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MAGNETIC FIELD IN THE TAIL OF THE MAGNETOSPHERE AND ITS DIMENSIONS

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SUMMARY

Discussed in this note are the magnetic field in the tail of the magnetosphere as a function of the index of magnetic activity and the variations of the dimensions of the latter as a function of different mechanisms.

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It was shown in [1–3] that active polar aurorae appear most frequently along the oval aurora zone disposed eccentrically relative to the geomagnetic pole: at midday hours they appear on the corrected geomagnetic latitude $\Phi' \sim 75$ to 77° and at near-midnight hours on $\Phi' \sim 67°$. Comparison with satellite data has shown that the oval zone is disposed along the outer boundary of trapped electrons with energy $E > 40$ kev [4, 5]. Photometers and counte s of soft electrons aboard AES "INJUN-3" confirmed that the optimum luminescence intensity is attained at the outer boundary of the region of trapping [6].

According to present-day representations on the structure of the geomagnetic field, the lines of force emerging from the polar cap as a result of soft interaction between solar wind and the magnetosphere matter, are carried to the night side, forming the geomagnetic tail [7–9]. The presence of the latter is confirmed by the experiment on AES "IMP-1" [10]. Since the oval zone is disposedaat the boundary of closed lines of the geomagnetic field, the geomagnetic lines of force are carried into the tail from inside the oval. This is why, knowing the position of the oval zone, it is possible to compute the magnetic flux forming the tail of the magnetosphere.

On the night side of the Earth Φ' of the oval zone depends essentially on the intensity N of the field in the magnetosphere tail. The latitude was computed in [11, 12] of the boundary of the region from which the lines of force are carried into the magnetosphere tail (Φ') on the night side as a function of N, taking into account the current field at magnetosphere boundary [12] or of the ring current [11]. These calculations allow us to establish a relationship between N and the position of the oval on the night side of the Earth.

(*) MAGNITNOYE POLE V SHLYFE MAGNITOSFERY I YEYE RAZMERY

The position of the oval of aurorae for different intensities of DP is brought out in [13, 14], which allows to track the dynamics of field variation in the tail. In order to determine the field N_T as a function of Φ', the position of the oval, computations of [12], based upon the geomagnetic field model of [15], were utilized. Since the influence of ring current of Φ' was neglected in these computations, the aurora oval position on the night side was corrected by the quantity corresponding to D_{st}-variation. The value of the correction was determined according to [16, 17] and the values of Φ' used subsequently correspond to the absence of the ring current.

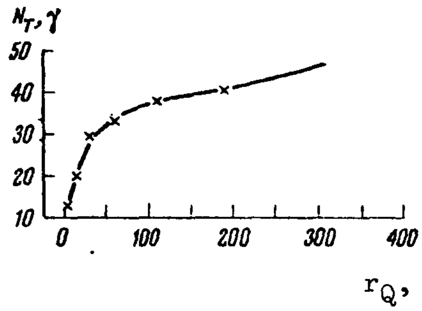

Fig.1. Magnetic field in the magnetosphere tail at intensity variation of the magnetic disturbance

r_Q is the equivalent amplitude of the Q-index (in gammas) of magnetic activity near midnight hours on the Earth's surface and at ∿ 65° geom.lat.

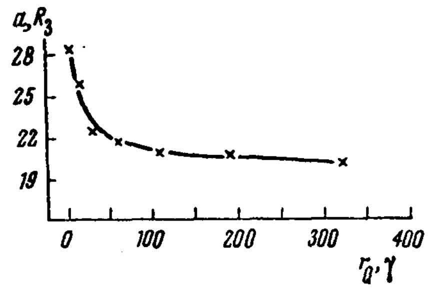

Fig.2. Variation of the radius of the magnetosphere tail as a function of r_Q(in γ)

The dependence of N_T on the equivalent amplitude r_Q of the index Q of magnetic activity on the night side of the Earth is plotted in Fig.1. As the magnetic disturbance increases, so does the field in the tail, which is in agreement with the results of direct comparison of field intensity in the magentosphere tial with the value of the K_p-index [12, 18, 19]. As the disturance increases, the field in the tail increases rapidly at the beginning, and then it continues to do so more smoothly, apparently approaching saturation. The sharp increase of N_T by more than two times is accompanied by disturbance amplitude increase on the Earth's surface from 5 to 50 γ, while at increase of r_Q (in γ) from 50 to 300 γ, N_T increases only 1.5 times.

As DP increases so does also the magnetic flux carried by solar wind in to the magnetosphere tail. The magnetic flux into the tail originating from two polar regions is determined by the relation

$$F = \frac{4\pi M}{R_3} \cos\theta_M \sin^2\theta,$$

where M is the Earth's magnetic moment, R_3 is the radius of the Earth, θ_M is the polar distance of oval's center, θ is the polar distance of oval boundary to its center. The values of θ_M and θ for various indices Q are given in [13].

As Q varies from 0 to 6, the magnetic flux increases 1.8 times, which, according to [20], may lead to particle acceleration in the magnetic tail and explain the development of polar aurorae and of the ring current.

Aurora observations allow us to estimate independently two parameters characterizing the magnetic field of the magnetosphere tail: the intensity and the integral magnetic flux F. These two parameters are linked by the relation

$$F = N_T \cdot S,$$

where S is the area of magnetosphere cross-section. Assuming S to be a circle of radius a, we may, on the basis of data on oval's position, to determine the radius of the magnetosphere tail as a function of the index Q.

The results of these computations are plotted in Fig.2. In the absence of polar magnetic disturbances and of the ring current the radius of the geomagnetic tail constitutes 28.5 R_E , abruptly decreasing with the development of DP. The rapid rise of N_T for small r_Q is conditioned, besides the increase of the magnetic flux in the geomagnetic tail, by tail diameter decrease too. The contribution of the second mechanism to N_T increase is somewhat greater. At Q = 6 the radius of the tail is 16 R_E and, judging from the character of dependence of a on r, a further increase of r_Q does not lead to noticeable variation of a

*** THE END ***

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