17. COSMIC RAYS AND ELECTROMAGNETIC CONDITIONS IN CORPUSCULAR STREAMS, SOLAR FLARES, SUPER-CORONA AND IN INTERPLANETARY SPACE

L. I. DORMAN

As a result of investigations of cosmic ray variations the following conclusions have been obtained.

1. In corpuscular streams there are frozen magnetic fields which may be regular or turbulent. The former influence cosmic rays, the latter do not. Streams associated with high-latitude formations on the Sun have the value 300 $Hl \simeq 10^{10}$ eV (l is the stream's width near the Earth) and the number of streams changes very slowly during the solar cycle. Streams associated with low-latitude formation have 300 $Hl \simeq 10^{11}$ eV, the broad streams being long-lived ones (they produce 27-day cosmic ray variations), the narrow streams being short-lived ones (they produce the decrease of cosmic ray intensity during magnetic storms). The number of low-latitude streams is proportional to the number of the sunspot.

The retardation by interplanetary plasma of streams having frozen magnetic fields is calculated on the assumption of radial propagation for different density values of streams and interplanetary medium. It follows that the size of the cavity formed by streams (the cavity is free from galactic magnetic field) is not greater than 10 A.U.

2. The cosmic ray beam going directly from the Sun during the solar flare on 1956 February 23 is

$$\delta D_{\odot}(\epsilon, t) = 10^{10}\,\epsilon^{-7} \exp(-t/T_{\odot})\ \text{cm}^{-2}\,\text{hr}^{-1}\,\text{BeV}^{-1},$$

where $T_{\odot} \simeq \frac{1}{4}$ h. The total energy of the particles $\simeq 10^{32}$ ergs. The average speed of particle energy accumulation $\alpha = (1/\epsilon)(d\epsilon/dt) > 2 \times 10^{-3}$ sec^{-1}; the mean particle existence time in the flare volume is $\leqslant 10^2$ sec; the mean scatter range within the flare is $\leqslant 2 \times 10^7$ cm; magnetic field intensity of the moving formation is $\geqslant 3$ Oe and their velocity is $\geqslant 4 \times 10^7$ cm/sec. The injection energy in the chromosphere is $\simeq 20$ MeV, therefore the acceleration mechanism in the first stage must be more rapid than Fermi's. It may be concluded that it is the pinch-effect mechanism found in solar flares by Prof. Severny. If the pinch diameter is 10^8 cm, the squeezing rate is 3×10^7 cm/sec, $H \simeq 10^2$ Oe and the initial particle velocity is 10^6 cm/sec, then the obtained energy will be ~ 50 MeV for protons and further acceleration can be produced by Fermi's mechanism.

3. Before leaving the Sun, relativistic particles are scattered in the solar super-corona. Its radius is about 10^{12} cm, the mean scattering range in it is about 2×10^{10} cm and the intensity of magnetic fields in irregularities is 3×10^{-3} Oe.

4. It follows from the fact that solar particles reached certain regions of the Earth in the initial flare stage, that the regular field intensity between the Sun and the Earth is $\leqslant 2 \times 10^{-7}$ Oe. The mean scatter range on the magnetized clouds in interplanetary space is found to be 0·5–1 A.U.

The magnetic field intensity in these clouds is obtained; it is $\geqslant 10^{-5}$ Oe. The cavity radius (where galactic field is absent) may be found from the variation of scattered cosmic ray intensity. In 1949 it was about 3 A.U.; in 1956 it was about 10 A.U. Such a variation is evidently due to the variation of solar activity. The cavity size fits the results of calculation of the retardations of corpuscular stream by interplanetary plasma.

https://doi.org/10.1017/S0251107X00028030 Published online by Cambridge University Press