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RELATIONSHIP BETWEEN THE GEOMAGNETIC ACTIVITY AND THE ENERGY DENSITY OF QUIET SOLAR WIND FLUX

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SUMMARY

According to data of IMP-1 on the sectorial structure of the interplanetary magnetic field, apparently representing a quiet solar wind, estimates are made of energy fluxes of directed motion of thermal and electromagnetic energy incident upon the cross-section of the magnetosphere.

It is shown that there are enough energy fluxes of each kind separately even for the creation of the entire complex of geophysical events in a period of moderate magnetic storm. The character is investigated of the link between the three-hourly values of the K_p-index of geomagnetic activity or the amplitudes a_p equivalent to them, with the flux densities of the various forms of energy.

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* *

The sectorial structure of the interplanetary field detected on AES IMP-1 [1] apparently represents the quiet solar wind. According to measurements of plasma and of the magnetic field of such a structure [1] calculations were performed of densities of these different forms of energy and their relationship with the geomagnetic field was investigated [2, 3]. Besides, the densities of energy fluxes of the directed (q_1) and thermal flows (q_2), and also electromagnetic energy (q_3) have been computed in [4]. In the present paper we investigate the character of the relationship between the values of the K_p-index, or of a_p, averaged for the corresponding time intervals by all positive and negative sectors (see [2]), and q_1, q_2, q_3.

The interaction of solar plasma with the Earth's magnetic field leads to a series of geophysical effect: geomagnetic and ionospheric disturbances, aurorae and so forth. It is clear that this complex of phenomena is created at the expense of energy of plasma fluxes. However, there has been to date no unique opinion as regards the transfer mechanism of solar energy flux inside the magnetosphere [5 – 7]. For this reason it is important to know the magnitude

(*) SVYAZ' GEOMAGNITNOY AKTIVNOSTI S PLOTNOST'YU POTOKA ENERGII SPOKOYNOGO SOLNECHNOGO VETRA.

of the energy flux that may be acquired by the magnetosphere from the solar wind. Data on q from work [4] are utilized in the prssent work for the estimate of the mean and limit values of energy fluxes incident upon the cross-section of the magnetosphere S (according to [8] $S \approx 5 \cdot 10^{20}$ cm^2) for one second (qS) and for t ~ 24 hours (qSt) (in the assumption that t ~ 24 hours corresponds to the average duration of a storm). The mean values $\bar{q}_1S$, $\bar{q}_{2B}S$, $\bar{q}_{2H}S$, $\bar{q}_3S$, $\bar{q}_1St$, $\bar{q}_{2B}St$, $\bar{q}_{2H}St$, $\bar{q}_3St$ are given in Table 1 (the limit values being in parentheses) for the positive and negative sectors. The indices and point to the fact that q_2 was computed by the upper and lower level of temperature (see in this respect [2]). It may be seen from the table that the differences in the fluxes for the positive and negative simply do not exist. Moreover, $\bar{q}_1S \gg \bar{q}_2S \approx \bar{q}_3S$. Note that there is enough energy fluxes of each kind separately for the creation of the entire complex of events even in time of a magnetic storm in the period of which the rate of energy injection inside the magnetosphere must constitute $\sim 10^{18} - 10^{19}$ erg/sec [9], although the above data from IMP-1 are inherent to quiet solar wind. For a more perturbed interplanetary medium, observed in 1962 on MARINER-2, higher energy densities are characteristic (see [8] and the table. Ωet us pause on values of qst. It is known that for the creation of a magnetic storm during the main phase $\sim 100_\gamma$ energy of about $3 \cdot 10^{22}$ erg is required [7]. We see from Table 1 that each of energies q_1St, q_2St, q_3St separately are sufficiently for inducing such a storm.

TABLE 1		IMP-1		MARINER-2
		positive sector	negative sector	
$\bar{q}_1 S$	erg·sec^{-1}	$1,0 \cdot 10^{20}$ $(0,7 : 1,8) \cdot 10^{20}$	$1,2 \cdot 10^{20}$ $(0,7 : 1,8) \cdot 10^{20}$	$3,0 \cdot 10^{20}$ $(0,05 \div 15,0) \cdot 10^{20}$
$\bar{q}_{2B} S$	erg·sec^{-1}	$3,1 \cdot 10^{18}$ $(1,6 \div 7,7) \cdot 10^{18}$	$3,1 \cdot 10^{18}$ $(0,8 \div 6,5) \cdot 10^{18}$	$12,0 \cdot 10^{18}$ $(0,5 \div 50,0) \cdot 10^{18}$
$\bar{q}_{2H} S$	erg·sec^{-1}	$1,6 \cdot 10^{18}$ $(0,8 \div 3,9) \cdot 10^{18}$	$1,6 \cdot 10^{18}$ $(0,4 : 3,3) \cdot 10^{18}$	
$\bar{b}_3 S$		$2,6 \cdot 10^{18}$ $(0,6 : 4,8) \cdot 10^{18}$	$2,3 \cdot 10^{18}$ $(0,9 \div 4,3) \cdot 10^{18}$	$5,0 \cdot 10^{18}$ $(0,05 \div 20,0) \cdot 10^{18}$
$\bar{q}_1 S$	erg	$9,0 \cdot 10^{24}$ $(5,6 : 15,5) \cdot 10^{24}$	$9,9 \cdot 10^{24}$ $(6,05 : 15,5) \cdot 10^{24}$	$25,0 \cdot 10^{24}$ $(0,43 \div 130,0) \cdot 10^{24}$
$\bar{q}_{2B} S$	erg	$2,7 \cdot 10^{23}$ $(1,4 : 6,7) \cdot 10^{23}$	$2,7 \cdot 10^{23}$ $(0,7 : 5,6) \cdot 10^{23}$	$10,0 \cdot 10^{23}$ $(0,43 : 43,0) \cdot 10^{23}$
$q_{2H} S$	erg	$1,4 \cdot 10^{23}$ $(0,7 : 3,3) \cdot 10^{23}$	$1,3 \cdot 10^{23}$ $(0,4 : 2,8) \cdot 10^{23}$	
$\bar{q}_3 S$	erg	$2,2 \cdot 10^{23}$ $(0,5 \div 4,1) \cdot 10^{23}$	$1,9 \cdot 10^{23}$ $(0,7 : 3,7) \cdot 10^{23}$	$4,0 \cdot 10^{23}$ $(6,04 : 17,3) \cdot 10^{23}$

The importance of establishing the relationship between the parameters of the interplanetary medium, the magnetosphere and the ground data, in particular the indices of geomagnetic activity K_p and $\bar{a}_p$.* In order to determine the character of the dependence of geomagnetic activity on the value of flux density graphs of $\bar{K}_p^+(q_1)$, $\bar{K}_p^-(q_1)$, $\bar{K}_p^+(q_{2H})$, $\bar{K}_p(q_{2H})$, $\bar{K}_p^+(q_3)$, $\bar{K}_p^-(q_3)$, were plotted and shown in Figures 1 (a, b, c), where circles indicate single cases, triangles indicate 2 – 3 cases, and the squares more than 3 cases. Analysis of the graphs shows that there is no somewhat clearly defined link between K_p and q_1. This result qualitatively coincides with the one obtained in reference [10].

* insert omission " was emphasized in [3]".

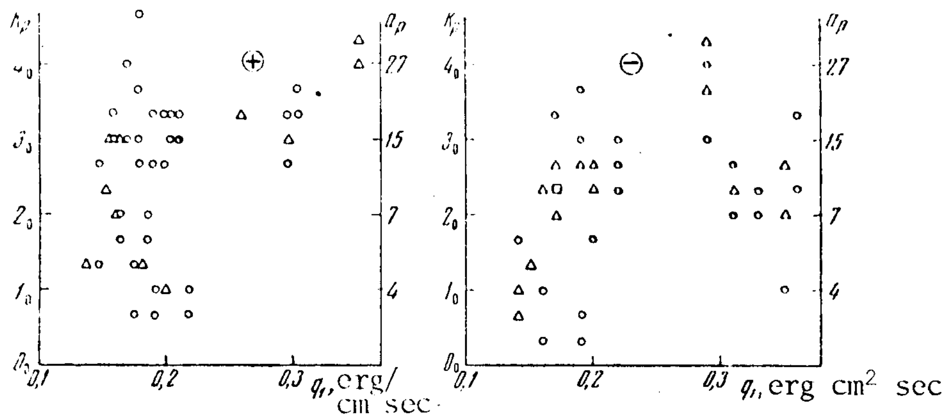

Fig.1a

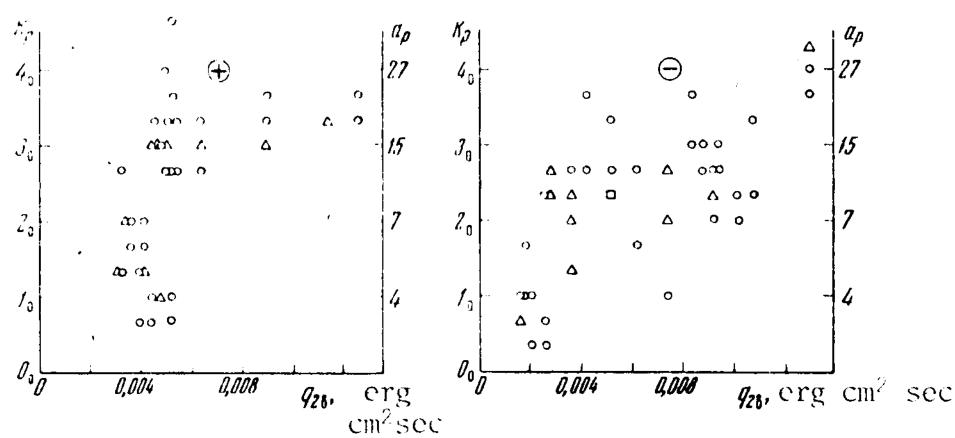

Fig.1b

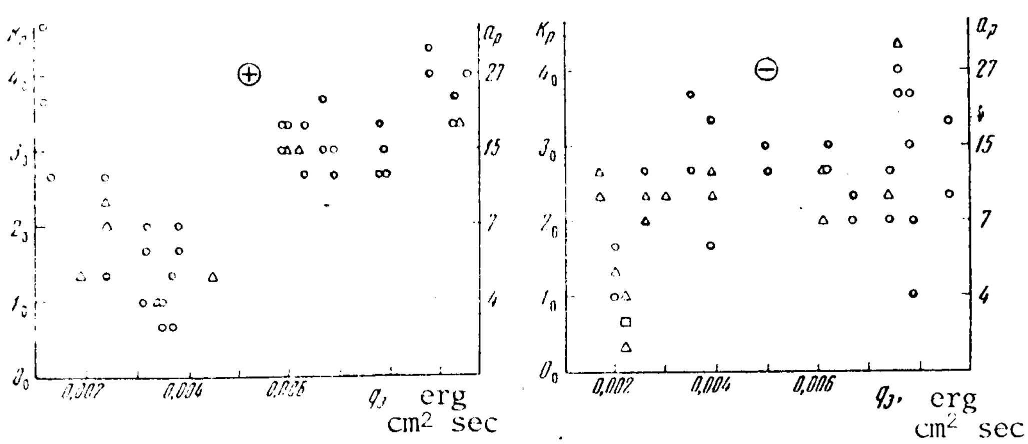

Fig.1c

However, note that for $q_1^+ > 0.22$ erg.cm^{-2}.sec^{-1} we observe $\overline{K}_p \geqslant 3_-$ or $\overline{a}_p \geqslant 12$. A tendency to link of $\overline{K}_p$ with q_{2n} is seen, though in this case for the negative sector the dispersion is greater. Moreover, $q_{2n}^+ > 5.4 \cdot 10^{-3}$ erg cm^{-2} $\cdot$sec, $\overline{K}_p \geqslant 3$ is inherent, or $\overline{a}_p \geqslant 12$, but $q_{2n}^- > 4.0 \cdot 10^{-3}$ erg$\cdot$cm$^{-2}\cdot$sec^{-1}, $K_p \geqslant 2_0$ or $\overline{a}_p > 7$. A good relationship is revealed between K_p and q_3, particularly for the positive sector. A great dispersion of points is observed in the negative sector. For $q_3^+ > 4.5 \cdot 10^{-3}$ erg.cm^{-2}.sec^{-1} $\overline{K}_p \geqslant 3_-$ or $\overline{a}_p > 12$, and for $q_3^- > 2.5 \cdot 10^{-3}$ erg.cm^{-2}.sec^{-1} $K_p > 2_0$ or $\overline{a}_p > 7$. A nearly linear dependence $\overline{K}_p(q_3^+)$ is apparently explained by the fact that plasma velocity V and the intensity of the magnetic field H, directly linked with $\overline{K}_p$ are part of

$$q_3 = VH\sqrt{H^2 - H_R^2}\ /\ 4$$

(H_R being a radial component of H) [1].

The author is indebted to Yu. D. Kalinin for discussing the work and making remarks.

(*) insert omission " and for $q_1^- > 0.2$ erg.cm$^{-2}\cdot$sec^{-1} $\overline{K}_p \geqslant 2_0$ or $\overline{a}_p \geqslant 7$

**** THE END ****

IZMIRAN

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