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POLAR DISTURBANCES AND THE FIELD OF THE MAGNETOSPHERE

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SUMMARY

Considerations of polar disturbances and of the field of the magnetosphere and involving the polar substorms' current systems in the presence of auroral current jets lead the author to conclude that the true distribution of currents in the ionosphere differs sharply from the commonly known scheme.

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The existence of stationary closed magnetosphere, whose outer layers are subject to viscous action from the solar wind side, is possible only when convective motions exist in it, which are analogous to those described by Axford and Hines [1]. In the scheme proposed by them plasma moves in the inner layers of the magnetosphere toward the Earth. If the magnetosphere is closed, there must exist a weak magnetic field in the plane of the tail; this field must have a northerly direction. The drift of plasma toward the Earth then presumes the presence of still an electric field directed from the morning side of the magnetosphere tail toward the evening side. The assumption of the existence of such a field is in accord with the increase in energetic electron fluxes on the morning side of the magnetosphere by comparison with the evening side, as registered by AES "VELA-2" [2]. The rotation of the Earth must induce in the magnetosphere tail an additional field, directed toward the Earth; the projection of both fields along the field lines on Earth must result in the emergence of a positive potential region in the morning-daytime sector of the ionosphere and of a negative one on the night-evening sector (Fig.1).

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Such a structure of the electric field corresponds also to the results of peculiarity analysis of spatial distribution of geophysical phenomena carried out by Hartz and Brice [3], and, in particular, to the peculiarities of spatial distribution of auroral absorption. The considered electric field results in plasma drift in the magnetosphere tail in a direction toward the neutral sheet and along it toward the Earth; any variation of this field must lead to drift velocity variation.

The most striking peculiarity of polar substorm's current system is the presence of auroral current jet flowing along the aurora zone along the high conduction channel. The ends of this channel rest on a comparatively poorly conducting polar ionosphere and, if the current is induced by some cause acting inside the channel, its ends must be inducing a polarization field characterized by surplus positive charges in the evening-night sector of the ionosphere and negative ones in the morning sector (Fig.2). The sign of the polarization field, induced by the auroral electrojet is thus opposite to the sign of the above considered magnetosphere field.

The presence of conducting field lines must transfer the polarization field to the magnetosphere and induce there effects which are opposite to the action of the magnetosphere field, and in the first place the drift of matter from Earth. It is not clear whether such an action is materialized in reality. However, from the fact that intrusions are still materialized, one may apparently derive the conclusion that the fundamental field is the one inducing the drift of matter toward the Earth and not from it, as in the case of the auroral electrojet field. Attempt should therefore be made to search for a kind of a mechanism that would not result in a large polarization field after inducing the polar jet, leaving for the field of the jet only a subordinate role.

Let us admit that the above considered fundamental magnetospheric field plays an essential role in inducing polar substorm, i. e. assume that under the action of some internal causes there emerges in the magnetosphere an electric field characterized by higher potential on the morning side of the tail as compared with the evening side of it. This difference in the potentials must induce a cureent in the circuit, consisting of lines of force and of the portion of the ionosphere between them. The current inflow to the ionosphere takes place on its morning-daytime sector and outflow goes through the evening-night sector. If the ionosphere is homogenous and isotropic and if Pedersen's conduction plays in it a fundamental role, the magnetic field then emerging on Earth will not be perceptible. The field of currents spreading in the ionosphere from the place of inflow will compensate the field of supplying conductors.

However, the auroral intrusion does disrupt the symmetry: conducting channels are formed, uniting regions with different potentials, and a disturbance occurs on Earth, of which the main parts will be the fields of the current flowing along the channel and along the lines of force (Fig.3). The first one is perceived by a ground observer as the field of the auroral electrojet, and the second as the field of currents closing the jets. At small but finite

conductivity of the ionosphere currents will exist in it, flowing directly from spots with high potential to spots with low potentials. However, the field of these currents will not be registered on Earth, for a stronger and inverse in direction field of feeding conductors will be superimposed to the former.

Consequently, the geomagnetic data do not exclude the fact that the true distribution of currents in the ionosphere differs sharply from the given commonly known scheme. When currents are distributed according to Fig.3, the polarization field plays a subordinate role and must not hinder the inflow of plasma to Earth from the magnetosphere tail.

***** T H E E N D *****

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[3]. T. R. HARTZ, N. M. BRICE. Planetary Space Sci., 15, 301, 1967.

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Figures follow..

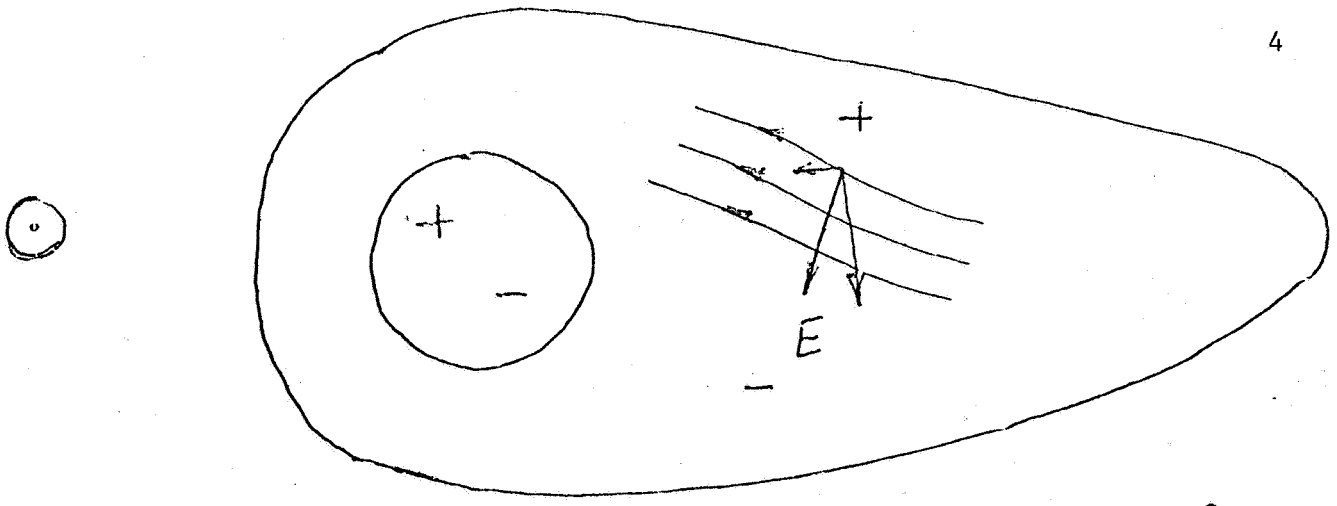

Fig.1

Рис 1

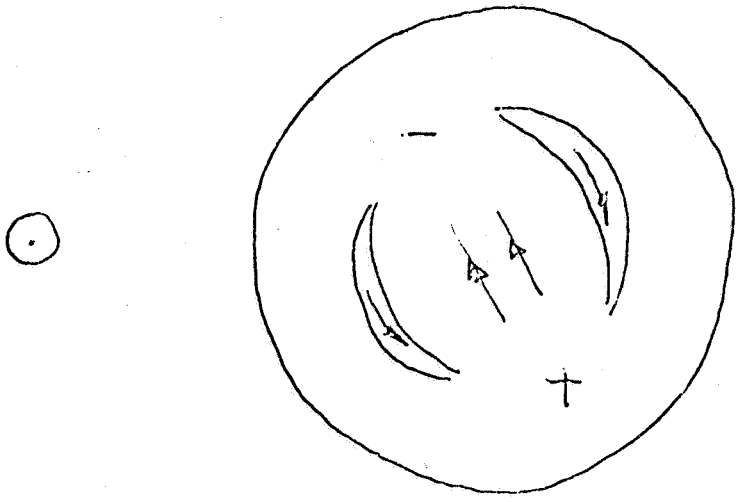

Рис 2

Fig.2

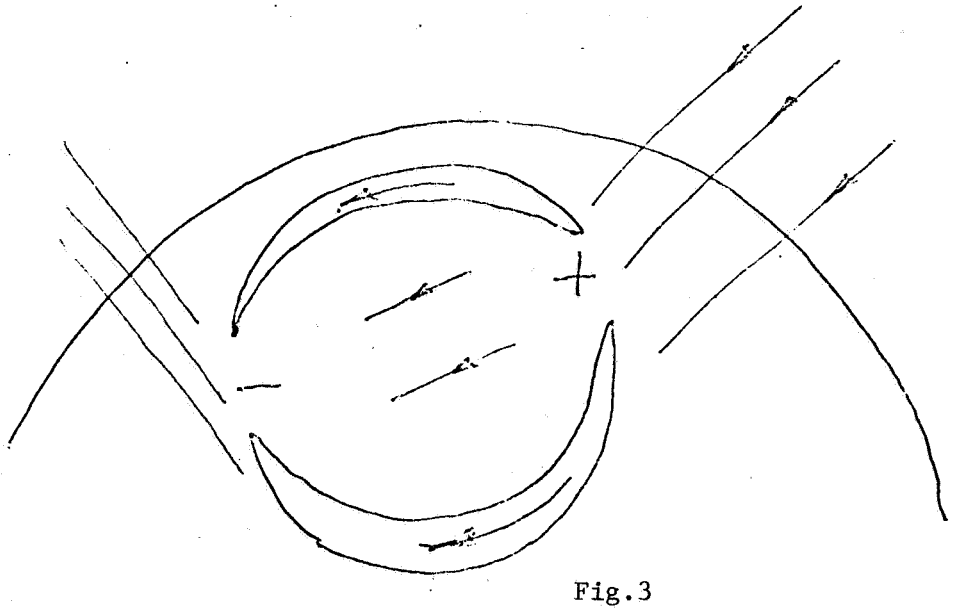

Рис 3

Fig.3