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The work during the period covered by this report concentrated mostly on two aspects of our proposal. The first one is a derivation of a kinetic equation for the propagation of protons produced by solar flares through interstellar space. The model we used consisted of well localized magnetic irregularities distributed in space according to an arbitrary, time and velocity independent, distribution function. Large scale magnetic field was not considered for the moment.

We used the multiple time-scale expansion technique(1) (which is based on Bogoliubov's(2) original ideas) to obtain approximations, of proton distribution function, to a desired order in the smallness parameter, namely, the dilution of the scattering magnetic irregularities. We have been able to show that the first order approximation yields in the limit of small gradients the well-known diffusion equations. Higher order corrections can be obtained and evaluated.

An H theorem was shown to exist in first order, but breaks down in second order, which is unfortunately common in perturbation expansions.

The second part of the work attempts to calculate an effective average cross-section for scattering of charged particles by magnetic irregularities. To do this one has first to choose a model for the magnetic irregularities. We considered the following models:

1) The magnetic irregularity is confined to a sphere of radius a. The field inside $\vec{B}_i$ the sphere fluctuates very rapidly (i.e., its Fourier components are of wavelengths much smaller than a) such that any line integral $\int \vec{B}_i \, d\ell$ along a straight line penetrating through the sphere vanishes. On the other hand,

the magnitude of the field $|\vec{B}_i|^2$ varies slowly inside the sphere and vanishes at its boundaries.

2) The magnetic irregularities consist of an average field in a given fixed direction, its magnitude varies slowly and vanishes at the boundaries of the sphere. The direction, though, may vary from one irregularity to another.

3) The magnetic irregularity comprised of an effective resultant magnetic dipole (with or without a cutoff). The direction of the dipole varies from one irregularity to another.

The attached report discussed only the first model. Large scale magnetic field was again ignored at this stage. The model that seems to come closest to observations by Ness et al[3] is probably a combination of the first and second, or the first and third models. The direction of the field (or dipole) in the second (or third) model is directed towards the sun or away from it depending on the sector[4] in which the irregularity is located.

Part of this work was done in collaboration with Dr. G. Sandri of A.R.A.P. An abstract was submitted to the American Physical Society for a talk to be given at the A.P.S. meeting in Washington, D.C. in April 1966. A revised and extended manuscript will be submitted for publication.

[redacted]

(1) G. Sandri, Ann. Phys. (N.Y.) 24, 332 (1963)
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(2) N.N. Bogoliubov in "Studies in Statistical Mechanics" Vol. 1, ed. J. deBoer and G.E. Uhlenbeck, North Holland Publishing Co., Amsterdam, 1962.

(3) N.F. Ness et al, NASA, Goddard Space Flight Center Reports X-612-64-95 (April 1964) and X-612-65-180 (May 1965)

(4) N.F. Ness et al, NASA G.S.F.C Report X-612-65-157 (April 1965)