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Stuart G. Hibben, et al

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This is the third collection of abstracts to be published under this contract on Soviet work with geomagnetic pulsations. It covers material received in the first half of 1974, as well as a few earlier items not reported in the two previous issues. Emphasis is on Pc 1 phenomena, but any article relating to hydromagnetic wave propagation has been included.

An index identifying source abbreviations and a first-author index to the abstracts are appended.

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INTRODUCTION

This is the third collection of abstracts to be published under this contract on Soviet work with geomagnetic pulsations. It covers material received in the first half of 1974, as well as a few earlier items not reported in the two previous issues. Emphasis is on Pc 1 phenomena, but any article relating to hydromagnetic wave propagation has been included.

An index identifying source abbreviations and a first-author index to the abstracts are appended.

Gul'yel'mi, A. V., and V. A. Troitskaya.
Geomagnitnyye pul'satsii i diagnostika magnitosfery
(Geomagnetic pulsations and diagnostics of the
magnetosphere). Moskva, Izd-vo Nauka, 1973,
206 p.

This monograph is concerned with diagnostics of the magnetosphere from data on geomagnetic pulsations, as well as with the results of experimental and theoretical studies of geomagnetic pulsations. It was written for a wide circle of geophysicists doing research on the magnetosphere and interplanetary space, as well as for physicists concerned with the geophysical application of plasma theory.

Chapter I-IV are mostly background, with contents as follows. Chapter I gives a short description of the main characteristics of geomagnetic pulsations. Chapter II deals with some elements of plasma electrodynamics; waves with infinitesimal amplitudes in a homogeneous infinite plasma are considered. Chapter III gives an account of oscillations and waves in the magnetosphere; here the main concern is with the analysis of the spectra of Alfve'n oscillations. Chapter IV gives an interpretation of diverse types of geomagnetic pulsations.

Chapter V describes some methods and actual results of diagnostics of the magnetosphere. The following text hence is basically an abstract of Chapter V, with some figures and tables from preceding chapters included.

A summary of the diagnostics of the magnetosphere based on pulsation data is given in Table 1.

Table 1. Diagnostics of the Magnetosphere and Interplanetary Space

Type of pulsations	Parameter or Process	Method of diagnostics
Pc 1 (Pearls)	Concentration of cold plasma. Energy of resonant protons.	Dispersion analysis. Analysis of carrier frequency change during Ssc and si±
	Slow nonstationary processes (amplification and decay of quiet ring current, weak electric fields, plasmapause drift).	Analysis of slow changes in carrier frequency.
Pc 2-4 Continuous pulsations	Location of the subsolar boundary of the magnetosphere. Strength of the IMF.	Using the empirical relation between the period of pulsations and parameters under consideration.
	Large-scale inhomogeneites of the IMF.	Analysis of variations in the envelope of pulsation amplitude.
Pc 5 Giant pulsations	Plasma density at the equatorial plane.	Analysis of the dependence of the pulsation period on latitude.
	Sharpness of the plasma density decrease along force lines	Analysis of the nonequidistance of harmonics

Pi 1 wideband noise bursts	Injection of energetic particles from the neutral layer of the geomagnetic tail into the auroral zone. Periodical processes in the geomagnetic tail.	Analysis of the spectra and periodicity of noise bursts in the vicinity of the midnight meridian.
IPDP Hydromagnetic howling	Nonstationary drift of energetic protons. Electric fields during magnetospheric substorms.	Analysis of the nonstationarity of spectra. Measurement of the western "frequency drift".
Auroral agitation	Nonstationary drift of electrons injected during magnetospheric substorms.	Analysis of the drift of characteristic details of spectra from midnight eastwards.
Pi 2 Pulse trains	Location of the southern boundary of the auroral zone in the midnight sector.	Using the empirical relation between pulsation period and the latitude of the southern boundary of the auroral zone.

Diagnostics of cold plasma

1. Diagnostics of plasma density from spectra of Alfve'n oscillations.

Two methods for determining plasma density in the magnetosphere using long-period micropulsations are reviewed: a) the method assuming spherical symmetry of the plasma density distribution (Gul'yel'mi, 1966) and b) the method assuming axial symmetry of the plasma density distribution (Gul'yel'mi, 1967; Kitamura, 1965; Namgaladze, 1969; Gul'yel'mi, 1970). The first method was stated to have only methodological value. The latter assumes that oscillation periods of certain field lines have only weak dependence on plasma distribution along the field line, but depend strongly on the equatorial plasma density N_o. This allows one to select more or less arbitrarily the plasma density distribution along a field line and determine $N_o(L)$ from $T(L)$.

For practical purposes, diagnostic graphs are constructed by numerical calculation of spectra of Alfve'n oscillations. An example of a diagnostic graph is shown in Fig. 1.

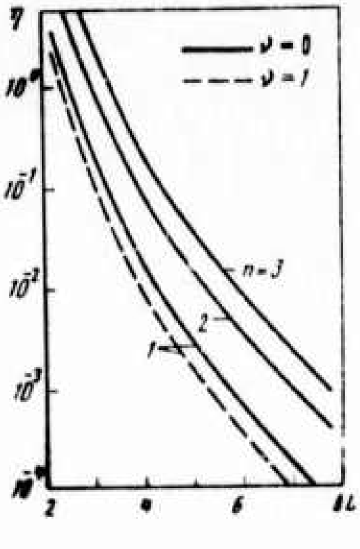

Fig. 1. Diagnostics of plasma density from periods of Alfve'n oscillations (s = 4)

This graph is calculated by

$$\eta_n^{(\nu)}(L) = \frac{M^2\lambda_n^{(\nu)}(L)}{16\pi^2 r_e^8 m_i L^8}. \qquad (1)$$

where dipole field and field line plasma density distribution $\rho \sim (1-x^2)^s$. The equatorial plasma density N_o is determined by

$$N_0(L) = \eta_n^{(\nu)} T_n^{(\nu)2}. \qquad (2)$$

If $n \geq 2$ then the uncertainty of N_o due to the uncertainty of ν is insignificant. As can be seen in Fig. 1, the order of harmonic n is the most uncertain parameter. For determination of n a method using data on nonequidistance of harmonics $\varkappa_{nm}$ is suggested. The method is based on the fact that $\varkappa_{nm}$ depends only weakly on L (see Fig. 2) and does not depend on N(0).

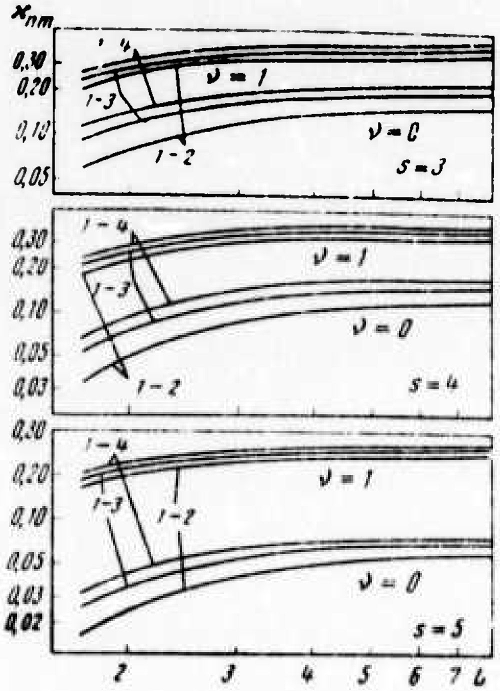

Fig. 2. Nonequidistance of harmonics of Alfvén oscillations.

Fig. 3 shows the theoretical dependence of $\varkappa_{nm}$ on s for n = 1; m = 2, 3, 4. Calculation of $\varkappa_{nm}$ for different combinations of indices is done by $\varkappa_{nm} = 1 - \frac{m}{n}\sqrt{\frac{\lambda_n}{\lambda_m}}$.

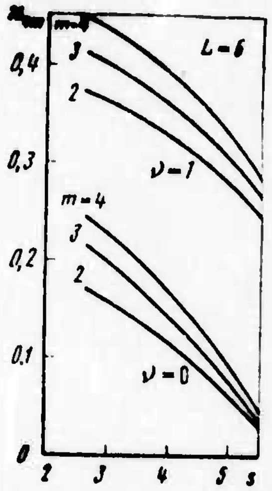

Fig. 3. $\varkappa_{nm}$ (5) for n = 1; m = 2, 3, 4.

The plasma density in the equatorial plane estimated for n = 2, s ~ 4 (indices were determined from $\varkappa_{nm}$ using data on periods of Pc 4 pulsations reported by Annexstad and Wilson in 1968) is shown in Fig. 4 (open circle).

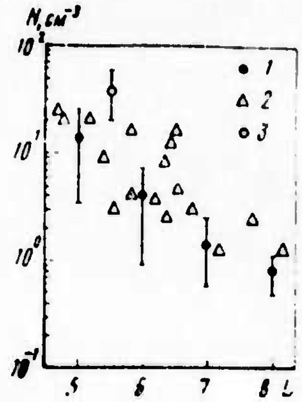

Fig. 4. Cold plasma density in the magnetic equatorial plane.

1- from dispersion analysis data; 2- from data on sudden change of carrier frequency of pearls; 3- from spectra of Alfvén oscillations.

2. Diagnostics of plasma density from spectra of hydromagnetic whistlers.

The method of plasma density diagnostics from data on dispersion of pearls is reviewed (Wentworth, 1966; Liemohn et al., 1967; Kenney et al., 1968; Gul'yel'mi, 1969; Feygin et al., 1970; Gul'yel'mi et al., 1972). The method for determination of plasma density from proton whistlers (Gurnett and Shawhan, 1966) is also reviewed.

Diagnostic graphs for evaluation of ω/Ω_p from τ, ω, and $d\tau/d\omega$ are shown in Fig. 5 and Fig. 6.

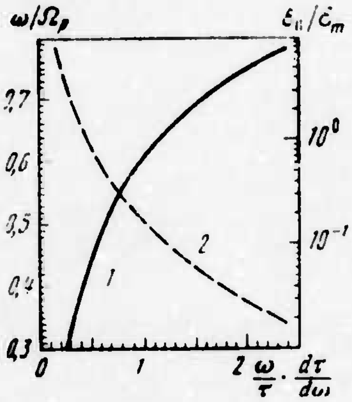

Fig. 5. Dependence of $\omega/\Omega p$ (1) and $\varepsilon_{\parallel}/\xi_m$ (2) on dispersion of pearls.

The graphs in Fig. 6 are calculated for $x_o = 0.9$ and $s = 4$ [$N(x) = N_o(1-x^2)^{-s}$]. Fig. 7. shows diagnostic graphs calculated for different values of x_o and s.

The results of the evaluation of N_o by dispersion analysis, based on about 100 series of Pc 1 registered at Sogra from 1964-69, are shown by the triangular points in Fig. 4. The integral distribution of dispersion ψ measured in each Pc 1 series is shown in Fig. 8. These results are in agreement with those of diagnostics from atmospheric whistlers and with satellite measurements.

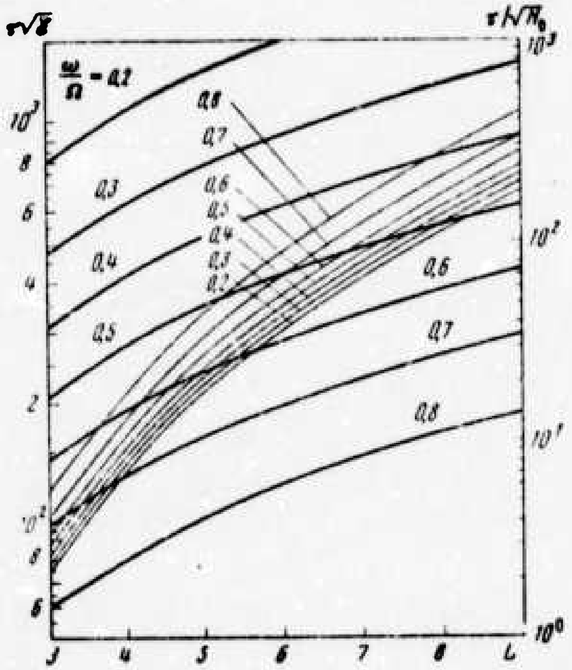

Fig. 6. Diagnostics of the cold plasma density N_0 (thin lines) and the energy of resonant protons ξ_p (heavy lines).

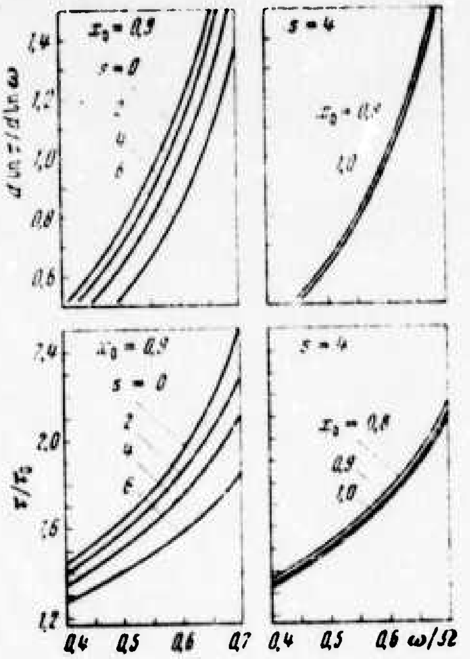

Fig. 7. Dispersion functions for different values of parameters x_0 and s.

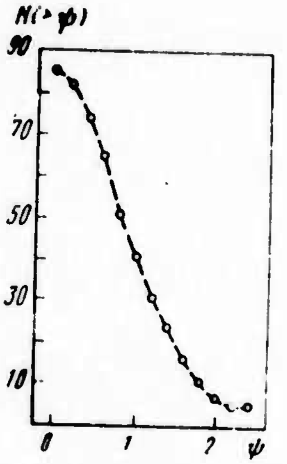

Fig. 8. Integral distribution of pearls with respect to ψ.

Energetic particles

1. Energy of resonant protons

The theory of diagnostics of the energy of resonant protons, using data on sudden change in carrier frequency of pearls during Ssc and si*, was presented.

The procedure of diagnostics concludes in determining ω/Ω_p and $\epsilon_{\parallel p}/\epsilon_m$ from observed values of $\Delta\omega$(sudden change in carrier frequency) and ΔB (sudden change in field strength at an equatorial station) using the appropriate set of diagnostic diagrams (see Fig. 9). The next

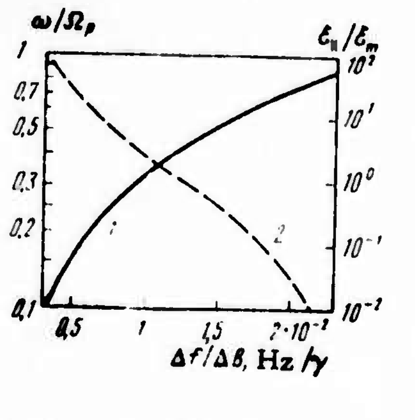

Fig. 9. Relation of ω/Ω_p (1) and $\epsilon_{\parallel}/\epsilon_m$ (2) with $\Delta f/\Delta B$.

step is calculating the L parameter of the generation region by the approximate formula

$$L \approx 5{,}7\left[\frac{\Delta f}{f}\,\frac{10^{5}}{\Delta B_{\gamma}}\right]^{1/4}. \tag{3}$$

In order to determine ϵ_p, information on the repetition period must be included. Finally, from τ, L and ω/Ω_p the energy of resonant protons ϵ_p is evaluated, using the diagnostic diagrams shown in Fig. 6.

Fig. 10 shows the relationship between carrier frequency jump Δf and magnetic impulse ΔB. The dashed line in the figure represents $\Delta f \sim \chi \Delta B$ where $\chi \sim 1.2 \times 10^{-2}$ (Hz/γ).

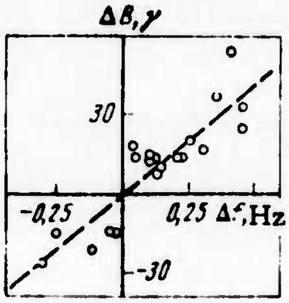

Fig. 10. Dependence of carrier frequency jump of pearls on magnetic pulse amplitude.

The distribution of generation regions of Pc 1 with respect to L parameters is shown in Fig. 11 (lower histogram, dashed line). The figure illustrates results of diagnostics by dispersion analysis as well. The distribution of pearls with respect to average particle energies is shown in Fig. 12 (obtained by both methods). The average energy of resonant protons is $\epsilon_p \sim$ 10-30 keV.

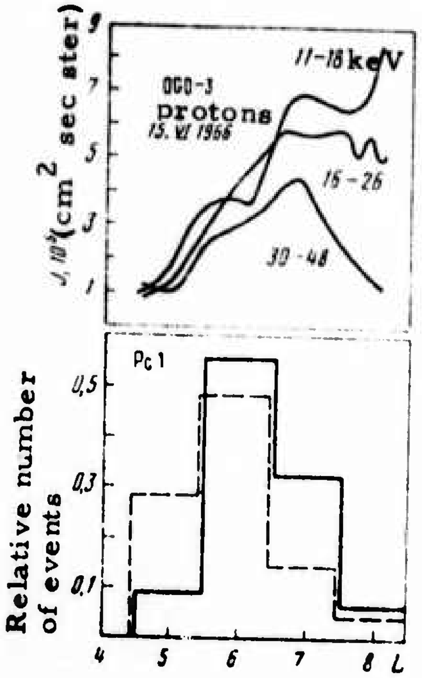

Fig. 11. Distribution of pearls with respect to L shells.

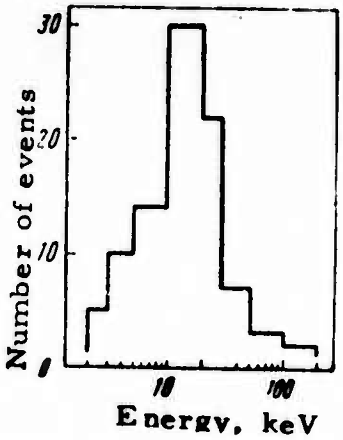

Fig. 12. Energy of resonant protons.

2. Distribution function of energetic protons.

The authors propose a method for the determination of the distribution function of energetic protons from data on pearls. The method is based on the comparison between experimental data on amplification of pearls while passing the active part of the radiation belt $Q = Q_1 + Q_2$ (where Q_1 is amplification factor, Q_2 attenuation factor), and the computed values for different parameters of the distribution function assumed. A preliminary analysis was done using 40 well-developed pearl series with duration of 10-60 min, which were recorded at the Borok, Sogra, Petropavlovsk, Lovozero, and Tiksi stations during 1964-68. The average value of pearl carrier frequency was ~ 0.75 Hz, repetition period about 140 sec. Fig. 13 shows histograms of Q_1 and Q_2. A preliminary estimate of $J\eta$ was made using the formula $Q(\text{db}) \cong 10^{-9} L^4 J\eta$. For $Q = 7.7$ db, $L = 6$ it gives $J\eta \cong 5 \times 10^6 \text{ cm}^{-2} \text{ sec}^{-1}$. At $\eta \gtrsim 1$ this estimate does not conflict with the value obtained by direct measurements of protons with energy of ~ 20 keV.

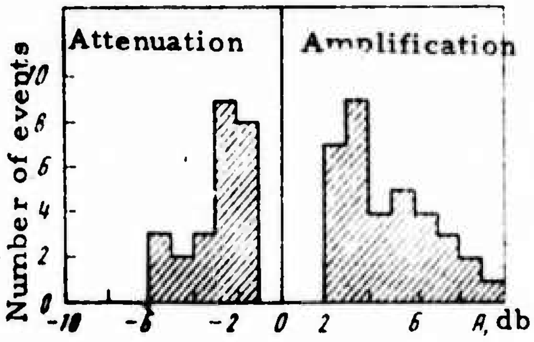

Fig. 13. Distribution of amplification and attenuation factors of pearls.

3. Spectra of fluctuations of auroral electrons.

It is pointed out that for purposes of diagnostics it is necessary to establish correlation coefficients between fluctuation spectra of electron fluxes and spectra of accompanying Pi 1 pulsations.

Nonstationary processes

Information on nonstationary processes in the magnetosphere can be derived from IPDP's. Data on frequency gradients of IPDP are suggested to be used for a tentative estimate of the intensity of electron flux in the radiation belt:

$$E\ (\mathrm{v/cm}) \cong 1.5 \times 10^{-3}\ (df/dt)\ L \qquad (4)$$

Thus, for typical values $f = 10^{-3}$ $\sec^{-2}$ and $L = 6$ the formula gives $E = 10^{-5}$ v/cm. In addition, the estimated "westward frequency drift" of IPDP's enables one to calculate a correction for the above estimate of E, as well as to estimate the energy of protons injected into the magnetosphere during substorms. The typical energy $L\epsilon_p$ of nonstationary drifting particles was estimated to be about 10^2 keV. Thus the occurrence of IPDP's gives evidence for the injection of a new portion of hot protons. The onset of the injection is determined from the occurrence of Pi 1 bursts, which are followed by IPDP's. In addition, it can be assumed that a relatively slow increase of frequency of the structured elements of IPDP's is caused by nonstationarity of the medium through which wave packets propagate. Similar information on the processes in the morning sector of the magnetosphere can be derived from data on auroral agitation.

Furthermore, the relaxation of the magnetosphere in the post-storm period can be monitored by an analysis of slow variations of Pc 1 frequencies (see Fig. 14). According to the theory, nonstationarities of

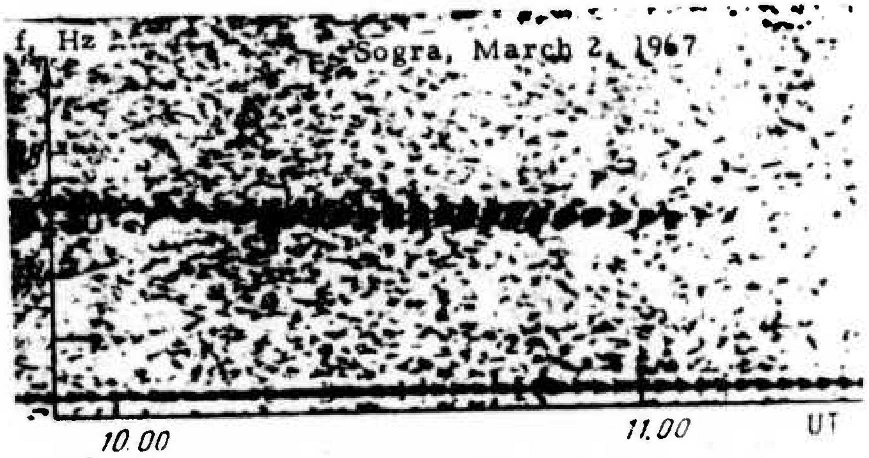

Fig. 14. Decrease of carrier frequency during development of a Pc 1 series.

Pc 1 spectra should make it possible to determine slow drift of the plasmapause from smaller to larger L shells. The relative rate of the frequency decrease of Pc 1 is $\omega/\omega = (-)\ 10^{-4}$ sec^{-1}. For $\omega \sim \Omega_p$ this corresponds to the rate of the plasmapause drift $d\ln L/dt \sim 3 \times 10^{-5}$ sec^{-1}. Some results of calculation are shown in Table 2.

Table 2. Nonstationarity of pulsation spectra

Storm phase	Pulsation type	$\dot{\omega}/\omega$, sec^{-1}	$\dot{L}/L$, sec^{-1}	E, Vcm^{-1}
Main phase	IPDP	$\sim 10^{-3}$	$\sim (-)\ 3\mathrm{x}10^{-4}$	$\sim 10^{-5}$
Recovery phase	Pc 1	$\sim (-)\ 10^{-4}$	$\sim 3\mathrm{x}10^{-5}$	$\sim 10^{-6}$

Fig. 15 shows a plot of $\dot{\tau}/\tau$ vs. $\dot{\omega}/\omega$ for pearls. The figure reveals an inverse proportionality between carrier frequency and repetition period. The fact indirectly proves the hypothesis on the radial drift of the generation region in the course of a Pc 1 series having a nonstationary spectrum.

Another proof of this hypothesis is a direct proportionality between the magnetic index Q and $\dot{\omega}/\omega$, as shown in Fig. 16.

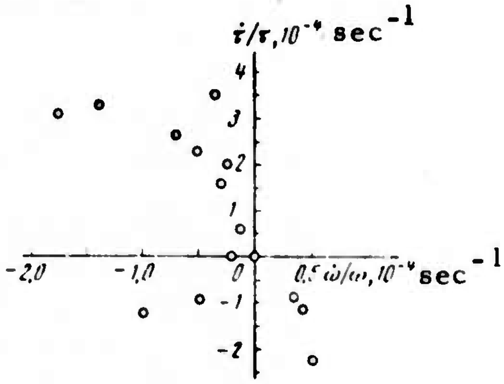

Fig. 15. Relation between $\dot{\omega}/\omega$ and $\dot{\tau}/\tau$ for nonstationary pearls series.

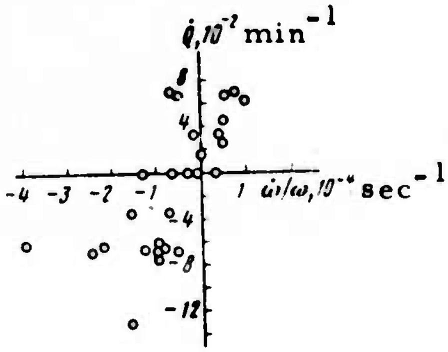

Fig. 16. Relation between $\dot{\omega}/\omega$ of pearls and magnetic activity.

Periphery of the magnetosphere and interplanetary space

1. Magnetopause

Empirical formulas used for the determination of the geocentric distance of the subsolar magnetopause from periods of Pc 3, 4 pulsations have a relatively low accuracy, owing to high data point scatter (see Fig. 17 and Table 3).

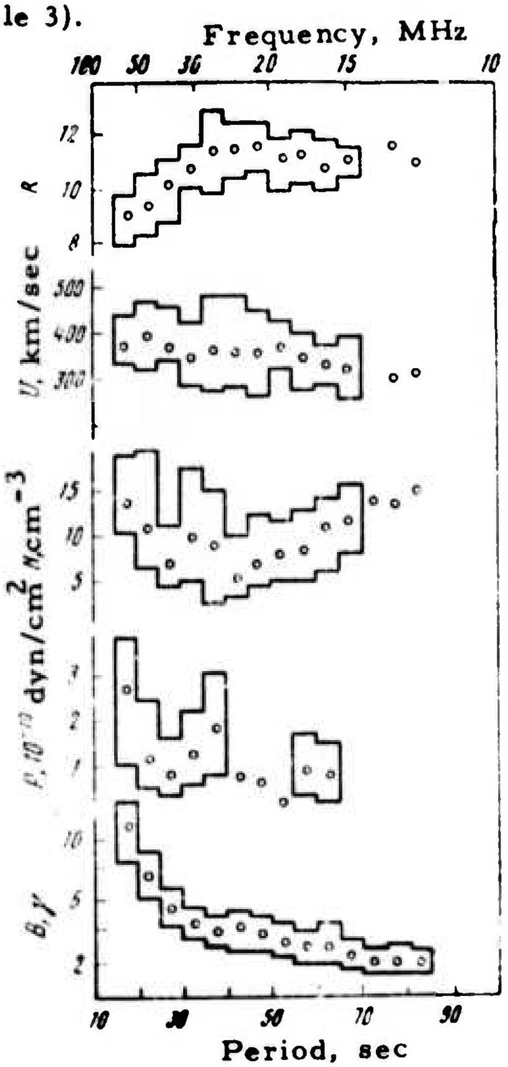

Fig. 17. Dependence of periods of daytime pulsations on the parameters of the near-Earth medium.

Table 3. Correlation between periods of Pc 3, 4 and the parameters of the near Earth medium

Parameter	Correlation coefficient
R	0,58±0,07 (93)
U	−0,47±0,06 (161)
N	0,05±0,08 (150)
P	−0,24±0,09 (98)
B	−0,82±0,02 (165)

However, the results of diagnostics can be improved by utilizing additional information contained in the Kp, AE and Dst magnetic indices.

2. Low-latitude boundary of the auroral zone.

Diagnostics of the low-latitude boundary of the auroral zone can be accomplished by using the dependence of the periods of Pi 2 pulsation on the dimension of the closed nightside magnetosphere. Brief remarks on this technique are made and several pertinent sources cited.

3. Geomagnetic tail.

Observations at the polar caps of waves from the geomagnetic tail could in theory be used for diagnostics of processes in the geomagnetic tail; Pc 2 pulsations are thought to originate in the geomagnetic tail. It is also useful to observe waves in the frequency range of atmospheric whistlers, which can be excited simultaneously with Pi 2's. In addition, a secondary effect of tail oscillations is observed in the auroral zone in the form of Pi 1 bursts. Their repetition period is very probably equal to the period of tail oscillations.

4. Interplanetary magnetic field.

The periods of Pc 3, 4 pulsations are found to be proportional to the strength of the IMF, as illustrated in Fig. 18. Fig. 18 shows a plot of Pc 3, 4 frequencies vs IMF strength based on some 400 measurements. The empirical expression for f (B) derived from these data is

$$f\ (\mathrm{MHz}) \cong 11.8 + 5.1\ B\gamma \qquad (5)$$

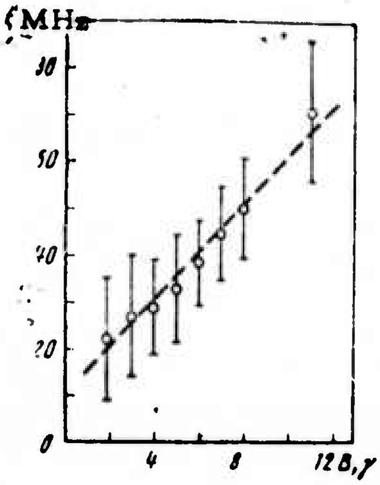

Fig. 18. Frequencies of Pc 2-4 vs. magnitude of IMF.

The reliability of the diagnosis of B can be improved if frequency data are used in conjunction with data on the K_p and AE magnetic indices.

5. Inhomogeneities in the solar wind.

Data on amplitude fading of Pc 3, 4 permit one to deduce the distribution of the directional changes of IMF by $\Delta\varphi = 45^{\circ}$. Fig. 19 shows the distribution of amplitude fading in respect to duration. The average duration of amplitude fading is $t_1 = 6 \times 10^2$ sec, and the average duration of oscillation, $t_2 = 1.8 \times 10^3$ sec. If it is assumed that inhomogeneities propagate toward earth at the solar wind velocity, than $\ell_1 = 2.5 \times 10^{10}$ cm and $\ell_2 = 7 \times 10^9$ cm, giving a value of ℓ_2/ℓ_1 on the order of 3.

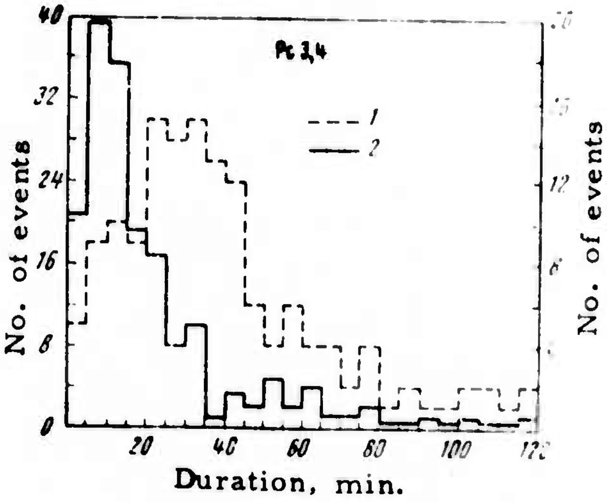

Fig. 19. Distribution of fading (left ordinate) and oscillation (right) duration in Pc 3, 4.

1- oscillation; 2- fading.

Energy of geomagnetic pulsations

The major portion of the energy of geomagnetic pulsations is contained in the natural oscillations of the magnetosphere (Pc 3-5, Pi 2). In a low-pressure plasma the energy of Alfvén and magnetoacoustic waves is $\epsilon = \rho_0 u^2/2 + b^2/4\pi$. The total energy of oscillations in a resonant cavity with volume V is $\epsilon = Vb^2/8\pi$, and the energy dissipation rate is $\epsilon = -\omega\epsilon/Q$. An estimate made for the energy of Pc 5, at $L = 7$, $\Delta L = 1$, $\Delta\omega = 1^o$, $T = 300$ sec, $b = 20\gamma$ and $Q = 10$-20, gives $\epsilon = 3 \times 10^{19}$ erg and $\epsilon = 5 \times 10^{16}$ erg/sec. The energy of the daytime continuous pulsations, at $T = 30$ sec, $b = 5\gamma$, $Q = 10$ and $V = 10^{29} cm^3$, is $\epsilon = 10^{19}$ erg, and $\epsilon = 2 \times 10^{17}$ erg/sec. The figures for nightime Pi 2 pulsations, at $T \approx 100$ sec, $b = 10\gamma$, $Q = 5$, $V = 5 \times 10^{28}$ cm^3, is $E \sim 2.10^{19}$ erg, $\epsilon = 2 \times 10^{17}$ erg, Table 4 gives a comparison between the energies of geomagnetic pulsations and storms.

Table 4. Energies of geomagnetic pulsations and storms

Stored energy ϵ, erg	Energy influx rate ϵ, erg/sec	Energy dissipation rate ϵ, erg/sec	Conversion coefficient χ
$10^{19} - 10^{20}$	Pulsations $10^{16} - 3 \times 10^{17}$	$10^{16} - 10^{17}$	$10^{-3} - 10^{-4}$
$10^{22} - 10^{23}$	Storms 3×10^{18}	10^{18}	3×10^{-4}

The amplitude of pearls and IPDP's in the generation region is tentatively estimated to be about 1 γ

In closing the authors note that many factors contribute to the question of pulsation energetics; these include the spectral makeup of radiation, input energy channel, conversion method, dissipation paths, and space localization of energy. All these factors would have tobe accounted for in a comprehensive treatment of pulsation diagnostics.

Yukhimuk, A. K., A. G. Kasymova, and
A. N. Zavorot'ko. Techniques in the study of
time variations of geomagnetic micropulsations.
IN: Geofiz. sb. AN USSR, no. 56, 1973, 57-62.
(RZhGeofiz, 3/74, no. 3A309) (Translation)

A program has been proposed for computer processing of data on geomagnetic pulsations. Using a Minsk-22 computer, data on Pc 3 and Pc 4 pulsations were processed. It was found that the median values used are more suitable than arithmetical means for study of time variations in the parameters of geomagnetic pulsations.

Prikner, K., Y. Strestik, and K. Dobes.
Frequency-directional analysis of geomagnetic
pulsations. Part II. Pc 3 (Bpc 3) Pulsations.
Stud. geophys. et geod., no. 4, 1973, 337-345.
(RZhGeofiz, 3/74, no. 3A311). (Translation)

Using the method described in Part I of this article (RZhGeofiz, 1973, no. 2A223), records of Pc 3 at the Budkov observatory ($\Phi = 49^{\circ}02'$N, $\Lambda = 69^{\circ}02'$E) were analyzed. Spectral composition, relative amplitude, direction of the major axis and ellipticity of the polarization ellipse, and rotation sense of the pulsation vector were studied for 104 Pc 3 events during the summer months of 1968 and 1969. The average frequency of Pc 3's at the maximum amplitude is 0.039 Hz. The average frequency displays a diurnal variation, from 0.042 Hz in the morning to 0.032 Hz in the afternoon hours. The amplitudes of the main spectral peaks display a diurnal variation, with the maximum of 0.6 γ observed in the forenoon hours. The average ellipticity is ~ 0.26. The average ellipticity for pulsations with a counterclockwise vector rotation is 0.31; with a clockwise rotation, 0.20. The ccw rotation sense prevails in the morning hours, clockwise at the afternoon hours. The average azimuth of the major axis of the polarization ellipse is +4.9°. The azimuth of the major axis displays a diurnal variation from +10.9° in the morning, through +2.6° at the forenoon hours, to +0.1° in the afternoon. The pattern of pulsation behavior, as revealed using the proposed method, concurs well with data of other authors.

Kleymenova, N. G. Further progress in studies of
VLF emissions in the framework of the Soviet-
French experiments at conjugate points. Geofiz. byul.,
no. 26, 1973, 13-19.

The results are summarized of the joint Soviet-French studies on VLF emissions at magnetically conjugate points. Complex geomagnetic studies were begun in 1964 at the Sogra-Kerguelen conjugate point stations. Since 1971, observations have been conducted at two pairs of conjugate stations: Sogra-Kerguelen and Dolgoshchel'ye-Heard. In 1969 observations of VLF emission during substorms at conjugate points were complemented by observation at stations within the 46°E - 130°E longitude range: Dolgoshchel'ye ($\varphi = 66^\circ$N, $\lambda = 46^\circ$E), Noril'sk ($\varphi = 69^\circ$N, $\lambda = 88^\circ$E), and Yakutsk ($\varphi = 61^\circ$N, $\lambda = 130^\circ$E). During this period simultaneous observations on geomagnetic micropulsations with 10-300 sec periods were conducted at Sogra and Dolgoshchel'ye. The purpose of these observations was to study amplitude modulation of VLF emissions by geomagnetic micropulsations, and the relationships between generation of VLF emission and various geomagnetic micropulsations.

During these observations it was noted that some Pi 2 bursts are followed with a time delay of 20 min, by VLF hiss, with a frequency lower than 2kHz. The necessary conditions for this to be observed are the development of Pi 2 at the leading edge of magnetic bays, and location of the Pi 2 source near the meridian of the station. From the delay time between VLF hiss and Pi 2 bursts one can estimate the magnitude of the electrical field in the magnetospheric tail, if VLF hiss is assumed to be generated due to instabilities at or near the plasmapause.

Zhulin, I. A. Microbursts of bremsstrahlung at subauroral latitudes. In-t zemn. magn., ionosfery i rasprostr. radiovoln AN SSSR. M., 1973, 15 p. (RZhGeofiz, 3/74, no. 3A349 DEP). (Translation).

Data on space-time dynamics of microbursts (duration ~0.2 sec, repetition period ~1 sec) obtained during the Soviet-French balloon-borne experiment in the Kerguelen-Arkhangelsk magnetically conjugate regions ($L = 3.8$) in 1968-71, give evidence of the existence of microbursts in the midnight sector, but only equatorwards from the central line of an "instant" auroral oval. As that line shifts equatorwards the balloon recording of microbursts cuts off. The physical interpretation is related to the difference in the hardness of particles penetrating the ionosphere inside and outside the auroral oval, which changes the conditions for excitement of local plasma instabilities. The difference from conclusions of other authors is explained by the fact that the largest amount of data previously known was obtained at L = 6. Thus microburstswere recorded starting from the morning sector where the "instant" auroral oval was situated polewards from the balloon. At midnight the balloon was always within the oval, where microbursts are absent.

Adam, A., Y. Cz. Miletits, and Y. Vero". <u>The micropulsation field in Eastern Europe (results of simultaneous observations in 1969 according to the KAPG program).</u> Acta geod., geophys. et montanist. Acad. sci. hung., no. 3-4, 1972 (1973), 289-304. (RZhGeofiz, 3/74, no. 3A303). (Translation).

Some characteristic [micropulsation] phenomena were investigated. It was shown that in spite of a strong latitude dependence of the period of micropulsations, the magnetotelluric parameters obtained by an analysis of micropulsations are very stable. The latitude dependence of periods does not exclude a harmonic nature of the primary field.

Afanas'yeva, L. T., S. N. Kuznetsov, and O. M. Raspopov. <u>On the relationship of irregular electron fluxes in the magnetosphere with geomagnetic pulsations.</u> IN: Issled. po geomagnetizmu i aeron. avroral'n. zony. (Leningrad, Nauka, 1973, 3-12. (RZhGeofiz, 2/74, no. 2A317). (Translation)

Data from the Elektron 4 satellite obtained from July 11-September 9, 1964 were used for an analysis of the correlation of Pc 4 and Pc 5 pulsations with increase in high-energy electron flux in the remote magnetosphere. Records of the Lovozero station with 6 mm/min and 90 mm/h times bases, and records of the Petropavlovsk station with a 90 mm/h time base, were used for the analysis of Pc 4 and Pi 2 pulsations. Generation of Pc 5 pulsations is typical for intense particle fluxes; excitation of Pc 4 occurs at a medium intensity of irregular fluxes. In the case of weak particle fluxes, Pc 4 pulsations do not occur. Analysis of the behavior of Pi 2 and Pc 5 pulsations permits one to construct a picture of the development dynamics of the "electron islands" drifting toward the day side of the magnetosphere.

Van'yan, L. L., L. A. Abramov, M. B. Gokhberg, and V. L. Yudovich. Hydromagnetic waves directed by the geomagnetic field. IN: Sb. Mezhplanet. sreda i fiz magnitosfery. Moskva, Izd-vo nauka, 1972. 26-32 (RZhMekh, 3/73, no. 3B10). (Translation)

Features are examined of MHD waves propagating in the magnetosphere from finite-dimension sources. It is shown that they clearly correlate with electric currents along geomagnetic force lines. The hypotheses developed give a theoretical basis for interpreting pulsations in polar bays.

Van'yan, L. L., and A. S. Lipatov.
Propagation of hydromagnetic waves in a three-dimensional magnetosphere. I. GiA, no. 3,
1974, 496-501.

A numerical solution was obtained using a hydromagnetic formulation for the three-dimensional nonstationary problem of small oscillations of the cold magnetospheric plasma, which grow during interaction of the solar wind and the magnetopause. Large-scale heterogeneities in the solar wind were represented in the form of plane waves. An open model geomagnetic field as proposed by Mead and Beard (1964) was considered. The oscillation condition was set at a cross-section of the magnetospheric tail at a distance of 20-30 r_E. It was assumed that particles of the cold solar plasma are reflected at the magnetopause, and the pressure at the magnetopause is determined by the Newton formula. The initial value problem was solved by the method of finite differences; solutions were obtained with the BESM-6 computer using ALGOL and AUTO CODE. The time required for computing a single wave passage in the studied region was about one hour; for the case of multiple reflections from the ionosphere, computation time increases to several hours.

Van'yan, L. L., and A. A. Kozhevnikov. Effect of the inclination of the geomagnetic field on reflecting of guided hydromagnetic waves from the ionosphere. GiA, no. 2, 1974, 309-315.

The propagation of three-dimensional guided Alfve'n waves in the magnetosphere was considered for the case in which the geomagnetic field is oblique to the ionosphere. The wave structure was analyzed within 1000 km from the tube of force lines passing through the source. Representing the magnetosphere by a cold plasma and the source by an oscillating electric dipole with extrinsic current perpendicular to the geomagnetic field and located 4-8 R_E from the ionosphere, the authors derive an expression for the index of reflection for an arbitrary angle of incidence.

In the case considered the reflected waves are guided along the same tube of force lines as the incident ones. The reflected wave can be divided into two modes: one associated with Pederson's conductivity with index of reflection

$$N = \frac{\mu_0 \Sigma v_A / \sin \alpha - 1}{\mu_0 \Sigma v_A / \sin \alpha + 1}, \qquad (1)$$

another associated with Hall conductivity. The latter mode represents a force line passing through a lower order source. Therefore near the tube of force lines passing through the source the Pederson term governs mainly the reflected wave. At $\mu_o \Sigma v_A = \sin \alpha$ the index N may represent an imaginary value with small absolute magnitude. In this case multiple reflection of guided Alfve'n waves at conjugate points is impossible. The Hall term falls off with a decrease of α, and in the near equatorial region it does not contribute to the reflected wave.

Gokhberg, M. B., B. N. Kazak, O. M. Raspopov, V. K. Roldugin, V. A. Troitskaya, and V. I. Fedoseyev. Pulsating aurorae at conjugate points. GiA, no. 2, 1970, 367-370.

An analysis is given of pulsating aurorae and geomagnetic micropulsations recorded simultaneously at magnetically conjugate points (Sogra-Kerguelen) during February-April 1968. An example of simultaneous records is shown in Fig. 1. As can be seen in the figure, auroral impulses are always accompanied by geomagnetic pulsations (events A). These

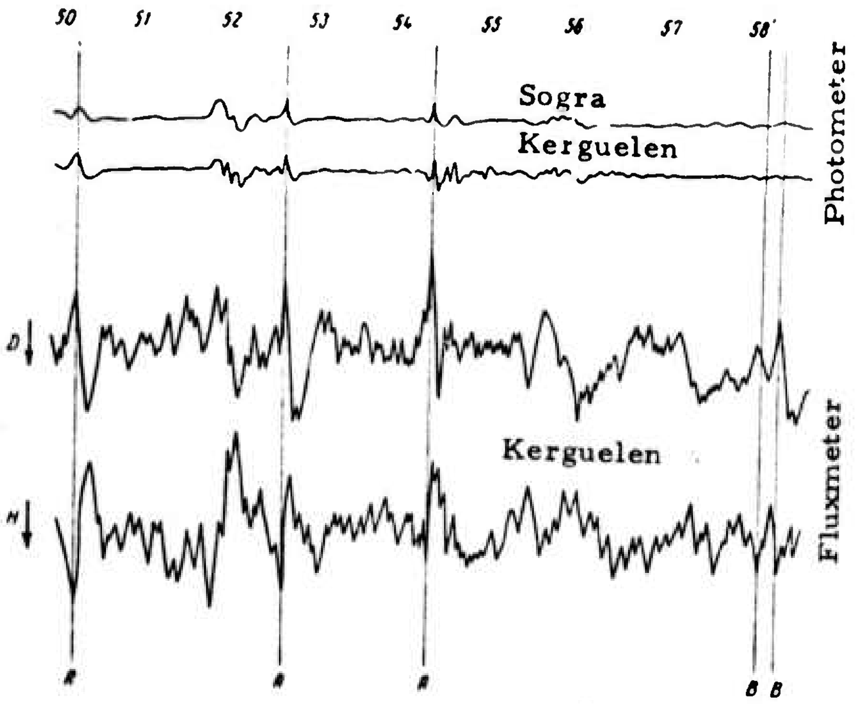

Fig. 1. Micropulsations at Sogra-Kerguelen, 1968.

geomagnetic pulsations are characterized by a linear polarization. However, geomagnetic pulsations which are not associated with auroral pulsations (events B in Fig. 1) are elliptically polarized. Related micropulsation data also registered at Kem' and Loparskaya are shown graphically and briefly discussed.

Gokhberg, M. B., O. A. Pokhotelov, and
Ye. B. Kocharyants. Problem of generation
of continuous pulsations in the geomagnetic field,
DAN SSSR, no. 3, 1971, 568-571.

The conversion of magnetoacoustic waves into hydromagnetic waves occurring at the plasmapause is suggested to be a possible mechanism of generation of Pc 2-3 pulsations. The velocities of hydromagnetic waves propagating meridionally and latitudinally are estimated on the basis of the suggested generation mechanism, and the results are compared to experimental data.

The velocity of h-m waves propagating across geomagnetic force lines at $n_h/n_o = 10^{-1}$ (n_h/n_o = the ratio between densities of hot and cold plasma) is evaluated to be $v_y = 200$ km/sec, which at the earth's surface corresponds to a few tens of kilometers per second in the latitudinal direction. The velocity in the earth-Sun direction is evaluated to be $v_x =$ 20 km/sec; at the earth's surface this corresponds to a few kilometers per second in the meridional direction.

The propagation of Pc 3 wave packets based on the observations of several stations was recorded and examples are illustrated. The velocity of Pc 3 propagation in the latitudinal direction is found to be 50 km/sec, and in the meridional direction, 10 km/sec.

Gokhberg, M. B., O. A. Pokhotelov, S. Perro , N. Wehrilin, and K. Vil'dari . Nonlinear interaction between ion-cyclotron waves in the magnetosphere. ZhETF P, v. 18, no. 9, 1973, 554-557.

Nonlinear interaction between pearl type h-m waves in the magnetosphere is analyzed, using data from fifteen events observed at Sogra in 1971.

The results of a spectral-time analysis are shown in Figs. 1-4. The analysis shows that nonlinear interaction of pearl-type h-m waves appear as periodic energy exchanges between initial waves and satellite waves with period $\tau = (2\text{-}3)\ T$. At small phase shifts between initial and satellite waves ($\Delta f_s = 0.02$ Hz), energy exchange occurs fairly rapidly, while at large phase shifts ($\Delta f_s = 0.16$ Hz) it occurs slowly (see Fig. 4).

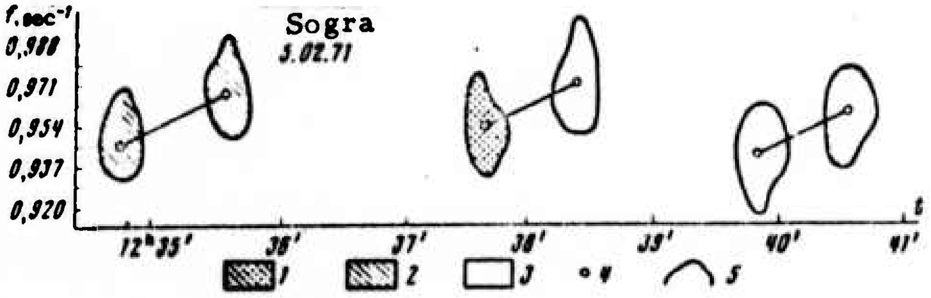

Fig. 1. Spectral-time analysis of a pearl series.
1- $H^2_{max/f} > 25\ m\gamma^2$ sec; 2- $H^2_{max/f} > 10\ m\gamma^2$ sec;
3- $H^2_{max/f} > 3\ m\gamma^2$ sec; 4- H_{max}; 5- $H = H_{max}\ e^{-1/2}$.

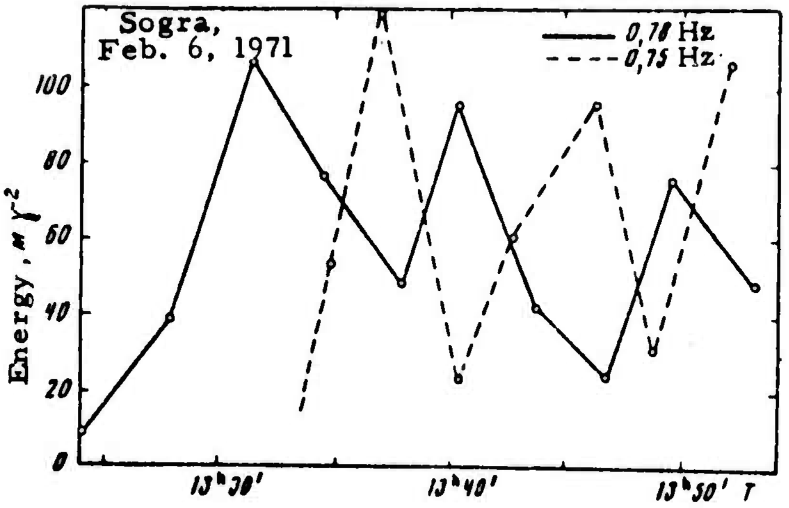

Fig. 2. Fluctuation in amplitudes of initial and satellite waves (Δf = 0.03 Hz)

solid line - initial wave, dashed line - satellite wave.

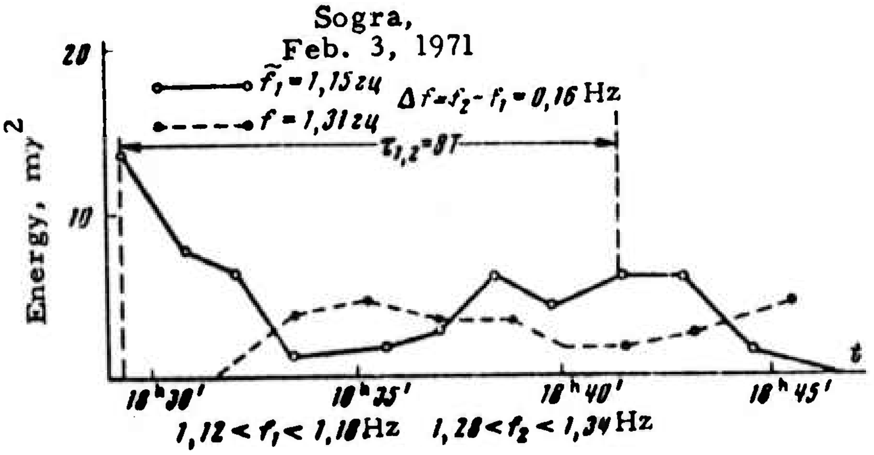

Fig. 3. Fluctuation in amplitudes of initial and satellite waves (Δf = 0.16 Hz).

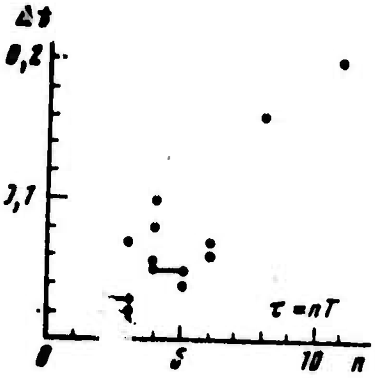

Fig. 4. Dependence of the characteristic period of energy exchange on phase shift.

Kalisher, A. L., A. N. Popov, S. I. Solov'yev, and S. A. Chernous. Characteristics of latitudinal distribution of Pi 1 geomagnetic pulsations. GiA, no. 2, 1974, 328-331.

This analysis was made using data obtained at Borok, Sogra, Lovozero, Observatory "A" ($\phi' = 65.4^\circ$; $\Lambda' = 132.6^\circ$), Cape Zhelaniye, and Heiss Island during the Omega 2 experiment in February-March 1971. The data include 26 events observed at $K_p < 4$ and 11 events at $K_p > 4$.

The latitudinal distributions of Pi 1 amplitudes are shown in Fig. 1. The maximum is seen to fall between 58° and 68°, depending on geomagnetic activity. A comparative analysis shows that this maximum is related to the position of the equatorward boundary of the auroral oval and to pulsating auroras. Fig. 2 shows the ratios of the Pi 1 amplitudes at Borok and Heiss Island (A_B/A_H) for different geomagnetic activities.

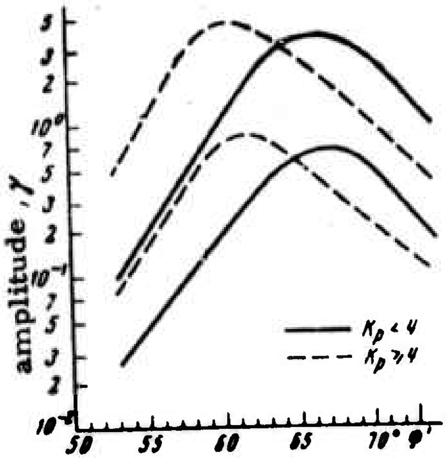

Fig. 1. Pi 1 amplitude vs. latitude.

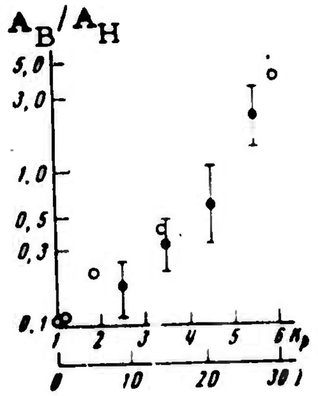

Fig. 2. Comparative Pi 1 amplitudes.

● - A_B/A_H; o - pulsating auroras at Sogra.

The authors conclude that the maximum in the latitudinal distribution of Pi 1 pulsations is associated with the region of direct precipitation of fluctuating electron streams. A further tentative conclusion was made that Pi 1 pulsations contain information on the position of the inner boundary of the plasma sheath in the magnetosphere.

Mal'tsev, Yu. P., S. V. Leont'yev, and V. B. Lyatskiy. Generation and normal modes of Pi 2 pulsations. GiA, no. 1, 1974, 124-131.

A generation mechanism is proposed suggesting that Pi 2 pulsations originate as eigen oscillations in auroral field lines, being initiated by a current system set up in the ionosphere as an impulse response to the influx energy from the tail of the magnetosphere. Resonant oscillations of a magnetic force tube, defining in the ionosphere two regions of high conductivity, were studied by two methods: a) an approximate method based on the analogy between guided Alfve'n waves and a bifilar line connecting two ionospheric regions (see Fig. 1a), and b) a wave method (Fig. 1b).

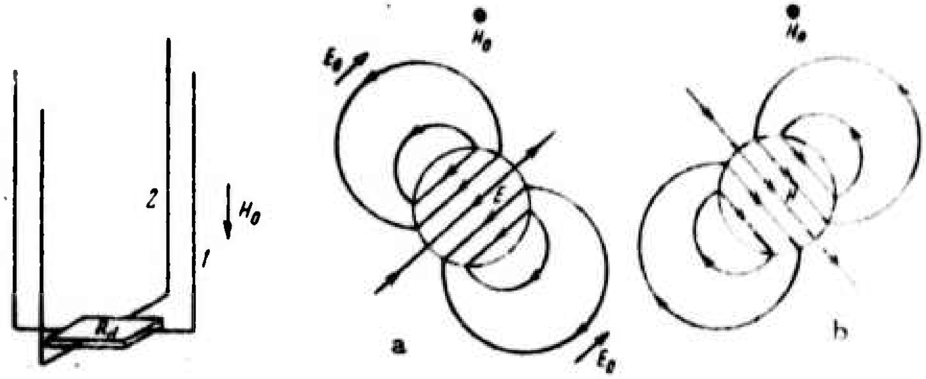

Fig. 1. Models for Pi 2 pulsation study.

The expression for normal modes of the resonator derived by the approximate method is

$$\frac{\omega}{\omega_0} = 2m + \frac{2i}{\pi}\,\mathrm{arth}\left(\frac{\Sigma_P - i\Sigma_H}{\Sigma_w}\right), \qquad (1)$$

where m = 0, ± 1, ± 2, ... Σ_P, Σ_H are the Pedersen and Hall conductivity in the ionosphere, and Σ_ω is conductivity in the magnetosphere.

The expression derived by the wave method for the case of a homogeneous ionosphere (resonator in the form of a circular cylinder) is:

$$\frac{\omega}{\omega_0} = m + \frac{1}{\pi}\arg R - \frac{i}{\pi}\ln|R| = m + \frac{2i}{\pi}\,\mathrm{arth}\,\frac{\Sigma_A}{\Sigma_P}. \qquad (2)$$

where $R_N = R_S = R$ is reflection coefficient at the north and south ends of the resonator; arg R is equal to the angle of rotation of the vector of the wave electrical field during its reflection from the ionosphere. Behavior of the normal modes of the resonator and of the wave polarization in the horizontal plane as a function of ionospheric characteristics is illustrated.

An analysis of resonance oscillations in the case of an inhomogeneous ionosphere (resonator in the form of an elliptical cylinder) shows that even quite extended inhomogeneities can be a source of elliptically polarized waves (ellipse axis ratios a/b = 6-37). It was also noted that the wave polarization does not depend on the magnetospheric parameters.

Raspopov, O. M., V. K. Koshelevskiy,
and G. V. Starkov. Relationship of dynamic
spectra of Pi 2 geomagnetic pulsations and
motion of auroral formations. GiA, no. 2,
1974, 332-336.

A study of the relationship between spectral composition of Pi 2 pulsations and motion of auroral formations was performed, using observations made during the March 5-10 1970 magnetic storm. An estimate of the large-scale electric field responsible for the occurrence of aurorae was made, using data on Pi 2 pulsations associated with a substorm of March 8, 1970.

The motion of auroral formations as observed at the Borok Station during the break-up phase of a substorm on March 8 is shown in Fig. 1. The figure also shows change in spectral composition

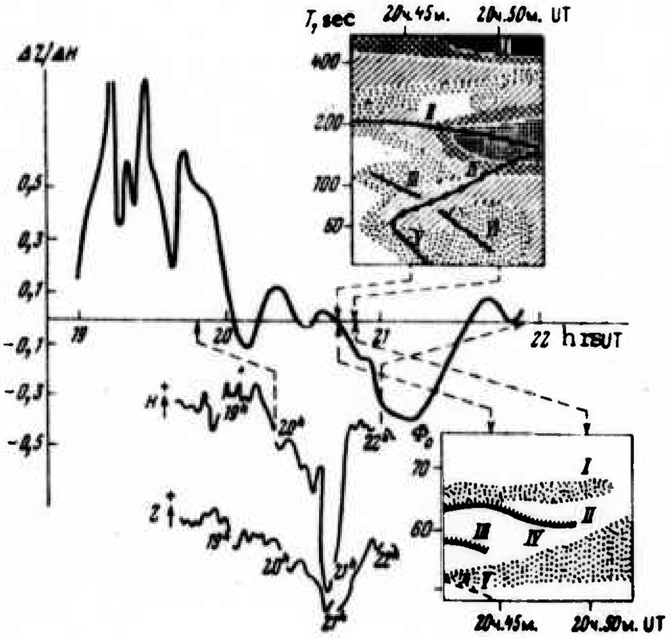

Fig. 1. Pi 2 behavior during breakup of substorm.

of Pi 2 pulsations observed during the same time interval. This experimental pattern of spectral composition was found to follow closely the theoretical one.

The values of the large-scale electric field calculated from rates of Pi 2 period decrease are found to be:

Time:	2040-2052 UT	2052-2059 UT	2058-2103 UT	2103 UT and later
E [V/cm]:	$0.5\text{-}0.7 \times 10^{-4}$	$1.3\text{-}2.0 \times 10^{-4}$	2.0×10^{-4}	$0.5\text{-}0.7 \times 10^{-4}$

Fig. 2 illustrates the motion of three simultaneously observed auroral arcs and corresponding dynamic spectrum of a Pi 2 train that occurred on November 18, 1968 at a moderate magnetic activity [Koshelevskiy et al., 1972]. The large-scale electric field estimated from data on these events was found to be $E = 0.6 \times 10^{-5}$ V/cm.

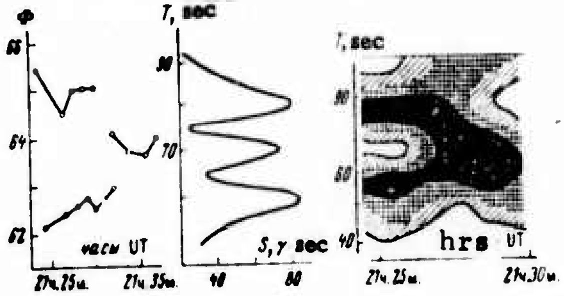

Fig. 2. Pi 2 spectrum and auroral arcs, Nov. 18, 1968.

Afanas'yeva, L. T., S. N. Kuznetsov, and
O. M. Raspopov. On the relation of irregular
electron fluxes in the magnetosphere to geomagnetic
pulsations. IN: Issledovaniya po geomagnetizmu i
aeronomii avroral'noy zony, Leningrad, Izd-vo
Nauka, Leningradskoye otdeleniye, 1973, 3-12.

The relations between high-energy electron fluxes (E > 60 keV) in the magnetosphere and Pc 4, Pc 5 and Pi 2 micropulsations are analyzed. Data used included daytime observations of the Elektron 4 satellite made from 11 July to 9 September 1964, as well as observations from 23 auroral stations. It was found that there does exist a correlation between "electron islands" in the quasitrapping region in the magnetosphere and Pc 5 (Figs. 1 and 2) and Pi 2 pulsations (Figs. 3 and 4). Such a correlation is not however found for Pc 4 pulsations.

The following pattern of the dynamics of "electron islands" was inferred (see Fig. 5): Generation of electrons with energies of several tens up to several hundreds of keV takes place within the inner part of the auroral zone during development of geomagnetic disturbances in the night magnetosphere. Pi 2 micropulsations are an indicator of the onset of that process. The electron islands begin drifting toward the morning magnetosphere. They may be deflected toward larger equatorial distances from action of the magnetic disturbance field. Disintegration of the electron islands starts in the morning hours, and is manifested both by electron injection into the lower ionosphere, and by generation of Pc 5 pulsations.

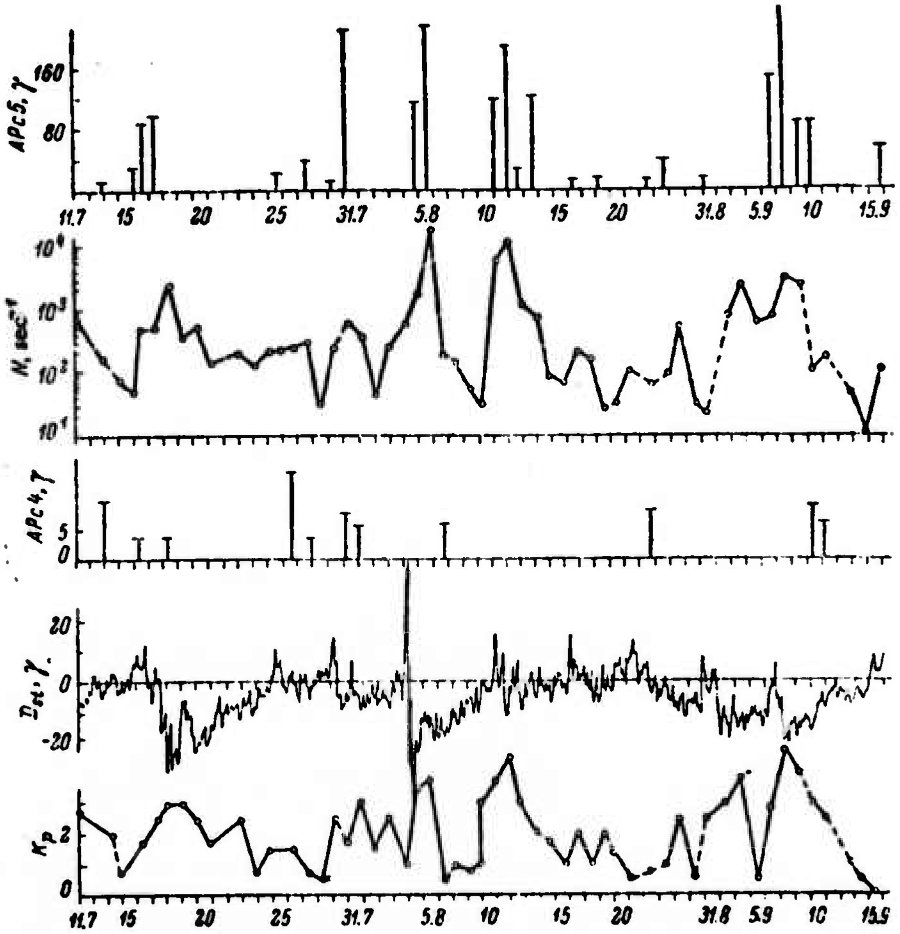

Fig. 1. Schematic comparison of time variations in the maximum electron count rate in the quasitrapping region on the day-side of the magnetosphere, and the maximum amplitude of Pc 4 and Pc 5 pulsations in the auroral zone.

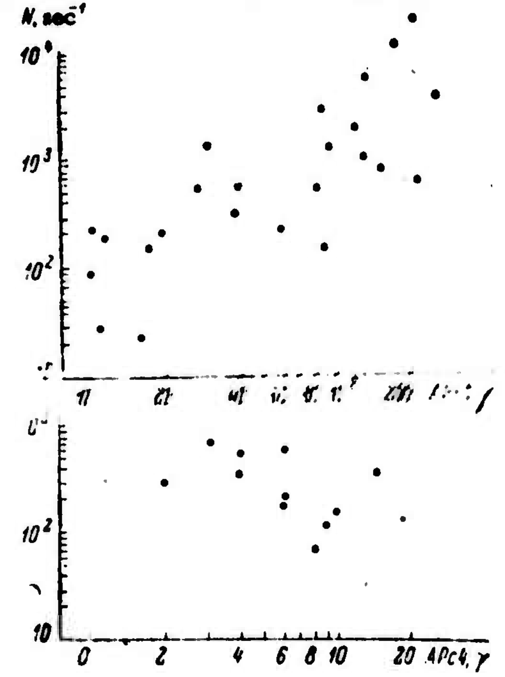

Fig. 2. Relation between amplitude of Pc 5 and Pc 4 miropulsations and electron count rate.

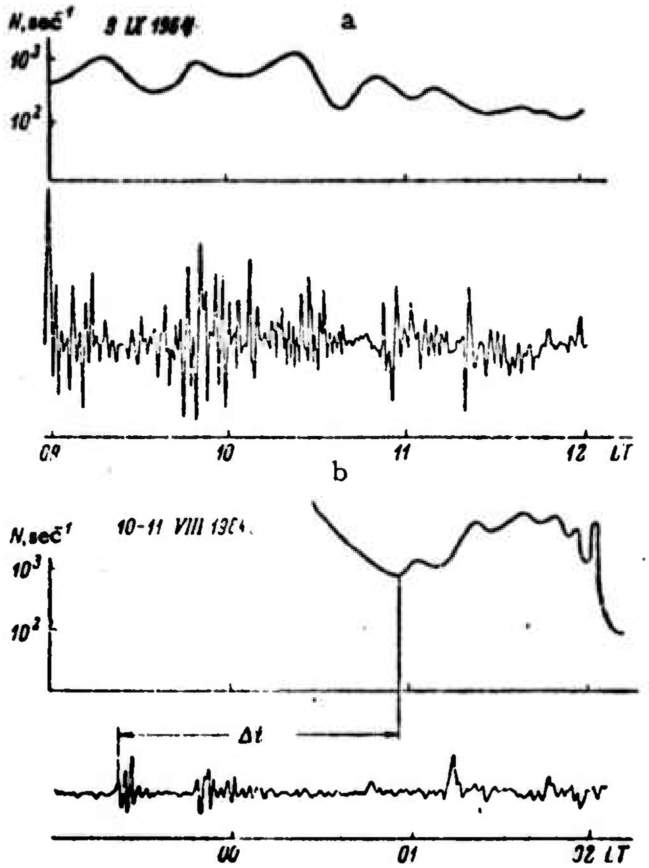

Fig. 3. Comparison of electron count rate and Pc 5 record (a) and time delay Δt between Pi 2 generation in the night magnetosphere and electron count rate in the day magnetosphere (b).

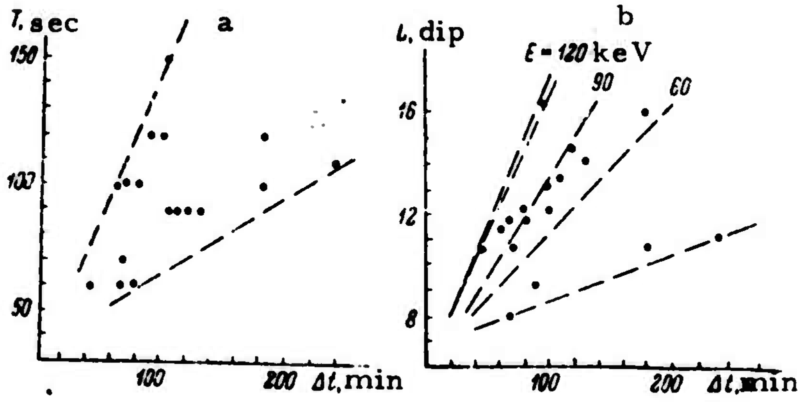

Fig. 4. Delay time Δt vs. L parameter (a) and Pi 2 period (b).

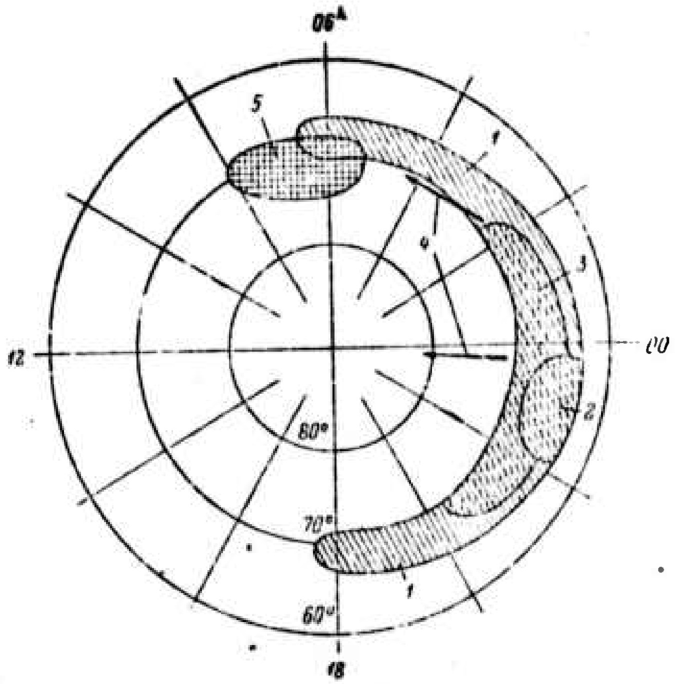

Fig. 5. Dynamics of the development of "electron islands".

1- auroral electrojet; 2- generation region of Pi 2; 3- generation region of electron islands; 4- drift direction of electron islands; 5- generation region of Pc 5.

Danilov, A. A., A. S. D'yakonov, S. O. Morozova, and V. T. Novikova. On solar plasma flows, responsible for recurrent geomagnetic disturbances. IN: Issled. po geomagnetizmu, aeron. i fiz. Solntsa, no. 37, 1973, 19-32 (RZhGeofiz, 11/73, no. 11A331). (Translation)

A long sequence of geomagnetic disturbances observed in 1962-64 is analyzed, together with data of the neutron supermonitor in

Deep River and contour maps. Recurrent storms of the observed sequence occurred every 27 days throughout 28-30 solar rotations; Forbush decreases were not always observed and were localized within two regions having epicenters at heliolatitudes $+7^{\circ}$ and 0°. During that period, stable active structures occurred only in the northern solar hemisphere. The conclusion is drawn that there are two types of solar plasma flows responsible for recurrent geomagnetic disturbances. The first type consists of corpuscular streams flowing out from the solar active regions; the second types are those formed during expansion of the solar equatorial region.

Chernous, S. A., L. N. Baranskiy, L. T. Afanas'yeva, and A. N. Popov. *Irregular geomagnetic pulsations during the breakup phase of a substorm.* IN: Probl. izuch. i osvoyeniya prirod. resursov Severa, Apatity, 1973, 99-111 (RZhGeof, 12/73, no. 12A329) (Translation)

Evolution of Pi 2 and Pi p irregular geomagnetic pulsations was studied using data of a meridional station chain ($32.6^{\circ} \leq \Phi \leq 74.3^{\circ}$ and $114^{\circ} \leq \Lambda \leq 147^{\circ}$). A close relation was shown between the generation of irregular pulsations and auroral phenomena. The results are given of a comparison between irregular pulsation and phenomena in the magnetospheric tail. Pi 2 and Pip pulsations correspond to two different stages of the breakup phase of a substorm. The results obtained are discussed from the viewpoint of their theoretical and practical applications.

Dobes, K., K. Prikner, and J. Strestik. Frequency-directional analysis of geomagnetic pulsations. Part I. The method. Stud. geophys. et geod., v. 17, no. 3, 1973, 240-244 (RZhGeofiz, 12/73, no. 12A330). (Translation)

A new method is proposed for spectral analysis by means of computers, which is suitable for the study of a plane stationary oscillatory event. The method is based on the knowledge of spectra of two perpendicular components of amplitude - time records, and is intended for the study of fine structure of short-period pulsations. Records of some Pc 3 pulsations made at Budkov Observatory (Czechoslovakia) have been processed. The method makes it possible to obtain a quantitative representation of frequency content, energy distribution, ellipticity of polarization ellipses, orientation of the major axis of ellipses, and rotation sense of the disturbance vector for each spectral peak. It also makes it possible to conduct an analysis of statistical relationships between line structures of different types of geomagnetic pulsations.

Baranskiy, L. N., J. A. Plyasova-Bakunina, K. R. Ramanudzhachari, L. V. Sobolev, and V. I. Selivanov. Intensity distribution of Pc 3-4 pulsations along a geomagnetic meridian. GiA, no. 6, 1973, 1092-1097.

Observations of 12 stations located along the geomagnetic meridian $\Lambda' = 130^\circ$ within the latitude range $\Phi' = 7\text{-}74^\circ$ (see Fig. 1) were analyzed. Data on Pc 3 included 93 3 to 5 minute events out of 12 series; on Pc 4, some 40 out of 10 series. The intensity of geomagnetic pulsations was taken to be $(H^2_{NS_{max}} + H^2_{EW_{max}})^{1/2}$.

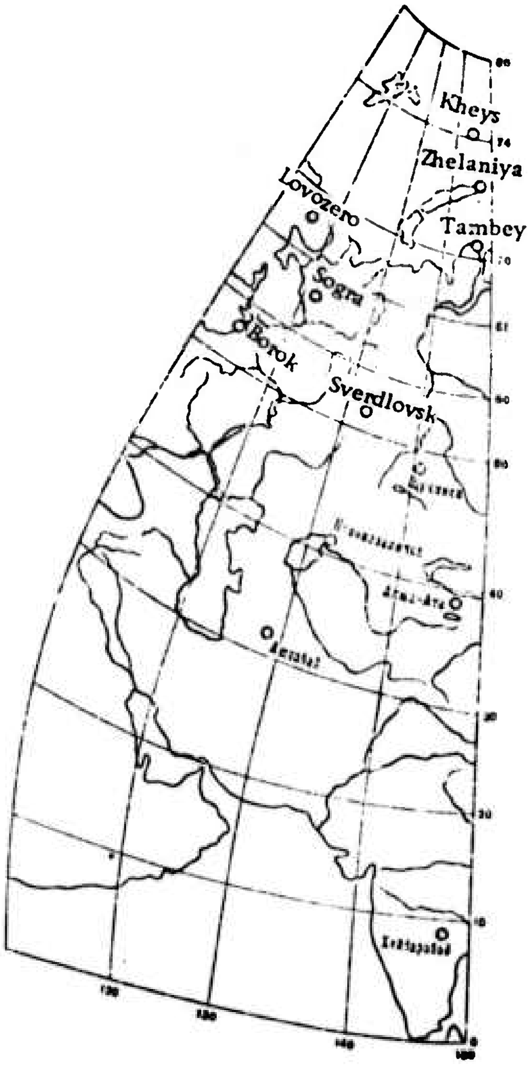

Fig. 1. Recording stations.

The distributions of the average normalized intensity of Pc 3 pulsations along the geomagnetic meridian for different UT intervals are shown in Fig. 2. The intensity of Pc 3 was found to have two maxima: a major one at the morning hours at the M. Zhelaniya station, and a minor one in the daytime hours at the Sogra station. Only the position of the daytime maximum was found to be correlated to the geomagnetic activity.

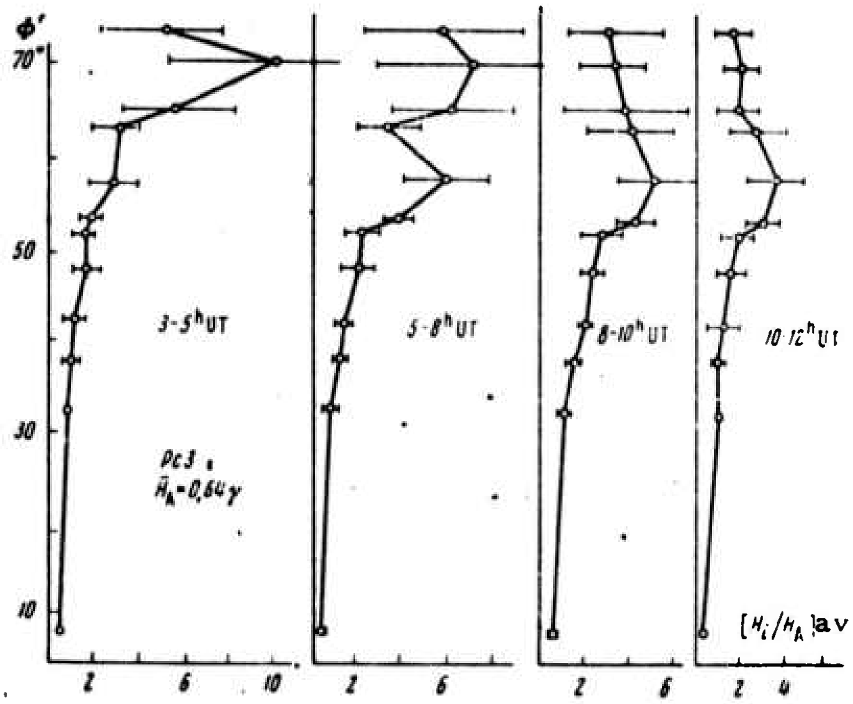

Fig. 2. Pc 3 variation with UT.

The analogous distributions of the average normalized intensity of Pc 4 pulsations along the geomagnetic meridian for different UT intervals are shown in Fig. 3. As seen in Fig. 3 the major maximum is observed at the M. Zhelaniya and Kheys (Heiss) Island stations throughout 1000 UT, while the minor one occurs at the Sogra and Borok Stations. After 1000 UT the major maximum is most probably located near the Lovozero station. As with Pc 3 pulsations, only the position of the daytime maximum for Pc 4 depends on the geomagnetic activity (Fig. 3).

The results were interpreted as supporting the hypothesis of an extramagnetospheric origin of Pc 2-4 pulsations. It is stressed that the L (K_{pm}) obtained is very similar to $L(K_{pm})$ for the plasmapause (Carpenter, 1967).

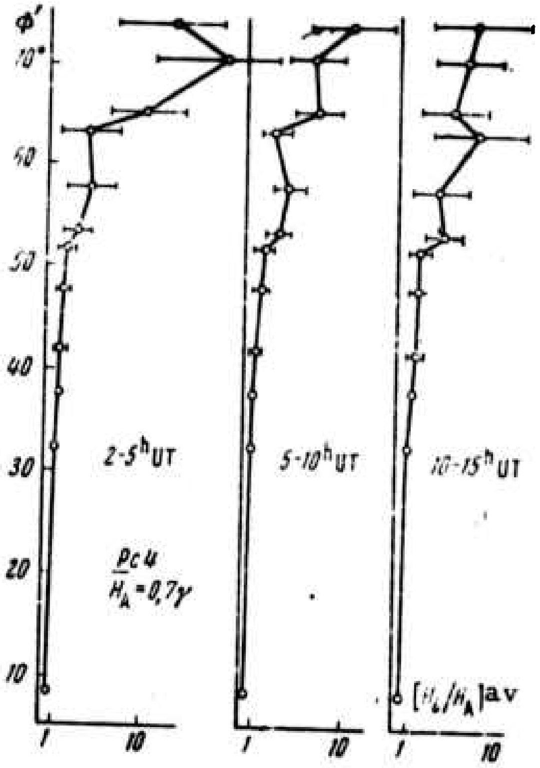

Fig. 3. Pc 4 variation with UT.

Kopytenko, Yu. A., and O. M. Raspopov. <u>Effect of magnetosphere structure on the behavior of the periods of continuous pulsations.</u> GiA, no. 6, 1973, 1087-1091.

Periods were analyzed of Pc 4 pulsations, observed simultaneously at the Lovozero and Borok stations during 1961-63 (IQSY). The cold plasma density in the magnetosphere was then diagnosed using data on Pc 4 pulsation periods.

The periods of Pc 4 pulsations at Borok were found to be stable and to have typical values of $T_B = 60$ sec, while those at Lovozero tended to vary significantly and to have typical values of $T_L = 80$ sec. Furthermore, well developed series of Pc 4 pulsations were observed at middle latitudes, when at the same time Pc 4 pulsations were absent at high latitudes.

The distributions of Pc 4 pulsations with respect to $\Delta T = T_L - T_B$ are shown in Fig. 1, for four different levels of geomagnetic

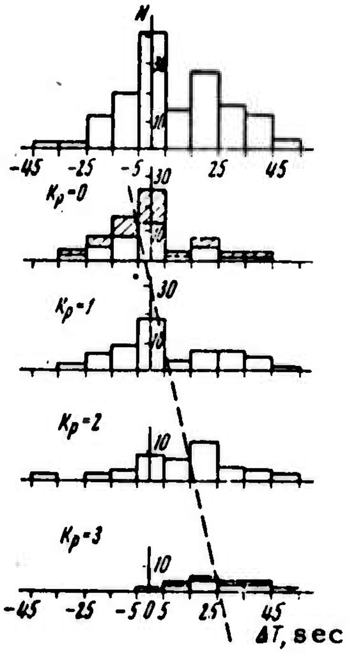

Fig. 1. Distribution of Pc 4 pulsations.

activity. The relationship between ΔT and geomagnetic activity is characterized by the following set of ranges:

1. $\Delta T > 0$, $k_p \geq 2$, $D_{st} \cong (-)10\gamma$ to $(-)20\gamma$;

2. $\Delta T = 0$, $k_p \sim 1$, $D_{st} \approxeq (-)5\gamma$ to $+5\gamma$;

3. $\Delta T < 0$, $k_p \sim 0\text{-}1$, $D_{st} \approxeq 0\gamma$ to $+10\gamma$.

The corresponding regression equations are:

$$\Delta T = 10\, k_p - 3 \text{ and } \Delta T = 5 - 1.2\, D_{st}.$$

The events observed only at one station occurred at $k_p \simeq 2\text{-}4$ and $D_{st} \simeq 10\gamma$.

The distributions of Pc 4 pulsations with respect to periods are shown in Fig. 2 for different ΔT (a-c), for events observed only at one station (d) and for all events (e).

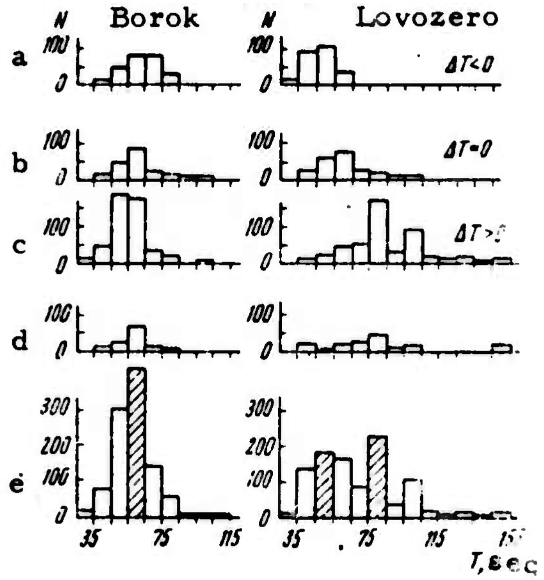

Fig. 2. N(T) for Pc 4.

The various ΔT values, the dependence of ΔT on geomagnetic activity and the stable T_B values observed were explained to be due to at least two regions of Pc 4 generation. The cold plasma density, and consequently the periods of Pc 4 pulsations in these regions, are differently affected by geomagnetic disturbances.

The latitude dependence of transit times, i.e. periods of Pc 4 pulsations, is shown, as calculated from experimental data on plasma density in the equatorial plane of the magnetosphere and assuming an R^{-3} power law for the distribution of plasma density along a magnetic field line. The results of calculations agree approximately with experimental data on ΔT.

Yelfimov, A. G., and F. M. Nekrasov.
Behavior of the spectra of Alfve'n oscillations, excited by decay instabilities. ZhTF, no. 1, 1974, 16-21.

The evolution is considered of the spectra of Alfve'n waves excited by decay instabilities, and their dependence on initial conditions. The problem is solved for Alfve'n waves in plasma with background magnetoacoustic waves, both with and without dissipative effects taken into account. The instability criteria for different initial and boundary conditions were determined as well as the stabilization time for spectra.

It was found that when dissipation is low, energy transfer into the high-frequency portion of spectra occurs. As high harmonics are excited, spectrum stabilization begins and stationary spectra are established in a time t_a, determined by the formulas

$$\left.\begin{aligned} \left| t_a \frac{k_\parallel^2 c^2}{32\pi\sigma}\left[a_0(q) + 1 + \frac{c_s^2}{c_A^2}\right]\right| &\sim 1, \\ \left| t_a \frac{k_\parallel^2 c^2}{32\pi\sigma}\left[b_2(q) + 1 + \frac{c_s^2}{c_A^2}\right]\right| &\sim 1. \end{aligned}\right\} \qquad (1)$$

where $a_0(q)$ and $b_2(q)$ are eigen values of Mathieu functions.

Fel'dshteyn, Ya. T. Variations of magnetic field in interplanetary space and at the earth's surface. VAN, no. 8, 1973, 15-27.

A review is given on results of the study of relationships between the interplanetary magnetic field and different types of geomagnetic variations. The article summarizes the relationships between the interplanetary magnetic field and the diurnal variations of the vertical component of geomagnetic field in the polar cap regions, and DP 1 and DP 2 variations as discovered by Soviet and Western scientists during recent years from ground-based and satellite-borne observations.

It is pointed out that the established relationships enable one to determine direction and intensity of the IMF from ground-based observations of variations of the Z-component of the geomagnetic field in the polar cap regions.

Geomagnitnyye pul'satsii (Geomagnetic pulsations). Moskva, Izd-vo nauka, 1973, 93 p. Van'yan, L. L., L. A. Abramov, L. S. Al'perovich, M. N. Berdichevskiy, M. B. Gokhberg, A. S. Debabov, N. A. Mershchikova, I. L. Osipova, Yu. G. Turbin, and V. A. Yudovich.

Introduction

This monograph gives a theoretical study on excitation of the magnetospheric resonator and penetration of pulsations through the lower ionosphere to the Earth's surface, considered in terms of electrodynamics. An electric dipole was selected as a basic type of source generating hydromagnetic pulses and exciting magnetospheric resonance. The monograph is intended for researchers and graduate students in geophysics.

Table of Contents

Gringauz, K. T., V. A. Troitskaya, E. K. Solomatina, and R. V. Shchepetnov. Variations of solar wind fluxes and pulsations of the Earth's electromagnetic field induced by them. GiA, no. 4, 1970, 569-574.

Preliminary results are described of an analysis of solar wind data recorded by Venera-5 and Venera-6 space vehicles during January 21 - March 21, 1969, together with data on Pc geomagnetic pulsations and short-period magnetic disturbances recorded at the Borok station.

The variations of the solar wind flux observed by Venera-5 together with variations of E_d index observed at Borok during February 25-28, 1969 are shown in Fig. 1.

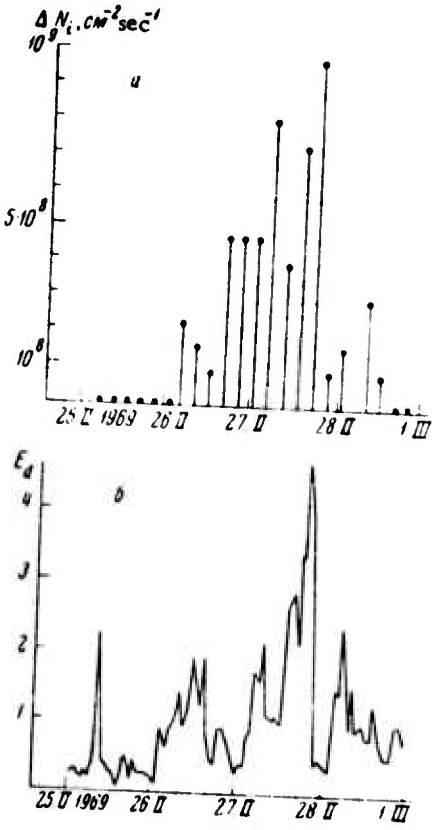

Fig. 1. Comparison of solar wind flux (a) with E_d index (b).

The analysis shows that for all increased solar wind flux observed ($\Delta N_i \geq 3 \times 10^8 \text{ cm}^{-2} \text{sec}^{-1}$) there is a corresponding increase in pulsation amplitudes of the Earth's electromagnetic field ($E_d \geq 1$). Furthermore, it was suggested that during February 25-28 at least two shock fronts affected the magnetosphere.

Ralchovski, T. M. Dispersion characteristics of atmospheric whistlers during increased geomagnetic activity. DAN B, no. 7, 1973, 875-878.

Measurements of the dispersion of atmospheric whistlers during relatively weak geomagnetic storms registered at the Sofia Observatory during October 1970 - June 1971 are analyzed. The relationships between the dispersion of atmospheric whistlers and k_p index and f0F2 were considered.

The variations of the whistler dispersion D, k_p index and f0f2 during geomagnetic storms are shown in Fig. 1. It can be seen that the whistler dispersion begins decreasing 3-4 days prior to the main phase of a geomagnetic storms and reaches a minimum from the main phase to 3-4 days after it.

The dependence of dispersion D on k_p index is given by the empirical expression $D = -1.1 k_p + 58.5$. However, D and f0F2 were found to be uncorrelated.

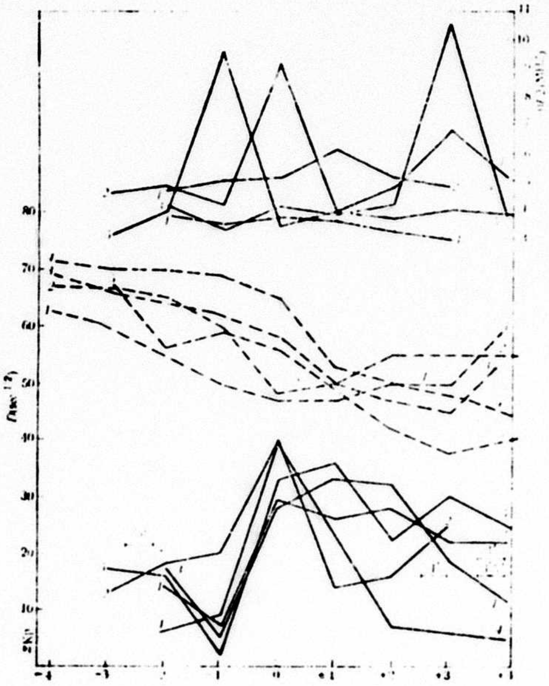

Fig. 1. K_p, D and f0F2 behavior during a geomagnetic storm.

Gul'yel'mi, A. V., and V. A. Troitskaya.
Geomagnitnyye pul'satsii i diagnostika
magnitosfery (<u>Geomagnetic pulsations and
diagnostics of the magnetosphere</u>). Moskva,
Nauka, 1973, 208 p. (RZhGeofiz, 1/74,
1A334 K). (Translation)

In the cosmic plasma surrounding the Earth there exists a wide spectrum of electromagnetic waves. Geomagnetic pulsations are ultralow-frequency waves observed on the earth's surface. The present book is devoted to the results of experimental and theoretical studies of such pulsations. Principal properties of pulsations are briefly described, and data on the relationships between these properties and the structure and dynamics of the magnetosphere are presented. Present concepts of the physical nature of geomagnetic pulsations are stated, and problems of the interpretation of various pulsation types are discussed. An account is given of the methods and results of diagnostics of the magnetosphere and of interplanetary space using data from ground-based observations on pulsations. Prospects of this new trend in research are evaluated.

Borod'ko, V. N. Theory of propagation of electromagnetic and hydrodynamic waves in a stratified atmosphere. IN: Sbornik. Vzaimodeystviye izlucheniya s veshchestvom. Moskva, 1972, 177-180. (RZhF, 6/73, no. 6Zhl02). (Translation).

Propagation of electromagnetic waves in a plane- stratified medium is considered, for the case of an arbitrary directivity of the e-m field relative to a boundary layer coordinate. The variation of all parameters along that coordinate is presented in the form of a Fourier integral, after which the standard wave equation is obtained for the determination of wave vectors. A solution for the corresponding boundary problem is given for a three-layer model. Standard matching of solutions at the boundaries of each homogeneous medium makes it possible to find field amplitudes.

Troitskaya, V. A. Investigations in geomagnetic conjugate regions. VAN, no. 9, 1973, 82-87.

A general review is given of the results of joint French-Soviet studies of geomagnetic, auroral and other magnetospheric phenomena in geomagnetic conjugate regions, which were reported at the March, 1973 symposium in Paris. Systematic joint studies were initiated in 1961-63 at the Sogra-Kerguelen conjugate points and later were complemented by particular experiments such as studies at two pairs of conjugate points, Omega 1 (1970) and Omega 2 (1972).

The conjugacy and the latitudinal distribution of amplitudes of Pc 3, Pi 2 and Pc 1 pulsations are reported to be affected by the position of the plasmapause. The conjugacy is most pronounced when the force line connecting conjugate points is within the plasmasphere. A second maximum in the latitudinal distribution of amplitude of Pc 3 and Pi 2 pulsations is also associated with the location of the plasmapause. The occurrence rate of IPDP's was found to be considerably larger in the auroral than in the subauroral zones. Frequency-amplitude analysis of Pc 1 pulsations has revealed two stages in their development: pseudosaturation with occurrence of so-called satellites, and saturation, which is characterized by a stationary particle distribution function. It has also been recognized that nonuniformity of magnetic field and plasma parameters along a geomagnetic force line is an important factor in the development and spectral characteristic of Pc 1 pulsations.

Vershinin, Ye. F., Yu. N. Gorshkov, and Ye. A. Ponomarev. Characteristics and occurrence conditions of VLF emission bursts of the noise storm type. IN: Issledovaniya po geomagnetizmu, aeronomii i fizike solntsa, no. 30, 1974, 3-9.

The relationship is analyzed between the noise storm type of VLF emission (intense, long-lasting emission occurring during strong global geomagnetic disturbances) as observed at Tiksi Bay and Yakutsk, and various solar, ionospheric and magnetospheric phenomena. (See Figs. 1 and 2).

The noise storm type of VLF emission was found to be very frequently accompanied by intense geomagnetic pulsations of different types. The best correlation was found to be with Pi 2 and Pc 3 pulsations. In the subauroral zone noise storms are fairly well correlated to Pi 1 pulsations as well.

(see Figs. 1 and 2 on following pages)

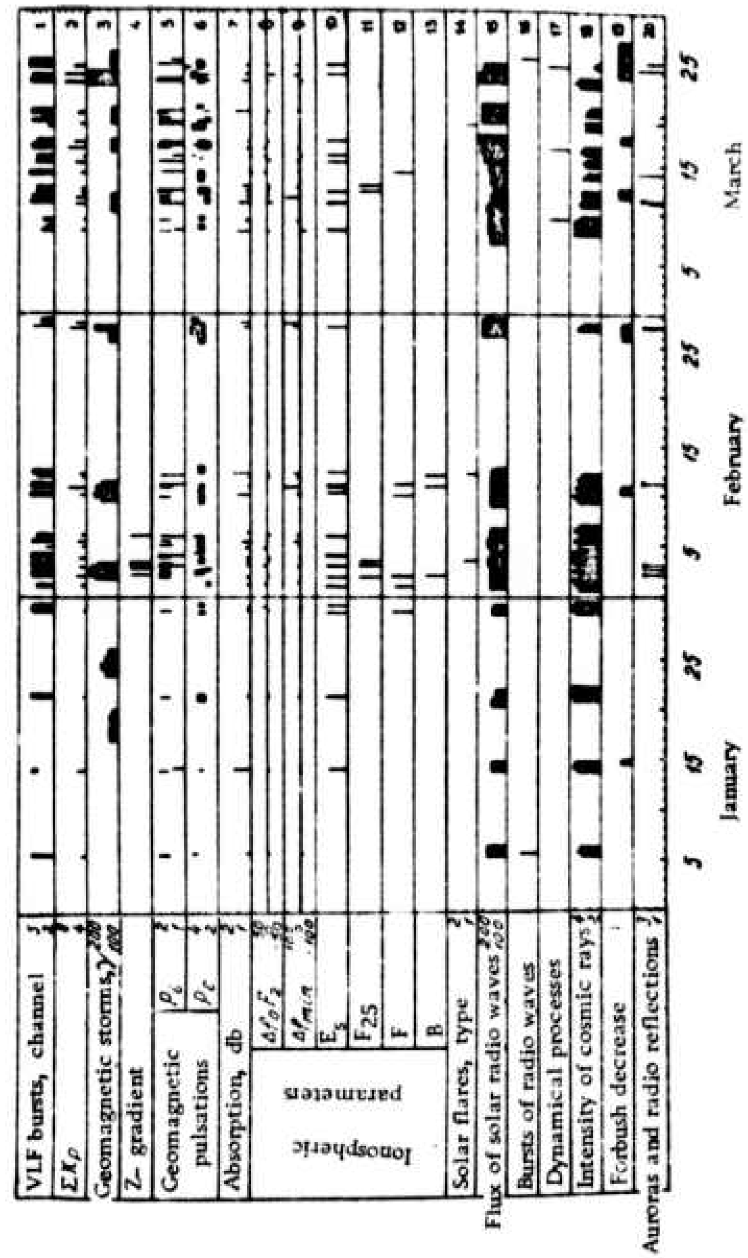

Fig. 1. Observations at Yakutsk.

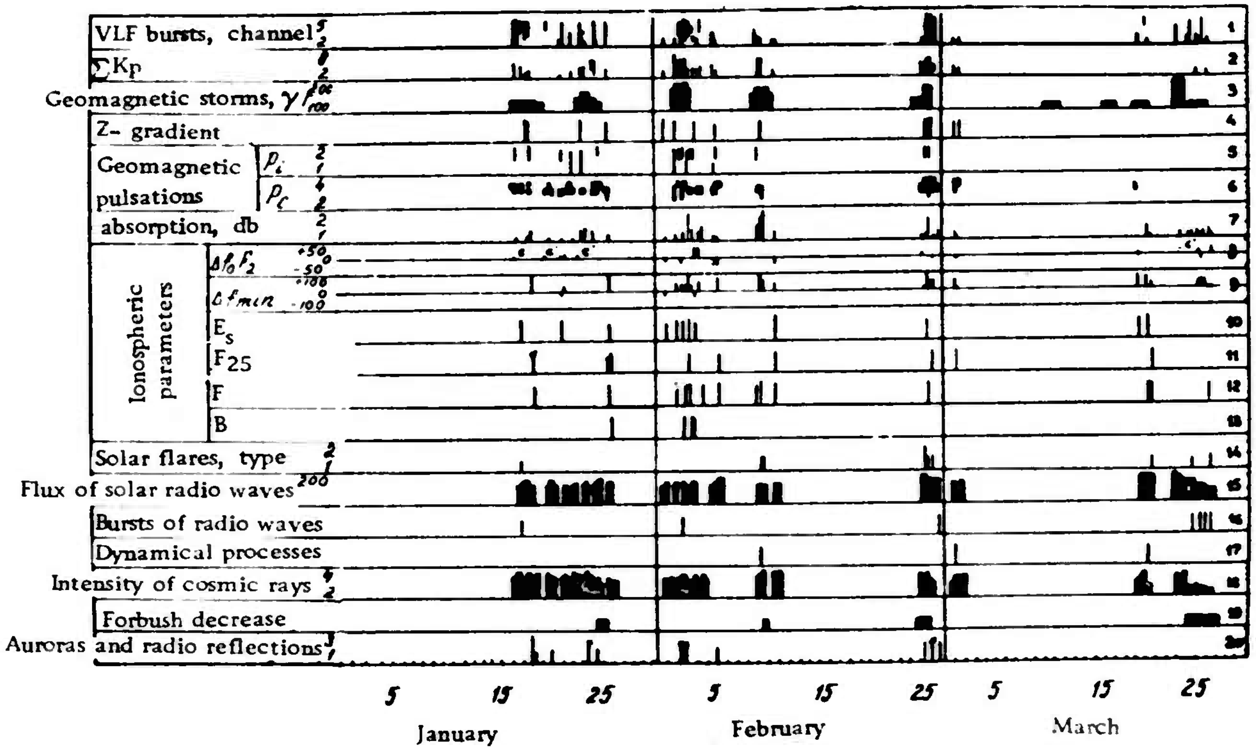

Fig. 2. Observations at Tiksi Bay.

Vershinin, Ye. F., Yu. N. Gorshkov, and Ye. A. Ponomarev. Geophysical conditions for occurrence of isolated broad-band bursts of VLF emission. IN: Issledovaniya po geomagnetizmu, aeronomii i fizike Solntsa, no. 30, 1974, 10-18; 19-34.

The relationship is analyzed between isolated bursts of VLF emission (frequency range 1-10 kHz, duration from several minutes to one hour) and various solar, ionospheric and magnetospheric phenomena at auroral and subauroral latitudes.

VLF emission of this type was found to be accompanied by Pi 2 pulsations in 30% of the cases; by Pc 4 pulsations in 25%; and by Pc 3 pulsations in 30% and 60% of the cases in subauroral and auroral zones, respectively (see Figs. 1 and 2).

VLF bursts are thus shown to be correlated with common conditions of geomagnetic disturbances but no close relation with any other specific phenomena in the ionosphere, aurorae or geomagnetic variations is found. On the other hand, there is a detailed relation with the eruptive solar phenomena - radiobursts, flares and, in particular, with the increase of cosmic ray intensity. Based on these facts a conclusion is drawn that the isolated bursts are generated in the Earth's magnetosphere by fast electrons emitted from the Sun and diffused into the magnetosphere from the solar wind. This conclusion is supported by the illustration of one burst recorded on Dec. 16, 1966 by the "Luna-12" satellite at 30 kHz, and 5.5 min later in Tiksi Bay at 11 kHz.

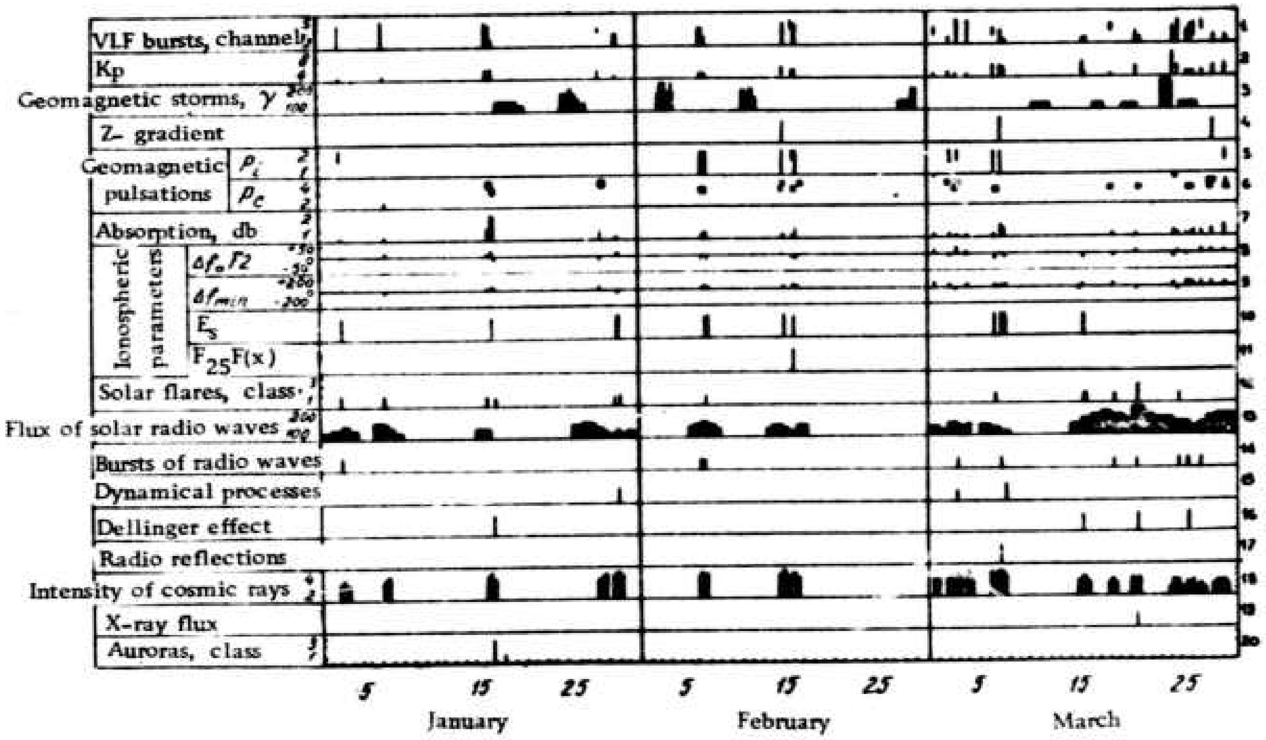

Fig. 1. Observations at Yakutsk.

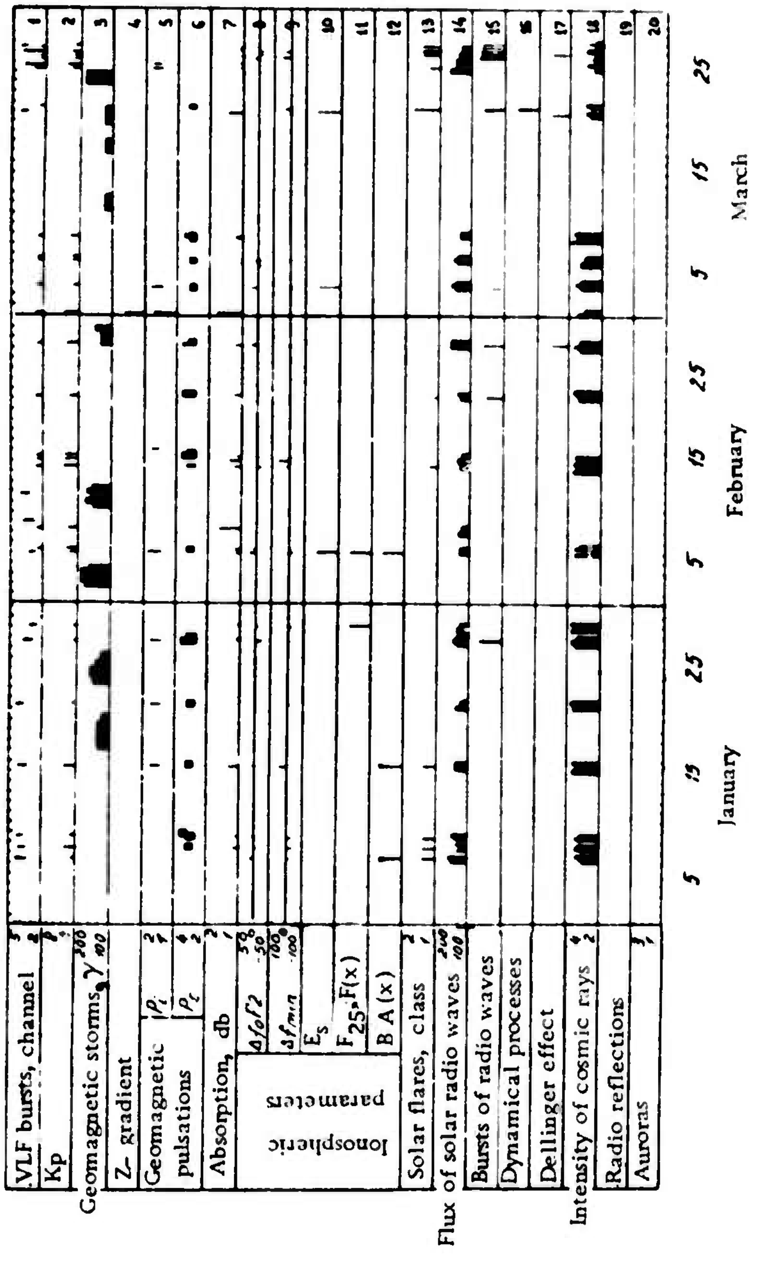

Fig. 2. Observations at Tiksi Bay.

In a second paper by the same authors, the geophysical conditions during the occurrence of VLF auroral emission bursts (AB) at the auroral and subauroral latitudes are further studied. The conclusion is made that these conditions - moderate or weak global magnetic disturbances and considerable local ones, weak riometric absorption, very close relation with high gradient values of a vertical field component of geomagnetic variations - show evidence for the relation between the AB generation region and that of the ion-sonic waves (ISW) responsible for radio auroras.

An attempt is made to evaluate the possibilities of two AB generation mechanisms ISW scatter at ionospheric nonuniformities and transformation of ISW to VLF waves when the refraction in the nonuniform ionosphere takes place. The evidence leans to the first mechanism for explanation of the specific features of AB generation.

Vershinin, Ye. F., Yu. N. Gorshkov, and Ye. A. Ponomarev. VLF emission bursts with frequency drift at high latitudes and their relationship with the ionospheric - magnetic complex. IN: Issledovaniya po geomagnetizmu, aeronomii i fizike Solntsa, no. 30, 1974, 35-42.

Continuing from their two foregoing papers, the authors analyze additional data on the relation between VLF emission with frequency drift observed at Tiksi Bay and Yakutsk during 1968-69 and various solar, ionospheric and magnetospheric phenomena (Figs. 1 and 2).

The analysis revealed a strong correlation between VLF bursts with frequency drift and Pc 3 pulsations; in the auroral zone this figure is 87% and at subauroral 80% (higher than in the case of the auroral and isolated

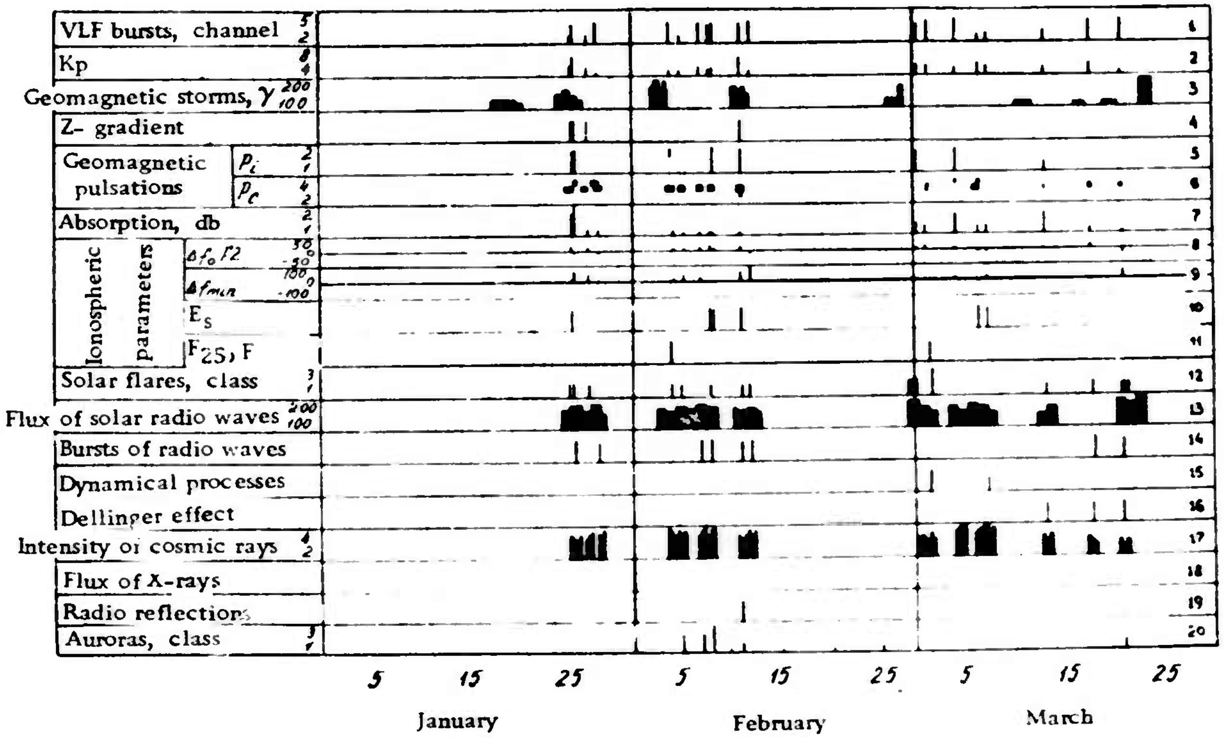

Fig. 1. Observations at Yakutsk.

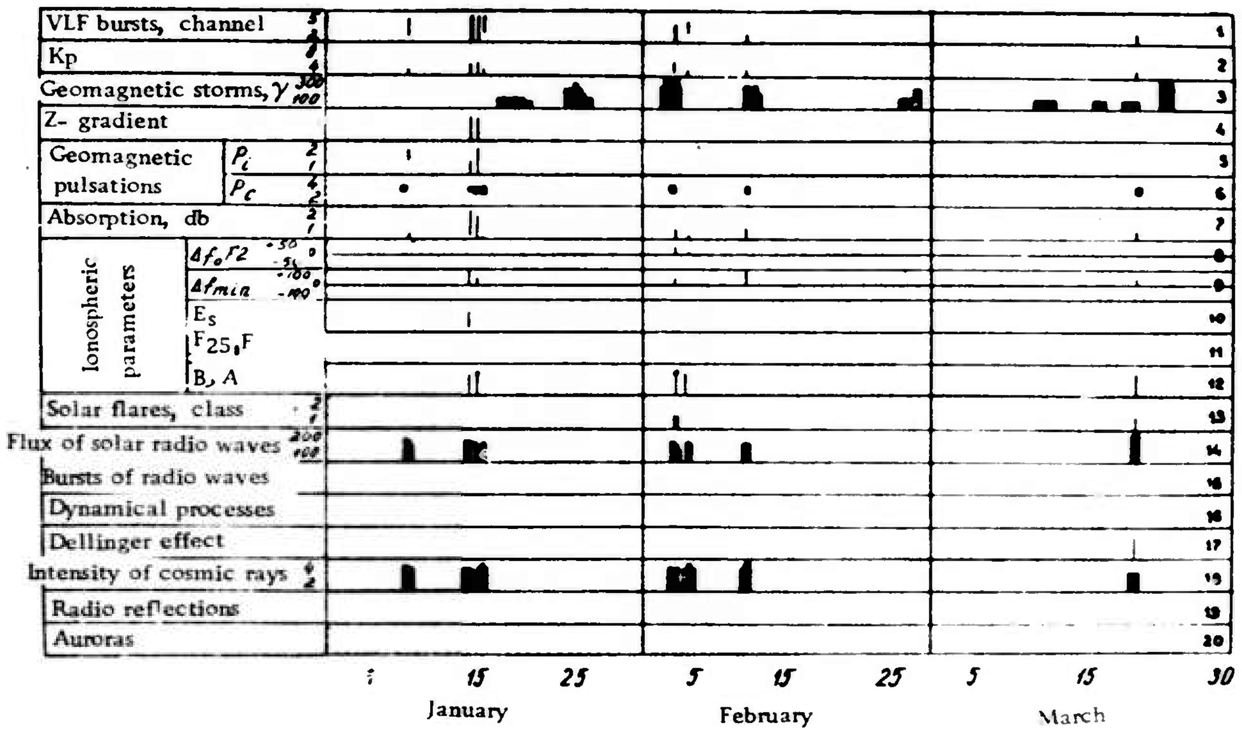

Fig. 2. Observations at Tiksi.

broad-band types of VLF emission). Such a high correlation suggests a common generation mechanism for VLF emission bursts with frequency drift and Pc 3 pulsations. According to Kiselev et al. (1969) and Gudkova et al. (1971) the sources of Pc 3 pulsations are located at 60° geomagnetic latitude and their periods are related to the position of the plasmapause.

Gul'yel'mi, A. V., and B. V. Dovbnya.
Hydromagnetic emission of interplanetary plasma. ZhETF P, v. 18, no. 10, 1973, 601-604.

Geomagnetic pulsations assumed to originate in interplanetary space due to cyclotron instability are described. The pulsations were observed at the Vostok station in 1968, and in view of the form of their dynamic spectra were named "serpentine emission" (see Fig. 1).

The most important feature of serpentine emission is the high modulation of the carrier frequency; this varies from f_{max} = 1Hz to f_{min} = 0.1 Hz, with a quasiperiod of τ = 10-60 min. The frequency modulation of hydromagnetic emission in interplanetary space is thought to be mainly due to the variation of the IMF orientation. An example of variation in the IMF orientation is illustrated in Fig. 2, recorded by the IMP-3 satellite in 1965.

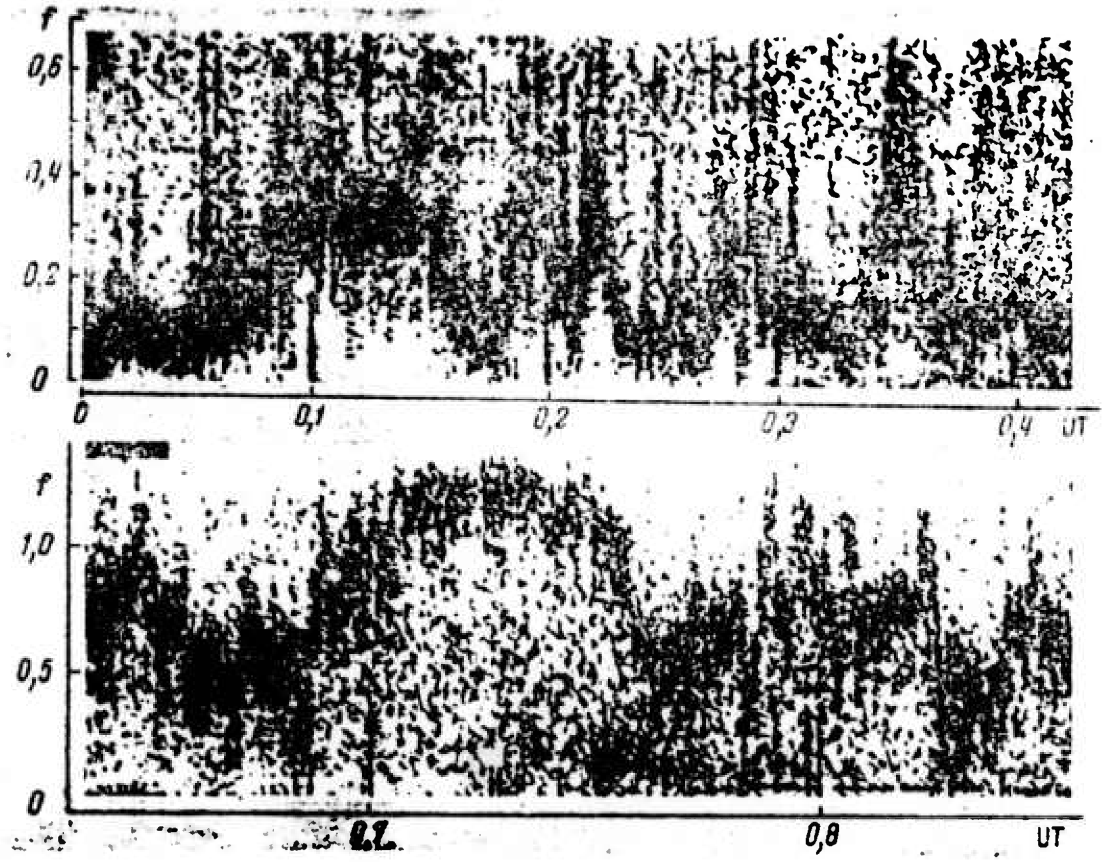

Fig. 1. Dynamic spectrum of the April 20, 1968 serpentine emission.

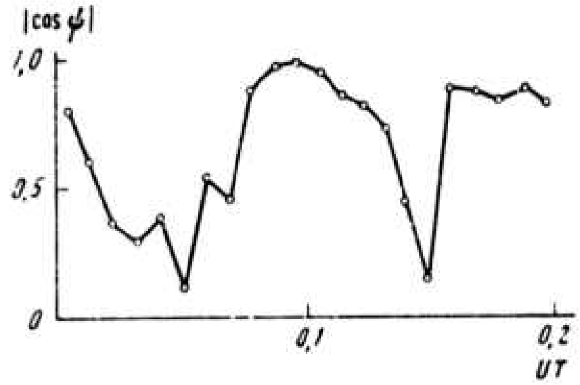

Fig. 2. Variation of angle ψ between the IMF and Sun-Earth line (data from IMP-3, August 8, 1965).

Dovbnya, B. V., A. L. Kalisher, and E. T. Matveyeva. Study of the instability in carrier frequency of Pc 1 geomagnetic pulsations. GiA, no. 3, 1974, 512-515.

The dependence of frequency change of Pc 1 pulsations on magnetic activity was studied. The radial drift rate of sources of Pc 1 pulsations and large-scale electric field in the magnetosphere were estimated. The data used included 400 Pc 1 series observed at Borok and Sogra from February 1969 to January 1972, and Q indices determined at the Sodankyla geophysical observatory from 1969-1972.

The results are shown in Figs. 1-6. The rate of frequency change during a Pc 1 event was measured by $\xi = d\ln\omega/dt$; the rate of repetition period change by $\eta = d\ln\tau/dt$. The radial drift rate of Pc 1 sources was estimated from the formula $V_L \sim (-)\, Lr_e/3f \;\; df/dt$, and the azimuthal component of the large-scale electric field in the magnetosphere by

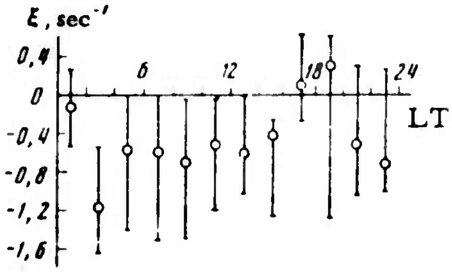

Fig. 1. Diurnal variation of the rate of Pc 1 frequency changes.

$$E_\varphi \approx \frac{0,7}{L^2 f}\frac{df}{dt}.$$

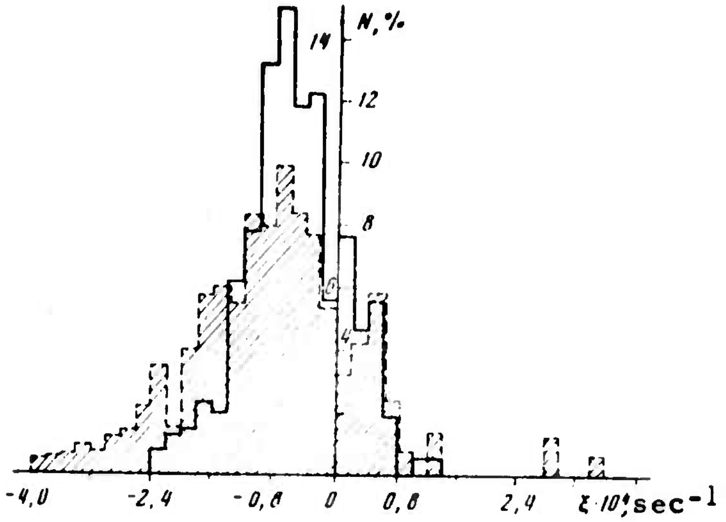

Fig. 2. Histograms of $\xi = d\ln\omega/dt$ for different magnetic activity.

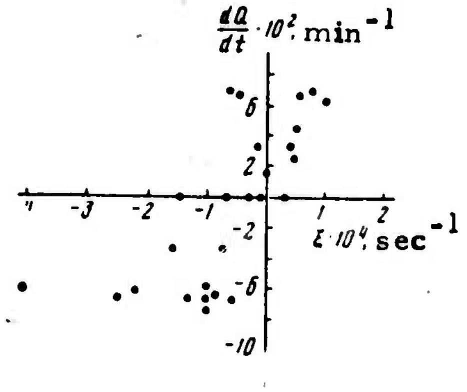

Fig. 3. Relationship between rates of Q-index and Pc 1 frequency change during nocturnal Pcl series.

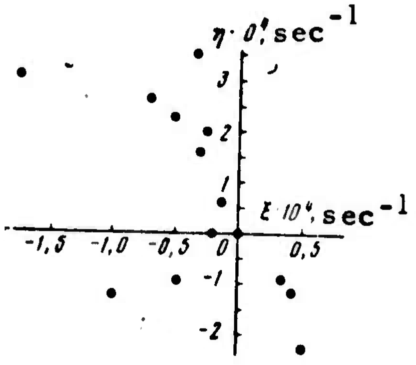

Fig. 4. Relationship between the rates of frequency change and repetition period change during Pc 1 series.

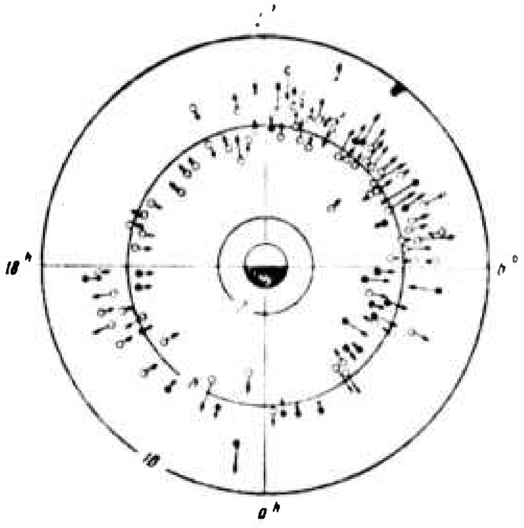

Fig. 5. Distribution of the magnitude and direction of V_L in the geomagnetic equatorial plane.

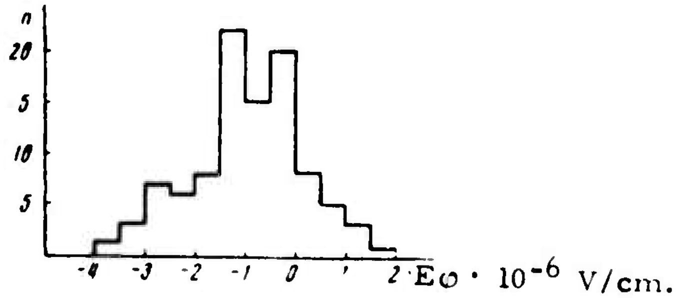

Fig. 6. Distribution of Pc 1 series with respect to E_ω.

The following conclusions are drawn, based on the present results and those reported by Fraser (1968), Offen (1972), and Kikuchi and Taylor (1972):

1. Under relatively quiet geomagnetic conditions, Pc 1 series are generated in the vicinity of the plasmapause;

2. In the majority of cases Pc 1 series have non-stationary spectra. Pc 1 series with decreasing frequencies are generated at a gradual drop in Q, those with rising frequencies at a slight increase in Q.

3. The rate of Pc 1 frequency change is an inverse function of the rate of repetition period change.

4. The nonstationary character of Pc 1 series is apparently caused by radial drift of the plasmapause. In the morning sector of the magnetosphere,drift away from the Earth at a rate of $\sim 5 \times 10^4$ cm/sec prevails; in the night sector an earthward drift at rates of $\sim (0.5\text{-}1.0) \times 10^5$ cm/sec is frequently observed.

5. The large-scale electric field in the magnetosphere which is responsible for the radial shift of Pc 1 sources varies between (-) 3×10^{-6} and 2×10^{-6} V/cm.

Baranskiy, L. N., T. A. Plyasova-Bakunina, P. A. Vinogradov, G. A. Loginov, and A. N. Popov. Distribution in intensity of Pc 3 geomagnetic pulsations in the territory of the Eurasian continent. GiA, no. 2, 1974, 337-339.

The distribution of Pc 3 intensity given in Fig. 1 is inferred from data of 22 geomagnetic stations recorded at 0300-0500 UT during the spring of 1971. The figure shows isolines of the average intensity of Pc 3 pulsations normalized to the Ashkhabad value ($\overline{H}_A = 0.64\ \gamma$) on the day side of the Earth. The isoline pattern inferred is similar to that derived by Baranskiy et al. (cf. previous paper by Baranskiy et al. this report)

The diurnal variations of Pc 3 intensity deduced from Fig. 1 are in good agreement with those observed at Sogra, Ashkhabad and Yakutsk which are given in Fig. 2.

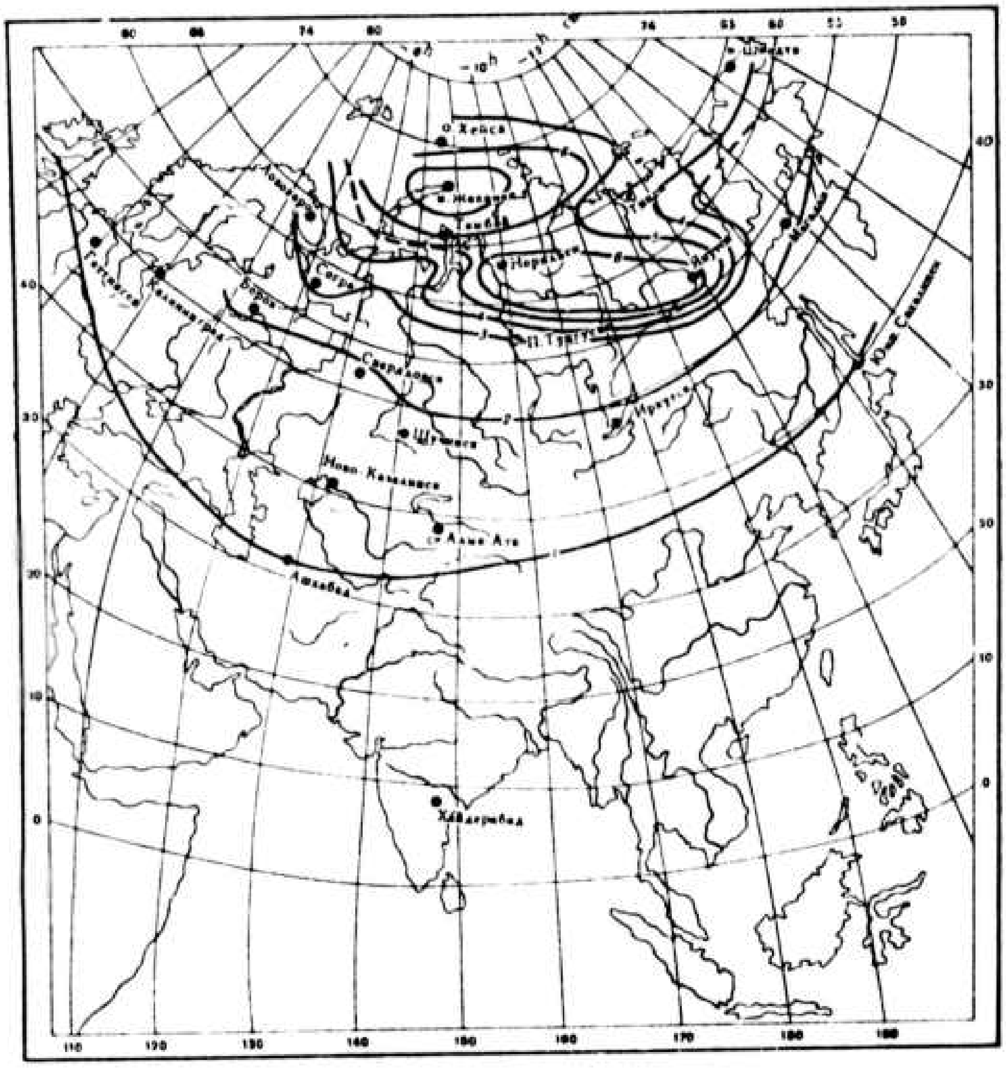

Fig. 1. Distribution of Pc 3.

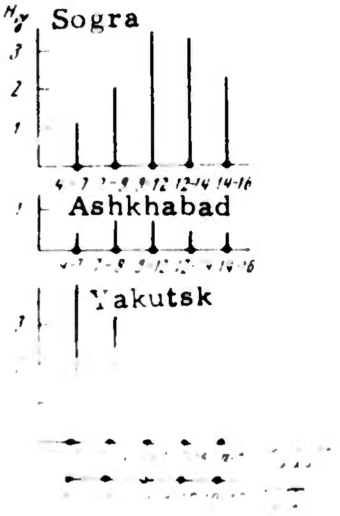

Fig. 2. Diurnal Pc 3 variation.

The established similarity between the distribution of Pc 3 intensity and that of Pi 2 intensity for the 1600-1700 UT interval (Baranskiy, 1970) suggests that Pc 3 pulsations can, like Pi 2, propagate equatorward by means of the ionospheric current system.

Shaftan, V. A., and L. K. Voshchina. *Irregular pulsations of geomagnetic field and radio aurorae as a result of the turbulization of the polar electrojet.* GiA, no. 2, 1974, 316-320.

A model is proposed for the electric current system in the E-region of the auroral ionosphere, responsible for irregular geomagnetic pulsations and radio aurorae. A qualitative analysis is made of the relationship between Pi pulsations with T on the order of 10 sec and radio aurorae. Experimental data were obtained during special observations of Pi pulsations at Tiksi and Yakutsk, and of radio aurora at Yakutsk, during January-March 1969.

The following phenomenological model is suggested: the equivalent electric current in the E-region is in each elementary volume characterized by a distribution function I (r, t) which represents a random function with a mathematical expectation Ir, standard deviation Is (Ir and Is = regular and sporadic components, respectively) and correlation distance of about 3 km. According to this model, Pi pulsations are determined by the entire set of elementary electric currents, while radio aurorae are determined by a subset of elementary currents which satisfies relatively strict conditions.

The analysis of experimental data was made using 10 events of geomagnetic pulsations which were accompanied by radio aurora. The mean amplitude Φ_t calculated from 8-10 readings per minute was used as a measure of the intensity of Pi pulsations. It was assumed that the distribution of elementary currents responsible for Pi pulsations is the same as the distributions of elementary currents detected by radar. The quantity $D_t = \sum_i I(i, t)\, d_i^{-3}$, defining Pi pulsation intensity, is introduced, where i - number of an element in the radar view field of 10° in azimuth by 25 km in range; $I(i,t) = 1$ if a radio aurora is detected in the i-th element, $I(i,t) = 0$ if not; and d_i = distance to the i-th element. According to the model considered, Φ_t and D_t should show a correlation (with some time delay Δ). Figure 1 demonstrates the existence of the expected correlation.

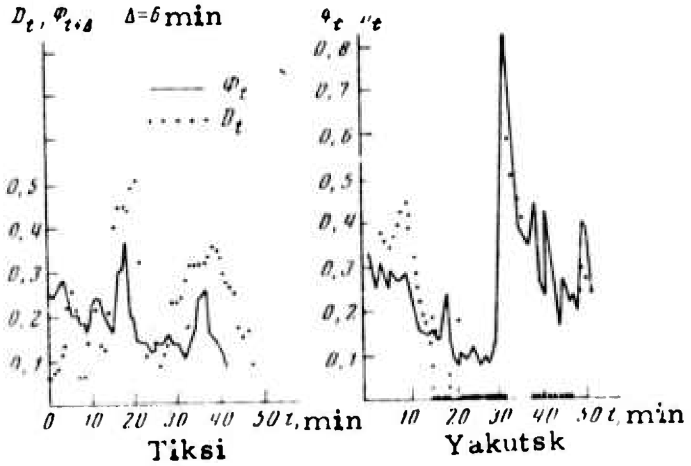

Fig. 1. D_t, Φ_t (t) for Tiksi and Yakutsk Stations.

The balance of the article contains a discussion of different mechanisms of the turbulization of the ionospheric electric current.

Yukhimuk, A. K., A. G. Kasymova, A. N. Zavorot'ko. Techniques for studying time variations of short-period oscillations of the Earth's magnetic field. IN: Geofizicheskiy sbornik, AN UkrSSR, no. 56, 1973, 57-62.

A method is proposed for computer calculation of time variations in different parameters of geomagnetic pulsations, in terms of their median values. Median rather than arithmetic mean values are preferable, since they are not affected by abnormally high or low values. The method was illustrated using data on Pc 3 and Pc 4 pulsations observed at the Kiev Station. Results obtained on a Minsk-22 computer are shown in Figs. 1-3.

The following conclusions were drawn from the study:

1) Pc 3's appear most frequently at midday in the January through May interval; they were not ever observed from 18 to 20 hrs GMT.

2) Pc 4's are most commonly observed one or two hours after noon, with peak rates noted in July and August. No Pc 4 event was seen in the 19 to 21 hrs. daily interval.

3) Both Pc 3 and Pc 4 are observed fairly constantly on a seasonal basis, although Pc 4's are registered only 2/3 as often as Pc 3's.

4) Pc 3's show an unusual consistency in median period value (30-40 sec), in contrast to Pc 4 values with a spread of 60-120 sec.

5) For Pc 3's the median amplitude and period have appreciably less variation than for Pc 4; at 05 hrs values for the latter attained 3γ, compared to 1.1γ for Pc 3.

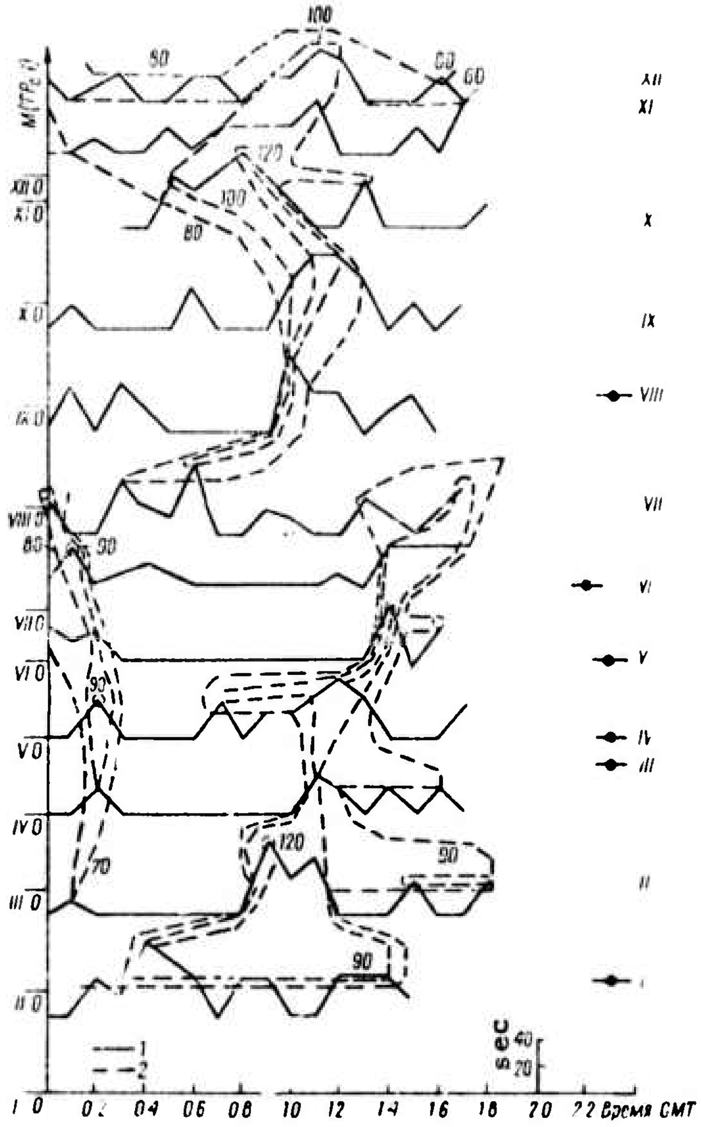

Fig. 1. Diurnal variations (solid line) and isolines (dashed) of median periods of Pc 4.

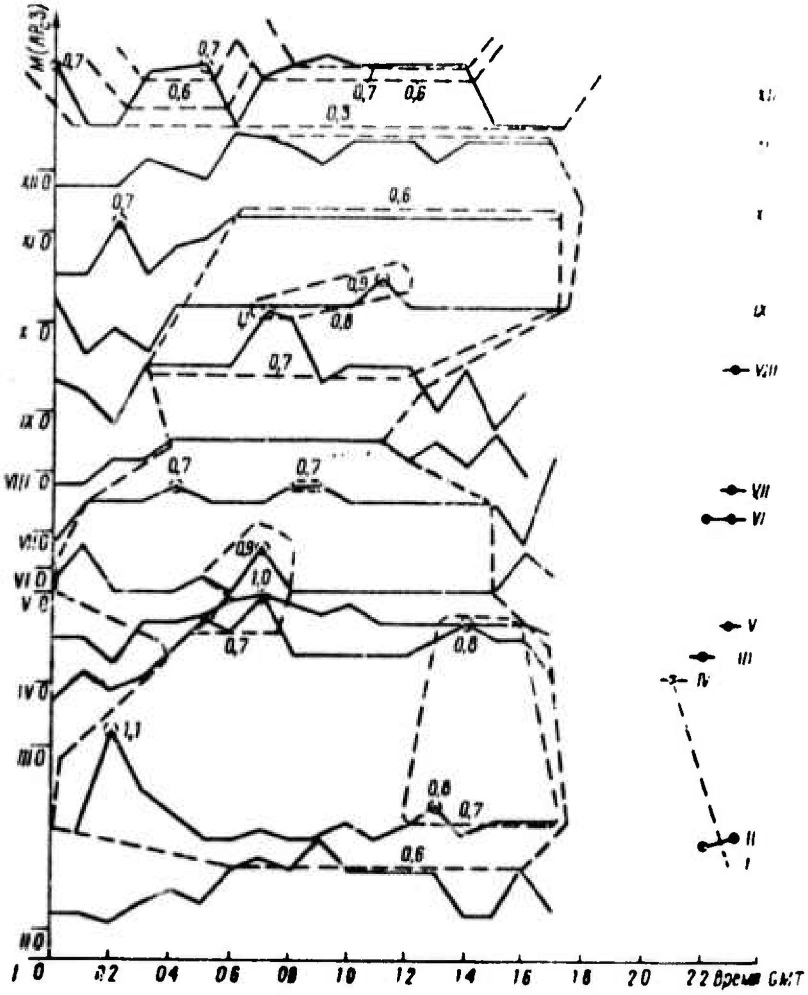

Fig. 2. Diurnal variations and isolines of median amplitudes of Pc 3. Designations the same as in Fig. 1.

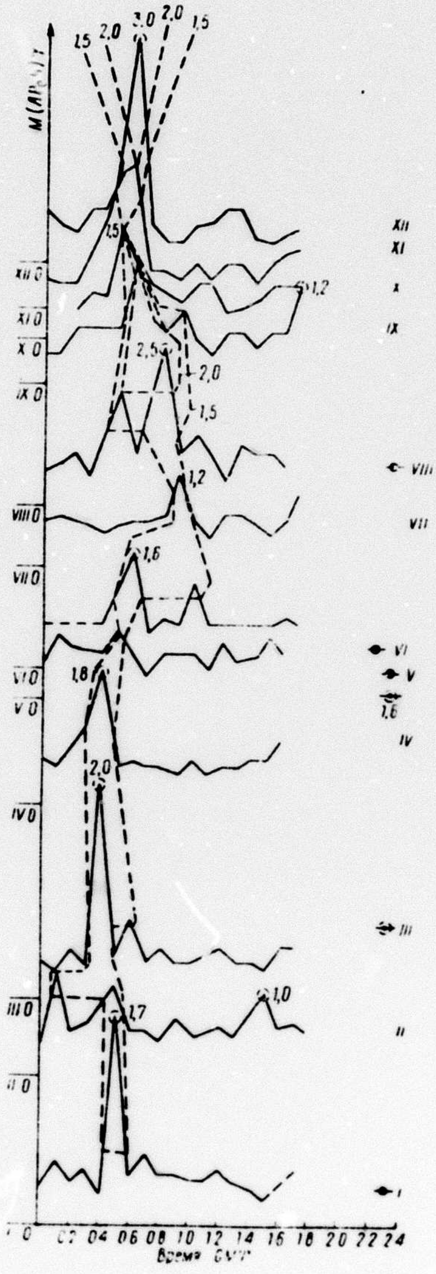

Fig. 3. Diurnal variations and isolines of median amplitudes of Pc 4. Designations the same as in Fig. 1.

Maksimov, V. P. On the effect of the zero magnetic field line on propagation of magnetohydrodynamic waves. IN: Issledovaniya po geomagnetizmu, aeronomii i fizike Solntsa, no. 30, 1974, 179-185.

The problem of the propagation of accelerated magnetosonic waves across the zero magnetic field line is considered in a magnetohydrodynamic formulation. Expressions for the indices of reflection and transmission are developed. It is shown that in the case of a sharp transition layer the waves are totally reflected.

SOURCE ABBREVIATIONS

AiT - Avtomatika i telemekhanika

APP - Acta physica polonica

DAN ArmSSR - Akademiya nauk Armyanskoy SSR. Doklady

DAN AzSSR - Akademiya nauk Azerbaydzhanskoy SSR. Doklady

DAN BSSR - Akademiya nauk Belorusskoy SSR. Doklady

DAN SSSR - Akademiya nauk SSSR. Doklady

DAN TadSSR - Akademiya nauk Tadzhikskoy SSR. Doklady

DAN UkrSSR - Akademiya nauk Ukrainskoy SSR. Dopovidi

DAN UzbSSR - Akademiya nauk Uzbekskoy SSR. Doklady

DBAN - Bulgarska akademiya na naukite. Doklady

EOM - Elektronnaya obrabotka materialov

FAiO - Akademiya nauk SSSR. Izvestiya. Fizika atmosfery i okeana

FGiV - Fizika goreniya i vzryva

FiKhOM - Fizika i khimiya obrabotka materialov

F-KhMM - Fiziko-khimicheskaya mekhanika materialov

FMiM - Fizika metallov i metallovedeniye

FTP - Fizika i tekhnika poluprovodnikov

FTT - Fizika tverdogo tela

FZh - Fiziologicheskiy zhurnal

GiA - Geomagnetizm i aeronomiya

GiK - Geodeziya i kartografiya

IAN Arm - Akademiya nauk Armyanskoy SSR. Izvestiya. Fizika

IAN Az - Akademiya nauk Azerbaydzhanskoy SSR. Izvestiya. Seriya fiziko-tekhnicheskikh i matematicheskikh nauk

IAN B - Akademiya nauk Belorusskoy SSR. Izvestiya. Seriya fiziko-matematicheskikh nauk

IAN Biol - Akademiya nauk SSSR. Izvestiya. Seriya biologicheskaya

IAN Energ - Akademiya nauk SSSR. Izvestiya. Energetika i transport

IAN Est - Akademiya nauk Estonskoy SSR. Izvestiya. Fizika matematika

IAN Fiz - Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya

IAN Fizika zemli - Akademiya nauk SSSR. Izvestiya. Fizika zemli

IAN Kh - Akademiya nauk SSSR. Izvestiya. Seriya khimicheskaya

IAN Lat - Akademiya nauk Latviyskoy SSR. Izvestiya

IAN Met - Akademiya nauk SSSR. Izvestiya. Metally

IAN Mold - Akademiya nauk Moldavskoy SSR. Izvestiya. Seriya fiziko-tekhnicheskikh i matematicheskikh nauk

IAN SO SSSR - Akademiya nauk SSSR. Sibirskoye otdeleniye. Izvestiya

IAN Tadzh - Akademiya nauk Tadzhiksoy SSR. Izvestiya. Otdeleniye fiziko-matematicheskikh i geologo-khimicheskikh nauk

IAN TK - Akademiya nauk SSSR. Izvestiya. Tekhnicheskaya kibernetika

IAN Turk - Akademiya nauk Turkmenskoy SSR. Izvestiya. Seriya fiziko-tekhnicheskikh, khimicheskikh, i geologicheskikh nauk

IAN Uzb - Akademiya nauk Uzbekskoy SSR. Izvestiya. Seriya fiziko-matematicheskikh nauk

IBAN - Bulgarska akademiya na naukite. Fizicheski institut. Izvestiya na fizicheskaya institut s ANEB

I-FZh - Inzhenerno-fizicheskiy zhurnal

IiR	-	Izobretatel' i ratsionalizator
ILEI	-	Leningradskiy elektrotekhnicheskiy institut. Izvestiya
IT	-	Izmeritel'naya tekhnika
IVUZ Avia	-	Izvestiya vysshikh uchebnykh zavedeniy. Aviatsionnaya tekhnika
IVUZ Cher	-	Izvestiya vysshikh uchebnykh zavedeniy. Chernaya metallurgiya
IVUZ Energ	-	Izvestiya vysshikh uchebnykh zavedeniy. Energetika
IVUZ Fiz	-	Izvestiya vysshikh uchebnykh zavedeniy. Fizika
IVUZ Geod	-	Izvestiya vysshikh uchebnykh zavedeniy. Geodeziya i aerofotos"yemka
IVUZ Geol	-	Izvestiya vysshikh uchebnykh zavedeniy. Geologiya i razvedka
IVUZ Gorn	-	Izvestiya vysshikh uchebnykh zavedeniy. Gornyy zhurnal
IVUZ Mash	-	Izvestiya vysshikh uchebnykh zavedeniy. Mashinostroyeniye
IVUZ Priboro	-	Izvestiya vysshikh uchebnykh zavedeniy. Priborostroyeniye
IVUZ Radioelektr	-	Izvestiya vysshikh uchebnykh zavedeniy. Radioelektronika
IVUZ Radiofiz	-	Izvestiya vysshikh uchebnykh zavedeniy. Radiofizika
IVUZ Stroi	-	Izvestiya vysshikh uchebnykh zavedeniy. Stroitel'stvo i arkhitektura
KhVE	-	Khimiya vysokikh energiy
KiK	-	Kinetika i kataliz
KL	-	Knizhnaya letopis'
Kristall	-	Kristallografiya
KSpF	-	Kratkiye soobshcheniya po fizike

LZhS - Letopis' zhurnal'nykh statey

MiTOM - Metallovedeniye i termicheskaya obrabotka materialov

MP - Mekhanika polimerov

MTT - Akademiya nauk SSSR. Izvestiya. Mekhanika tverdogo tela

MZhiG - Akademiya nauk SSSR. Izvestiya. Mekhanika zhidkosti i gaza

NK - Novyye knigi

NM - Akademiya nauk SSSR. Izvestiya. Neorganicheskiye materialy

NTO SSSR - Nauchno-tekhnicheskiye obshchestva SSSR

OiS - Optika i spektroskopiya

OMP - Optiko-mekhanicheskaya promyshlennost'

Otkr izobr - Otkrytiya, izobreteniya, promyshlennyye obraztsy, tovarnyye znaki

PF - Postepy fizyki

Phys abs - Physics abstracts

PM - Prikladnaya mekhanika

PMM - Prikladnaya matematika i mekhanika

PSS - Physica status solidi

PSU - Pribory i sistemy upravleniya

PTE - Pribory i tekhnika eksperimenta

Radiotekh - Radiotekhnika

RiE - Radiotekhnika i elektronika

RZhAvtom - Referativnyy zhurnal. Avtomatika, telemekhanika i vychislitel'naya tekhnika

RZhElektr - Referativnyy zhurnal. Elektronika i yeye primeneniye

RZhF - Referativnyy zhurnal. Fizika

RZhFoto - Referativnyy zhurnal. Fotokinotekhnika

RZhGeod - Referativnyy zhurnal. Geodeziya i aeros"yemka

RZhGeofiz - Referativnyy zhurnal. Geofizika

RZhInf - Referativnyy zhurnal. Informatics

RZhKh - Referativnyy zhurnal. Khimiya

RZhMekh - Referativnyy zhurnal. Mekhanika

RZhMetrolog - Referativnyy zhurnal. Metrologiya i izmeritel'naya tekhnika

RZhRadiot - Referativnyy zhurnal. Radiotekhnika

SovSciRev - Soviet science review

TiEKh - Teoreticheskaya i eksperimental'naya khimiya

TKiT - Tekhnika kino i televideniya

TMF - Teoreticheskaya i matematicheskaya fizika

TVT - Teplofizika vysokikh temperatur

UFN - Uspekhi fizicheskikh nauk

UFZh - Ukrainskiy fizicheskiy zhurnal

UMS - Ustalost' metallov i splavov

UNF - Uspekhi nauchnoy fotografii

VAN - Akademiya nauk SSSR. Vestnik

VAN BSSR - Akademiya nauk Belorusskoy SSR. Vestnik

VAN KazSSR - Akademiya nauk Kazakhskoy SSR. Vestnik

VBU - Belorusskiy universitet. Vestnik

VNDKh SSSR - VNDKh SSSR. Informatsionnyy byulleten'

VLU - Leningradskiy universitet. Vestnik. Fizika, khimiya

VMU - Moskovskiy universitet. Vestnik. Seriya fizika, astronomiya

ZhETF - Zhurnal eksperimental'noy i teoreticheskoy fiziki

ZhETF P - Pis'ma v Zhurnal eksperimental'noy i teoreticheskoy fiziki

ZhFKh - Zhurnal fizicheskoy khimii

ZhNiPFiK - Zhurnal nauchnoy i prikladnoy fotografii i kinematografii

ZhNKh - Zhurnal neorganicheskoy khimii

ZhPK - Zhurnal prikladnoy khimii

ZhPMTF - Zhurnal prikladnoy mekhaniki i tekhnicheskoy fiziki

ZhPS - Zhurnal prikladnoy spektroskopii

ZhTF - Zhurnal tekhnicheskoy fiziki

ZhVMMF - Zhurnal vychislitel'noy matematiki i matematicheskoy fiziki

ZL - Zavodskaya laboratoriya

AUTHOR INDEX