Solar Flare and Magnetic Storm Effects in Cosmic-Ray Intensity near the Geomagnetic N Pole

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During the solar flare of July 25, 1946 an increase of 14 percent in hourly mean values of cosmic-ray ionization was observed at Thule, Greenland (geomagnetic latitude 88°N) at sea level, under 11 cm Pb. The increase and its gradual diminution toward normal during the 24 hours after the flare was statistically indistinguishable from results at Godhavn, Greenland (geomagnetic latitude 80°N). The subsequent decrease during the magnetic storm, which began 27 hours after the flare, was also in agreement at Thule and Godhavn. If the increase were due to charged particles from the sun, these observations at Thule emphasize the fact that the trajectories involved are markedly affected by factors other than the earth's magnetic dipole.

DURING the past decade or so, four large increases in cosmic-ray intensity began[1] within an hour or less after the onset of a solar flare. These increases were ascribed[2] to charged particles arriving from the sun. Efforts to answer the question of how such particles might accelerate, escape through the sun's magnetic field, and reach the earth were only partially successful.[3] The expected geographical distribution of "impact zones" for these cosmic-ray increases has been calculated by Schlüter[4] and Firor[5] for particles coming from the sun with no solar magnetic field. While the calculated impact zones are compatible with the meager observations[5] between geomagnetic latitudes from 60°S to 60°N, the calculations[4,5] indicate that no increase should be observed at geomagnetic latitudes greater than about 60°N or S. As the authors[4,5] point out, this conclusion is at variance with the fact that increases of cosmic-ray intensity were observed at Godhavn, geomagnetic latitude 80°N, during each of four flares and that an increase occurred at resolute,[6] geomagnetic latitude 83°N during the flare of November 19, 1946.

The increase of cosmic-ray ionization during the solar flare of July 25, 1946, was observed by one of us (J.W.G.), very near the geomagnetic N pole, while serving as technical observer for the Applied Physics Laboratory, The Johns Hopkins University, on the Navy's arctic operation Nanook. We are grateful to the Applied Physics Laboratory for making available to us

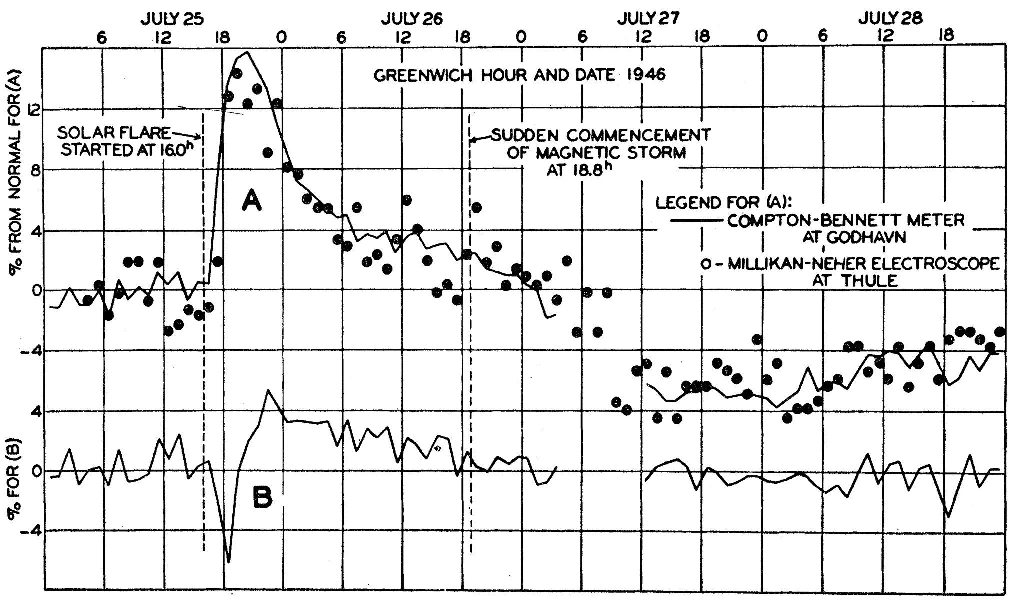

FIG. 1. (A) Hourly means of cosmic-ray ionization at Thule and at Godhavn, Greenland. (B) Hourly means at Godhavn less hourly means at Cheltenham.

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the Millikan-Neher records and a recently declassified report (by J.W.G.) describing the cosmic-ray effects at Thule. The results (shown by the open circles) in Fig. 1 were obtained aboard ship at Thule, Greenland, geomagnetic latitude 88°N, with a Carnegie Institution of Washington Millikan-Neher electroscope shielded by 11 cm Pb.

Since the range in barometric pressure at Thule was less than 4 mm Hg over the period covered in Fig. 1, corrections to the observed ionization were neglected. The agreement between hourly values at Thule and those at Godhavn where the applied barometric corrections were also nearly constant, is best indicated by the fact that the standard deviation of differences between hourly values in Fig. 1(A) is only 2.0 percent which is about what is expected from these two meters running at the same location.

The increase at Thule on July 25, 1946 emphasizes the fact that if the increase were due to charged particles from the sun, then the arrival of such particles so near the geomagnetic pole requires explanation. The effect may possibly be explained if the particles from the sun are deflected in magnetic fields carried away from the sun in highly conducting clouds, although such effects would also likely alter the position of impact zones as computed by Schlüter[4] and Firor.[5] While the cosmic-ray increase, at Godhavn, on July 25 is similar to that at Cheltenham[1] (geomagnetic latitude 50°N), curve B of Fig. 1 for the differences in hourly values shows deviations between 18 hr July 25 and 12 hr July 26, that are statistically significant in view of the quiet barometric conditions at both stations.

Figure 1(A) shows that the decrease in cosmic-ray intensity during the magnetic storm beginning July 26, was the same at Thule as at Godhavn, where it was similar to the world-wide decrease at other stations.[1]

It is interesting to note that for about 72 hours after the onset of the solar flare, no radio signals from WWV at 5, 10, and 15 Mc/sec could be received at Thule, although on frequencies from 15 to 80 kc/sec, signal reception was unusually good from all parts of the world.

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Diffusion Cloud-Chamber Study of Very Slow Mesons.* I. Internal Pair Formation

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A beam of negative pi and mu mesons was moderated to very low energies and allowed to enter a hydrogen-filled 20-atmosphere continuously sensitive cloud chamber. The various phenomena were observed and classified. A detailed study was made of the internal pair formation of mesonic gamma rays produced in the pion-hydrogen reactions. The conversion coefficient for the reaction $\pi^0\rightarrow\gamma+e^++e^-$ was found to be 0.0053 ±0.0009; for the reaction $\pi^-+p\rightarrow n+e^++e^-$ the coefficient is 0.0062±0.0013. Distributions in angle and energy were obtained from thirty-five of the forty-seven observed cases.

A. INTRODUCTION

THE development of the continuously sensitive high-pressure cloud chamber as a practical instrument of research[1] has opened new areas of investigation in particle physics. When accompanied by a precisely known, homogeneous magnetic field and suitable optics, it constitutes a powerful tool for precise measurements as well as for observations of rare processes. In this paper we describe the application of such an instrument to the observation of pi and mu mesons which are moderated and come to rest in the 19.4 atmosphere pressure of hydrogen gas that constitutes the chamber filling.

Earlier experiments[2] in this domain have consisted of a pair spectrometer study of high-energy gamma rays associated with π^- mesons stopping in high-pressure hydrogen gas. A broad peak in the spectrum was observed, centered about 70 Mev and attributed to the reaction:

$$\pi^-+p\rightarrow\pi^0+n;\quad \pi^0\rightarrow 2\gamma. \tag{1}$$

This assignment was confirmed by the counter detection of coincidences between the π^0 gamma rays.[3] Additional information was obtained from a study of the angular correlation of the two gamma rays.[4] The spectrum also yielded a sharper peak at about 130 Mev which was interpreted as the radiative capture reaction:

$$\pi^-+p\rightarrow n+\gamma. \tag{2}$$

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