulties were encountered at the Mt. Washington station during part of this period, but sufficient data was available to ascertain that the increase did not begin prior to 0348 UT. If it is assumed that the flare effect began at this time and increased as a linear function of time to its maximum value within 15 minutes, a comparison of the Mt. Washington and Durham data yields a conservative increase of 30-fold at Durham. From Fig. 1 it is more probable that the increase occurred as a step function in which case the flare effect began at 0359±5 UT and the increase at Durham was calculated to be 35-fold. A bank of four BF_3 proportional counters surrounded by a Cd shield which was in operation at this time increased by a factor of ~20.

Prior to the occurrence of this large flare a marked decrease in neutron intensity was evident at these two stations as shown in Fig. 2. The intensity decrease of approximately 9% at Durham and 10% at Mt. Washington, determined by comparing the minimum February 19 with daily averages for the two preceding months, appears to be the largest since the start of this monitoring program in 1953. During the period February 10–17, at which time the large decrease

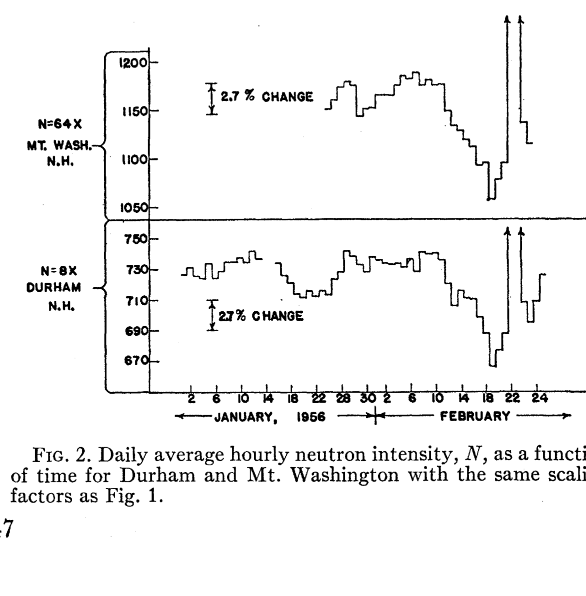

Fig. 2. Daily average hourly neutron intensity, N, as a function of time for Durham and Mt. Washington with the same scaling factors as Fig. 1.

* Supported by the Geophysical Research Directorate of the Air Force Cambridge Research Center, Air Research and Development Command.

[1] J. A. Simpson, "Cosmic radiation neutron intensity monitor," University of Chicago, 1955 (unpublished).

occurred, solar activity data[2] indicated the greatest outbreak of active regions since 1951. The mean of the daily averages from February 11 to 27 inclusive is 830 hr^{-1}, which is greater than the average of the preceding period, February 1–10, indicating that there is an average net increase of low-energy primaries and not a redistribution in time of the existing cosmic-ray flux.

These intensity-time variations of the nucleonic component of cosmic radiation will be reported later in more detail.

[2] Solar activity data furnished by High Altitude Observatory and National Bureau of Standards, Boulder, Colorado.

PHYSICAL REVIEW VOLUME 103, NUMBER 1 JULY 1, 1956

Two Hyperfragments from Negative K-Particle Capture and the Mass of the Negative K Particle*

FRANCIS C. GILBERT, CHARLES E. VIOLET, AND R. STEPHEN WHITE
Radiation Laboratory, University of California, Berkeley and Livermore, California
(Received March 26, 1956)

Two hyperfragments are described which have been found from 81 negative K-particle interactions at rest and in flight. Event 35 was identified as a K^- capture in carbon which emitted a ${}_\Lambda Li^7$ hyperfragment that decayed into a π^- meson and a Be^7 fragment. The binding energy of the Λ hyperon in ${}_\Lambda Li^7$ was found to be 4.4 ± 0.7 Mev. The mass of the negative K particle which was captured in this reaction was found to be 966.2 ± 5.0 electron masses. In Event 71, a negative K particle was captured in a light nucleus. Four charged particles and a π^- meson and a hyperfragment, ${}_\Lambda He^4$, left the K^- ending. The ${}_\Lambda He^4$ decayed into a proton, a π^- meson, and a He^3 fragment. The binding energy of the Λ hyperon in ${}_\Lambda He^4$ was found to be 1.5 ± 0.6 Mev.

A STACK of 112 Ilford $G.5$ emulsions, each 6 in. $\times$6 in.$\times$600μ thick, has been exposed to the "negative K-particle beam"[1] with momenta of 270 to 380 Mev/c at the Berkeley Bevatron. Among 81 negative K-particle interactions at rest and in flight that have been found in this experiment there are two examples of hyperfragment emission, herein designated as Events 35 and 71.

EVENT 35

In this event, drawn in Fig. 1, a negative K particle was captured at rest in a light element of the emulsion.[2] From the star were emitted a proton (D), a hyperfragment (B), a short prong (C), and a light meson (A) that escaped through the edge of the stack approximately 1 mm from the end of its range. The hyperfragment decayed into a π^- meson with a range of 2.19 cm and a recoil of 2 microns range.

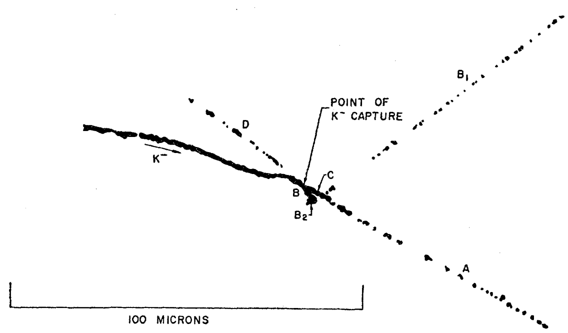

FIG. 1. A drawing of the decay of a ${}_\Lambda Li^7$ hyperfragment (track B) into a π^- meson (B_1) and a Be^7 nucleus (B_2). The ${}_\Lambda Li^7$ comes from the capture of a negative K particle in a C^{12} nucleus producing a π^- meson (A), a He^4 (C), and a proton (D) (Event 35).

The identities of prongs A, B_1, and D were obtained from ionization, scattering, and range measurements. The identities of prongs B, B_2, and C and the charge of prong A (π) were inferred from the following K^- capture and hyperfragment decay reactions:

$$K^-+C^{12}\rightarrow\pi^-+{}_\Lambda Li^7+He^4+H^1+Q_1, \quad (1)$$

$${}_\Lambda Li^7\rightarrow\pi^-+Be^7+Q_2. \quad (2)$$

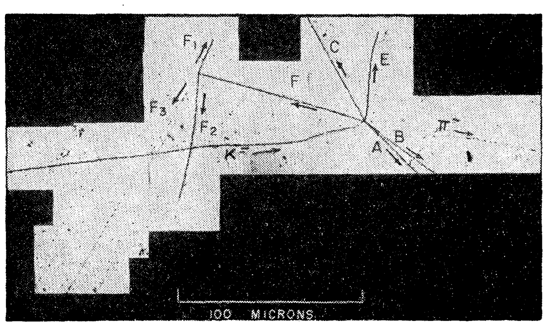

FIG. 2. A photomicrograph of the decay of a ${}_\Lambda He^4$ hyperfragment (track F) into a He^3 (F_1), a proton (F_2), and a π^- meson (F_3). The ${}_\Lambda He^4$ is emitted from the capture of a negative K particle, yielding, in addition to the hyperfragment, four charged particles (A, B, C, and E) and a π^- meson (Event 71).

* Work performed under the auspices of the U. S. Atomic Energy Commission.

[1] Kerth, Stork, Haddock, and Whitehead, Phys. Rev. **99**, 641(A) (1955).

[2] The energies of the short prongs (B and C) lie below the Coulomb barrier for the heavier elements in the emulsion.