LETTER TO EDITOR

On the Analysis of Sudden Indrease of Cosmic Ray associated with Solar Flare

The sudden increase of cosmic ray intensity associated with the solar flare is of very interest because it seems to give some clue to the origin of usual cosmic rays.

The questions which arise from this phenomenaon may be divided in the following three parts:

(1) Did what kind of incoming particles give rise such unusual increase of cosmic rays?

(2) Is there any possible mechanism that can accelerate the charged particle up to several Bev at the time of solar flare?

(3) If such mechanism is possible, can such particles escape from the strong magnetic field of the sun?

Questions (2) and (3) have already been studied and answered affirmatively by Swann[1] and Forbush et al[2] respectively.

In order to study the feature and the energy distribution of the incoming rays which produced such increase, the analysis was made using the data of the increase on Feb. 28, and Mar. 7. 1942, and the following results were obtained. (The available data for this analysis were obtained at Huancayo (1°Sm), Christchurch (48°Sm), Cheltenham, (50°Nm) Godhavn (78°Nm)[3] and Tokyo (25°Nm)).

(1) The increase at Godhavn was larger than that of Cheltenltenham. The difference was surely caused by the particles with energy less than the magnetic cut off energy at Cheltenham. Furthermore, the particles must have at least 2 Bev per nucleon to penetrate through the atmosphere. From Table I the platicles satisfying

Table. 1. Magnetic cut off energy per nucleon at Cheltenham.

particle	electron	proton	α particle	other nuclei
Magnetic cut off energy/nucleon	≈ 4 BeV	≈ 3 BeV	≈ 1.2 BeV	≈ 1 BeV

above conditions are protons or electons. However, the possibility that incident particles were only electrons can be excluded from the fact that the increase was also observed under the thick (10 cm or more) lead absorber[4]. We thus conclude that almost of alli ncident particles were protons. This conclusion was confirmed by recent experiment of photographic plate carrid out by Schein[5] et al, who found that only protons were increased at the time of solar flare.

If the particles had been accelerated so gradually that the heavy particles had not been destroyed, they would have been accelerated and observed. From this argument it may be concluded that the particles were not accelerated so gradually.

(2) From the latitude effect of the increase, the energy spectra of incoming particles which produced such increase are roughly estimated.[6]. As shown in Fig. 1, the average energy of particles decreases with increasing time on Feb. 28, while it is almost constant during the increase on Mar. 7.[7]

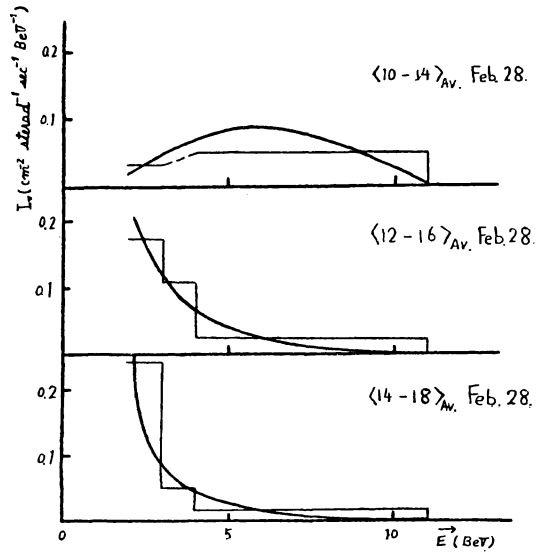

Fig. 1. Differential Spectra of Incoming Particles. <10—14>AV. means the average value from. 10 to 14 G.M.T.

This contradiction may be explained by the following assumptions:

(1) The tunnels[2] through the Störmers forbidden region opened up during the acceleration on both days. While the acceleration mechanism was gradually demped with time on Feb. 28, but was suddenly damped on Mar. 7 after having accelerated the particles for a short time.

(2) The acceleration mechanism was gradually damped on both days. While the tunnel opened up during the acceleration on Feb. 28, but on Mar. 7, it opened up for a short time and shut off before the acceleration mechanism was damped.

The assumption (1) does not seem to be plausible, and it may be due to the assumption (2). However, for the lack of information available to us, we can not decide whether this conclusion is right or not.

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(1) W.F.G. Swann, Phys. Rev. **43**, 217 (1933).
(2) S.E. Forbush, P.S. Gill. and M.S. Vallarta, Rev. Mod. Phys. **21**, 44 (49).
(3) I. Lunge, and S.E. Forbush, Terr. Mag. **47**, 185 (1942).
(4) in this issue.
(5) J.J. Lord, A.W. Elston, and M. Schein Phys. Rev. **79**, 540 (1950).
(6) T.H. Johnson, Rev. Mod. Phys. **10**, 193 (1938).
(7) This is not shown in Fig. 1, but it is evident from the data of reference (1).