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STUDY OF THE EARTH'S MAGNETIC FIELD WITH THE AID OF RADIATION BELTS

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SUMMARY

The possibility of studying the geomagnetic field with the aid of radiation belts is based upon the detection by Elektron-1 a stable electron belt with E > 6 Mev, its position being clarified by findings of Elektron-2, and explained by the existence of a ring current.

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It is considered in the course of investigation of radiation belts at great heights that the Earth's magnetic field differs little from a dipole field. This may be verified by investigating any narrow belt of charged particles, which would sharply depart from the characteristics of particles populating the radiation belts.

During the flights of satellites "ELEKTRON" an electron belt with $E_e > 6$ Mev was detected [1]. The maximum of this belt was on $L = 2.75 \pm 0.1$ everywhere except in the region of the South Atlantic anomaly. The belt's half-width was $\Delta L \approx 0.4$. The origin of this belt is obscure; there exists the assumption that it arose at time of the magnetic storm of 23—26 September 1963 [2]. The belt itself constituted a stable formation; the intensity of electrons was preserved in it for 1.5 months, and it did not shift from one shell to another. This is why it appeared to be possible to take advantage of this belt for the study of drift shells of electrons.

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* IZUCHENIYE MAGNITNOGO POLYA ZEMLI PRI POMOSHCHI RADIATSIONNYKH POYASOV

We plotted in Fig.1 a and b the coordinates of the points, at which ELEKTRON-1 crossed the electron belt maximum with $E_e > 6$ Mev. The geographic longitude is in the abscissa and the altitude above the Earth is in ordinates (a), the geographic latitude being in (b).

The satellite crossed the belt at 2100 – 2200 hours L.T. If on the given shell and altitude magnetic field distortions as a function of time are possible, their contribution to the results brought out is one and the same, and the possible departures of the shell from a dipole must have another origin.

If we assume that the Earth's magnetic field may be represented at such an altitude by the central dipole field, we may obtain from these data the direction of dipole axis. It is obvious that if the latter coincided with the axis of rotation of the Earth, the satellite would be crossing the drift shell of electrons at the same height and geographic latitude independently from the longitude.

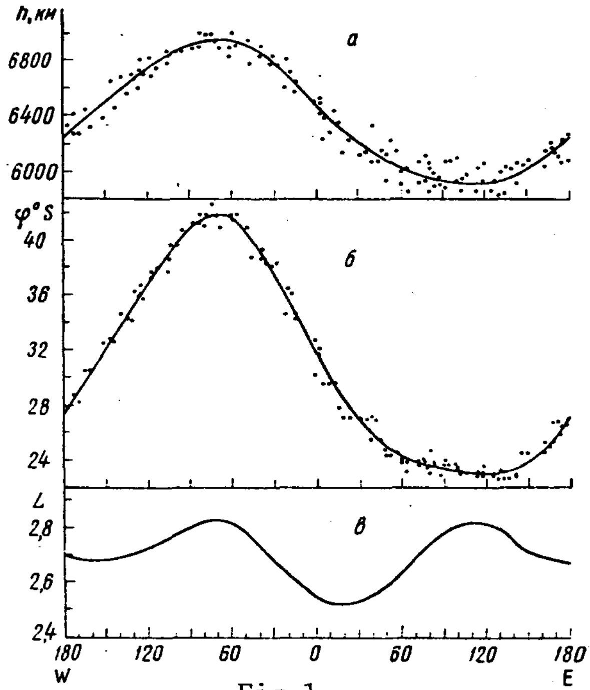

Fig.1

Captions for Fig.1

a) altitude above ground;
b) geographic latitude;
c) L as a function of longitude.

It may be seen from Fig.1 b that the magnetic dipole is inclined to the meridian plane (70 ± 10°)W (longitude at which the satellite crosses the drift shell of electrons at the greatest latitude).

The dipole inclination to the rotation axis of the Earth may be obtained from the following formulas:

$$\frac{1 + h_{-70}/R_3}{L} = \cos^2(\varphi_{-70} - \theta_0) \qquad (1)$$

$$\frac{1 + h_{110}/R_3}{L} = \cos^2(\varphi_{110} + \theta_0), \qquad (2)$$

where h_{-70} and ϕ_{-70} are the height and the latitude of shell's intersection by the satellite at -70° longitude; h_{110} and ϕ_{110} are the same at the longitude of 110°. R_3 is the Earth;s radius and θ_0 is the inclination angle of the dipole axis to Earth's rotation axis.

Dividing (1) by (2) and substituting the respective values from Fig.1 a and b, we obtain $\theta = 11.1 \pm 0.8$. Thus, the coordinates of the southern magnetic pole of the Earth coincided with those computed by ground data ($\lambda = 68.7° \pm 0.2°$, $\phi = 90° - \theta_0 = 78.4° \pm 0.1°$) [3]. It is possible to compute on the basis of these data the geomagnetic latitude of the intersection by the satellite of the given shell as a function of λ. Subsequently, the quantity L is easily computed as a function of longitude. The data of these calculations are plotted in Fig.1 b. The values of L are computed with a precision to 2.5 ÷ 3 percent. It may be seen that the influence of the nondipole members of the Earth's magnetic field is felt at the distance of $\sim$ 6500 km from the Earth s surface. The mean value of the L-shell is 2.71. We may reject the representation of central dipole and assume it is so shifted that in the anomaly region and at $\lambda = 170°$ the value of L coincides with that in the dipole approximation. Since the satellite crosses the belt sufficiently far from the equatorial plane, we conclude that as the dipole coordinates vary, the latitude of this point will vary also,besides the distance of the point of belt intersection by the satellite to the dipole.

Calculations show that near the geomagnetic equator plane the shift of dipole center from the center of the Earth must constitute d $\sim$ 1200 km. At the same time, L will vary at various longitudes within the limits from 2.62 to 2.85. The given dipole position differs significantly from that computed for the 1955 epoch on the basis of world magnetic charts (d=430 km, $\phi = 15.5°$, $\lambda = 151,5°$) [4].

Therefore the influence of the nondipole members of the magnetic field is made clearly apparent at the altitude of $\sim$ 6500 km above the surface of the Earth.

According to data of "ELEKTRON-2" the belt of electrons with $E_e > 6$ Mev is disposed in the geomagnetic equator plane on $L \approx 2.9$. This belt's displacement may be explained, if we assume the existence at a distance $R > 3R_E$ from the Earth's center of a ring current. The influence of the latter must be manifest in that the magnetic lines of force will be more stretched. This is corroborated by the data of ref. [5], from which it follows that at the distance $R < 5R_E$ the magnetic field is less than the dipole.

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

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