LETTERS TO THE EDITOR

PHYSICAL SCIENCES

Interstellar Magnetic Field

Roger and Shuter[1] have pointed out that the recent measurement (Smith[2]) of the interstellar magnetic field from the Faraday rotation of the plane polarized radio waves from the pulsar *CP* 0950 may be interpreted as a combination of ionospheric and interstellar rotation. They conclude that the upper limit of 2×10^{-7} gauss for the interstellar field should be replaced by an actual value of about 10^{-6} gauss.

This interpretation is based on values of the ionospheric electron density obtained only from estimates of the penetration frequency at the time of observation. The actual values of penetration frequency at the Radio and Space Research Station, Slough, are available through the kindness of the director, and they show that the new interpretation is not justified. From 18h to 22h UT on April 3, 1968, the penetration frequency fell linearly from 7 MHz to 4·8 MHz. Roger and Shuter quote a value of 7·6 MHz at 20h UT. Our present estimate of the ionospheric contribution is less than theirs by a factor of just over two chiefly because of this difference. Their calculation must therefore be revised to read: Measured rotation, +4 radians; ionospheric contribution, +6 radians; interstellar contribution, −2 radians. The original conclusion is unchanged, and the upper limit of the interstellar magnetic field remains at 2×10^{-7} gauss.

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[1] Roger, R. S., and Shuter, W. L. H., *Nature*, **218**, 1036 (1968).
[2] Smith, F. G., *Nature*, **218**, 325 (1968).

Magnetic Cut-off of Extragalactic Protons in the Galactic Disk

ACCORDING to the results of extensive air shower experiments, as inferred from observed electron densities, the integral energy spectrum of cosmic particle radiation $\int_E^\infty dE \int d\Omega \sum_A f(E,A,\Omega)$, where f is the combined distribution function of energy E, atomic number A and direction Ω, is of the form $E^{-\gamma}$, with $\gamma \simeq 1{\cdot}6$ for $E < \sim 10^{16}$ eV, $\gamma \simeq 1{\cdot}8$ for $\sim 10^{16}$ eV $< E < \sim 10^{18}$ eV and $\gamma \simeq 1{\cdot}6$ for $E > \sim 10^{18}$ eV. There is still some uncertainty about the exact position of the first knee and about the existence of the second one. If they really exist, they may be consequences of the transition from galactic to extragalactic contributions caused by the presence of a large scale ordered magnetic field in the galactic disk. The chemical composition of cosmic particle radiation, $\int d\Omega\ f(E,A,\Omega)$, which is well known in the low energy range, has also been the object of intensive, though still inconclusive, investigations in the high energy region $E > \sim 10^{14}$ eV, by the measurement of the muon content[1] or from the core structure of extensive air showers[2] in connexion with Monte Carlo simulations of cascade development[3]. The amplitude of possible anisotropic contributions to the angular distribution $\sum_A f(E,A,\Omega)$ has been found to be within the limits of statistical error, which are typically of the order of 0·1 per cent for $E < \sim 10^{16}$ eV (refs. 4 and 5), of the order of 1 per cent for $\sim 10^{16}$ eV $< E < \sim 10^{18}$ eV (ref. 6) and of the order of 10 per cent for $E > \sim 10^{18}$ eV. When studying the magnetic cut-off, the combined distribution function $f'(\rho,\Omega)$ of magnetic rigidity $\rho = E/Ze$ and direction Ω may be considered instead of $f(E,A,\Omega)$, where Z is the charge number corresponding to A.

The observed distribution function is expected to contain galactic as well as extragalactic contributions. Extragalactic particles may be assumed to be isotropically incident on the galactic disk. If the structure of the magnetic field of the galactic disk is at least partly closed, the angular distribution of extragalactic particles is expected to be isotropic in the neighbourhood of the Sun within the region of magnetic rigidity $\rho >$ max. $\rho_\infty(\Omega)$, where $\rho_\infty(\Omega)$ is the cut-off rigidity for extragalactic particles reaching the Earth from the direction Ω. The angular distribution of extragalactic particles is expected to be anisotropic in the neighbourhood of the Sun within the region of magnetic rigidity min. $\rho_\infty(\Omega) < \rho <$ max. $\rho_\infty(\Omega)$, because of the existence of Stoermer cones. There will be no extragalactic particles with $\rho <$ min. $\rho_\infty(\Omega)$ in the neighbourhood of the Sun. Purely galactic radiation is therefore expected to reach the Earth with $\rho <$ min. $\rho_\infty(\Omega)$, whereas a mixture of galactic and extragalactic contributions may be present with $\rho >$ min. $\rho_\infty(\Omega)$. Changes in the form of the rigidity spectrum are obviously expected for $\rho =$ min. $\rho_\infty(\Omega)$ and for $\rho =$ max. $\rho_\infty(\Omega)$. The corresponding changes in the form of the energy spectrum may be smeared somewhat because of the presence of particles with different charge to mass ratios. Cut-off rigidities $\rho_s(\Omega)$ have been calculated for extragalactic particles. These cut-off rigidities are defined

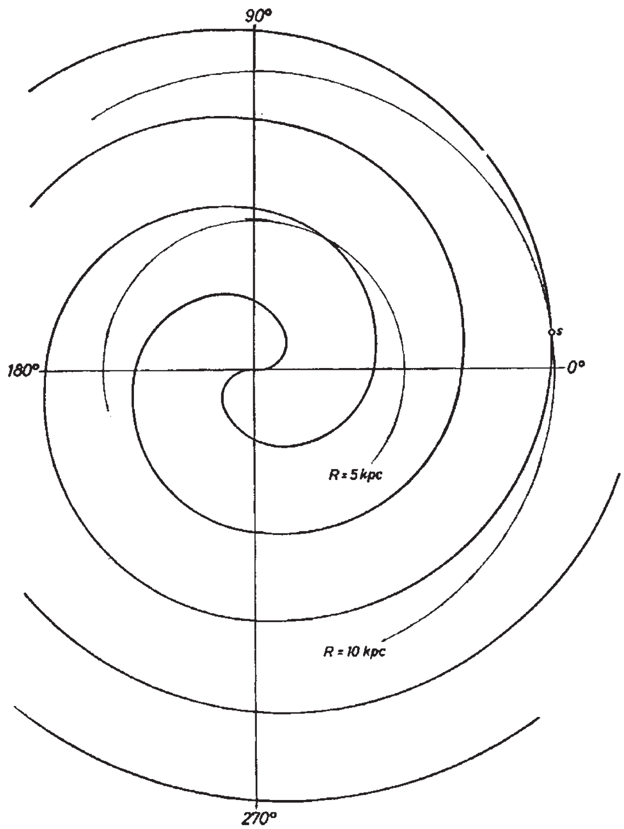

Fig. 1. Spiral function $\Phi(R) = b(R/k)$ arc tan (R/k) with $b = 1$ and $k = 1{\cdot}5$ kpc.