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BOUNDARY OF SOLAR COSMIC RAY PENETRATION INTO THE MAGNETOSPHERE ACCORDING TO DATA OF "INTERCOSMOS-17" AND "COSMOS-900"[1])

ГРАНИЦА ПРОНИКНОВЕНИЯ СОЛНЕЧНЫХ КОСМИЧЕСКИХ ЛУЧЕЙ В МАГНИТОСФЕРУ ПО ДАННЫМ СПУТНИКОВ «ИНТЕРКОСМОС-17» И «КОСМОС-900»

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Following the flare of Solar Cosmic Rays (SCR) on November 22, 1977, the penetration of SCR in a wide energy interval was investigated with the help of the data of the Intercosmos-17 and Cosmos-900 satellites. In the present paper the results of the boundary of the proton penetration for energies $E_p > 1$ MeV and $E_p > 100$ MeV, respectively, as well as the electrons $E_e > 30$ keV are presented.

The Earth's magnetosphere is known to be asymmetric due to its interaction with the solar wind. For the analysis of the magnetospheric phenomena there were suggested several models of the magnetosphere [1—5]. These models were used for the explanation of the trapped radiation structure and the polar aurora [5, 6]. It is natural to explain the registered dependence of the low energy cosmic ray penetration boundary on the local time by the asymmetry of the magnetosphere [7]. The computations of the cosmic ray penetration into the magnetosphere were provided in a wide energy interval [8]. There were published data on the proton penetration for protons with a threshold energy from 1.1 to 13 MeV into the magnetosphere [9]. However, in [9] data were used from several flares under conditions of a varying magnetispheric disturbance, which caused large fluctuations of the boundary. It was shown that the boundary of penetration of protons with different energies is situated at lower latitudes in comparison with computations [8]. An appropriate choice of a model parameter helps to make theoretical computations agree with experimental results [10]. However, the change of the parameters must be done in such a way that the situation of the trapped radiation as well as of the auroral zones or day's cusps is not affected.

Experimental investigation of the penetration of SCR in a wide energy interval gives the possibility to determine the parameters of the magnetospheric model. Fig. 1 of [11] presents an example of data obtained during one passage of the "Intercosmos-17" satellite through the polar cap. Electrons with energies $E_e > 30$ keV give the possibility to determine the situation of the polar cap boundary-region where the field lines are opened. At the boundary the intensity of SCR electrons sharply decreases or

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increases (duration of the burst is 5—15 sec) and then decreases, in agreement with [12]. At noon of MLT the decreasing fluxes have the fluctuating character of 10—20 sec. This corresponds to the day's cusp region. Protons with energies from 1 to 100 MeV give the possibility to determine the structure of the magnetosphere in the closed drift shell region, where the magnetic field is asymmetric. Using the data of two satellites we can obtain the situation of the SCR penetration boundary in the whole interval of MLT. The data on the SCR penetration boundary for different rigidities are given in Fig. 1. The term

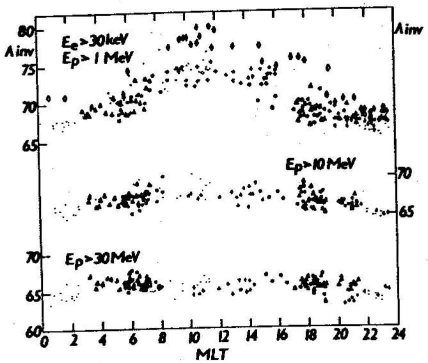

Fig. 1. The boundary of solar cosmic ray penetration into the Earth magnetosphere according to the satellites "Intercosmos-17" and "Cosmos-900". The boundary is defined as a place where there begins the monotonous decrease of intensity passing to the lower latitudes. ...E_e> 30 keV, Interkosmos-17; +...N, ●...S, Intercosmos-17, ○...N, △...S, Cosmos-900.

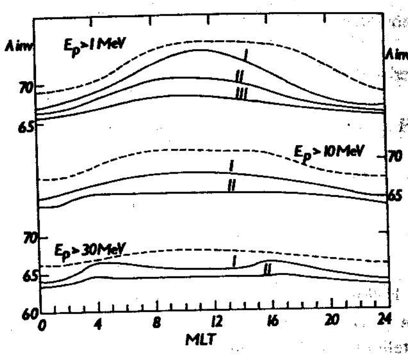

Fig. 2. The boundary of proton penetration into the magnetosphere for various energies. I — beginning of the monotonous intensity decrease, II — $N_b = N_{polar\ cap}/I$, III — $N_b = N_{polar\ cap}/10$, ---- computation [8].

boundary is used as a place where the intensity begins to decrease during the passage to lower latitudes. This means the end of the region of isotropic flux for particles of the given energy. We have also investigated the points where the intensity has the value N_{pc}/e (N_{pc} — the intensity in the polar cap) for protons with E_p>1, 10, 100 MeV and points where intensity was equal to $N_{pc}/10$ for protons E_p > 1 MeV.

All the three boundaries together with the results of computations [8] are presented in Fig. 2. We can compare also our data with the experimental data [9]. With the exception of the fact that the boundary of SCR penetration according to [9] is in average at 1—2° lower latitudes, the boundary structure according to our data and that given by [9] are similar.

Fig. 3 shows comparison of the computations [8, 10] for E_p > 5 MeV with the experimental data (boundary 1) according to measurements on the "Intercosmos-17" and "Cosmos-900" satellites.

During the SCR registration on November 22—25, 1977, the geomagnetic situation stayed undisturbed. In the interplanetary space $B_z \geq 0$ and the fluctuations of both the solar wind particles density and its speed resulting in the fluctuations of the solar wind pressure on the magnetosphere were characteristic.

Fig. 4 gives the average boundary 1 position for $MLT = 0, 6, 12, 19^h$ in dependence on the solar wind

pressure magnitude. For $MLT = 12^h$ there are presented the individual points taken from the northern as well as the southern hemisphere. The dependence of the SCR penetration boundary position on the solar wind pressure is seen separately for the north and the south hemisphere. Further, it is shown, that in the northern hemisphere the boundary of penetration is systematically at lower latitudes than that in the southern hemisphere. It is interesting to note that from the evening side the north-south asymmetry has a spatial character.

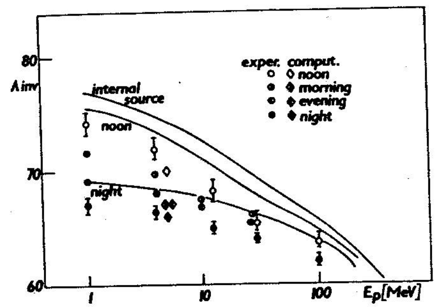

Fig. 3. Comparison of the experimental data at the boundary of proton penetration of different energies with the results of computations [8] (lines) and [11].

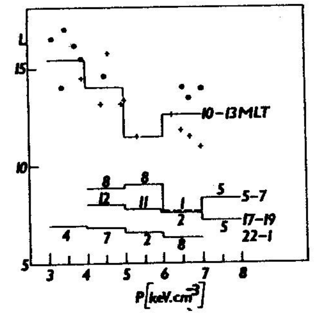

Fig. 4. The dependence of the boundary position I for protons with E_p > 1 MeV in four intervals of MLT on the solar wind pressure onto the magnetosphere. The numbers at the straight lines — the number of points according to which the determination of the boundary average position was obtained (+N, ● S).

Concluding we can state that with the help of the two satellites "Intercosmos-17" and "Cosmos-900" the boundary of the polar cap (region where electrons with E_e > 30 keV are penetrating) was obtained. It should be noted that from the evening side of the Earth the electrons are penetrating practically to $\Lambda_{inv} \sim 68°$, where the field lines have to be closed. Along the whole line the penetration of electrons onto the closed field lines takes place due to the electrical drift in the geomagnetic tail.

The structure of the boundary for penetrating protons with E_p > 1 MeV differs significantly because of different criteria used for its definition. It is connected with the splitting of the drift shells at the high-latitude magnetosphere. The structure of the boundary position for protons with higher energies in the magnetosphere is similar and the change of the definition of the boundary results only in a slight latitudinal parallel motion.

REFERENCES

[1] Williams, D. J., Mead, G. D.: J. Geophys. Res *70* (1965), 3017.
[2] Antonova, A. E., Shabansky, V. P.: Geomagnetizm i Aeronomia *8* (1965), 801.
[3] Alekseev, I. I., Shabansky, V. P.: Planetary Space Science *20* (1972), 117.
[4] Fairfield, D. H., Mead, G. D.: J. Geophys. Res *80* (1975), 535.
[5] Roeder, J. G.: *Dynamics of Geomagnetically Trapped Radiation.* Springer Verlag Heidelberg, New York 1970.
[6] Shabansky, V. P.: *Yavlenia v okolozemnom prostranstve.* Nauka Moskva 1972.
[7] Flindt, H. R.: J. Geophys. Res. *75* (1970), 39.
[8] Smart, D. F., Shea, M. A., Gall, R.: J. Geophys. Res *74* (1969), 4731.
[9] Fanselow, J. L., Stone, E. C.: J. Geophys. Res *77* (1972), 3999.

[10] Pfitzer, K. A.: in *"Quantitative Modelling of Magnetospheric Processes"*, Am. Geophys. Union, Washington D. C. 1979.

[11] Biryukov, A. S., Ivanova, T. A., Kovrygina, L. M., Kuznetsov, S. N., Sosnovets, E. N., Tverskaya, L. V., Kudela, K.: *The Boundary of Solar Cosmic Rays Penetration into the Magnetosphere according to the Data of Intercosmos-17 and Cosmos-900*, Acta Phys. Slov. (in this issue).

[12] Darchieva, L. A., Ivanova, T. A., Sosnovets, E. N., Kovrygina, L. M., Tverskaya, L. V.: *Diagnostika sostojanija magnitosfery Zemli po dannym o solnečnych kozmičeskih lučach.* Magnetism i aeronomia (in print).

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