COSMIC RAY EVIDENCE FOR THE MAGNETIC CONFIGURATION OF THE HELIOSPHERE

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Sekido and Murakami (1958) proposed the existence of the heliosphere to explain the scattered component of the solar cosmic rays. The heliosphere of their conception is a spherical shell around the sun. The shell contains a highly-irregular magnetic field and serves to scatter the cosmic rays emitted by the sun. It thereby gives rise to an isotropic component of solar cosmic rays, following the maximum in the ground level enhancement (GLE). Meyer et al. (1956) showed that a similar picture applies to the GLE of 23 February 1956. They conclude that the inner and outer radii of the shell should be 1.4 AU and 5 AU respectively. They suggest that a shell is formed by the "pile-up" of the solar wind under pressure exerted by the interstellar magnetic field, as suggested by Davis (1955).

Simpson (1963) presented a digest of the results of the 11-year variation of cosmic rays studied by means of balloons, shielded ion chambers, and neutron monitors. He concludes that the observed characteristics of the variation may be explained by a change in the inner radius of the heliosphere from $\sim$5 AU at solar minimum to $\sim$30 AU at solar maximum; the variation in the size of the heliosphere is brought about by a change in solar wind pressure and the frequency of the occurrence of shock waves in the interplanetary medium, with the solar activity cycle. We now know that the mean solar wind velocity does not change significantly over the period 1964-73.

Axford et al. (1963) considered the problem of the termination of the solar wind and the solar magnetic field. They point out that interstellar atomic hydrogen has an important bearing on the termination problem. Dessler (1965) estimates the inner and outer radii of the shell to be 30 AU and 70 AU, respectively.

Ahluwalia and Escobar (1963) noted that if solar wind velocity decreases with increasing heliolatitudes then the heliosphere should be ellipsoidal, rather than spherical. Their argument is still valid if the radial flux of the solar wind decreases systematically with increasing heliolatitude. Kumar and Broadfoot (1979) show that the radial

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flux of the wind does indeed decrease with increase in heliolatitude. However, Ahluwalia-Escobar model is not general enough; it does not take into account the relative motion of the solar system with respect to the local interstellar medium. Ahluwalia (1980) shows that this modification results in two model magnetic field configurations for the heliosphere shown in Fig. 1a,b provided that the local interstellar magnetic field has a significant component aligned normal to the direction of motion of the solar system. A "closed" heliosphere is obtainable during odd solar activity cycles (e.g., #17, 19) and an "open" heliosphere during even cycles (e.g., #18, 20). Among other things these models help us understand (a) large-scale changes in the properties of the gross interplanetary magnetic field; (b) "anomalous" recovery of the 11-year variation of the cosmic ray intensity during even solar activity cycles, when the magnetic moment of the sun is directed from the south to north; and (c) existence of anomalous components of energetic particles and their large heliolatitudinal gradients, observed by McKibben, et al. (1979).

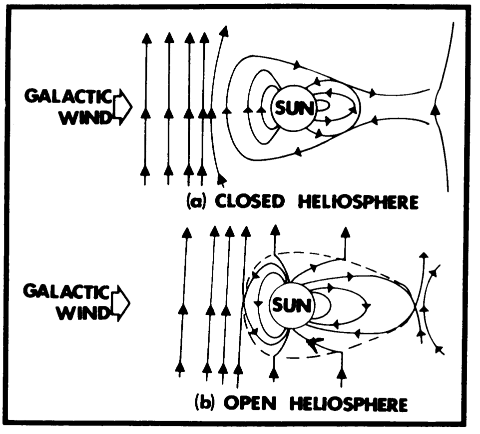

Figure 1a,b

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