ACADEMY OF SCIENCES OF THE USSR

Preprint

PRELIMINARY RESULTS OF EXPERIMENTS CARRIED OUT IN THE IONOSPHERE IN THE EARLY MORNING BY MEANS OF GEOPHYSICAL ROCKETS LAUNCHED IN THE AUTUMN OF 1965

K.I.Gringauz, G.L.Gdalevich, V.F.Gubsky,
I.A.Knorin, V.A.Rudakov, N.M.Shutte

To be presented at the Seventh International Space Science Symposium in Vienna,
May 1966

MOSCOW

K.I.Gringauz, G.L.Gdalevich, V.F.Gubsky, I.A.Knorin,
V.A.Rudakov, N.M.Shutte

Preliminary Results of Experiments Carried out in the Ionosphere in the Early Morning by Means of Geophysical Rockets Launched in the Autumn of 1965

(To be presented to the Seventh International
Space Science Symposium in Vienna, May 1966)

1. Some Information on Experiments.

Geophysical rockets launched vertically on September 20 and October 1, 1965, in the middle latitudes of the USSR carried, among other instruments, devices for simultaneous measurements of some parameters which characterize the morning ionosphere at heights up to ~480 km. During the launchings these instruments were used for simultaneous measurements of

a) electron concentration by a dispersion interferometer method at frequencies of 48 and 144 Megacycles per second;

b) electron concentration and electron temperature by a probe method;

c) changes in the intensity of solar ultraviolet emission along the rocket's trajectory by a method of measuring electron photoemission from the metallic surface.

Both rockets were launched along the trajectories close to the vertical and in flight were stabilized with respect to three mutually perpendicular axes with an accuracy of up to $\sim 1 \div 2^{o}$. On September 20 the rocket was launched at the solar zenith angle $\alpha \approx 81^\circ$ and October 1 at $\alpha \approx 76^\circ$.

The on-board and ground apparatus of the dispersion interferometer was similar to that used in previous years [1,2]. The reception of radio waves radiated from the rocket took place near the site of the rocket launching. For measurements of electron concentration and temperature each rocket carried a Langmuir planar probe, as well as two-electrode and three-electrode planar traps. Besides, each rocket had a three-electrode analyzer of photoelectrons with a platinum photocathode which differed from the analyzers used on the "Cosmos-2" satellite [3,4] only by the fact that its outer grid was planar. The analyzers were located on the rockets so that incidence of solar radiation onto the photocathodes was close to the normal.

The aim of simultaneous performance of the above-mentioned measurements was investigation of ionospheric characteristics in the initial phase of the formation of the day-time ionosphere and their correlation. Treatment and interpretation of all the primary data obtained have not yet been completed. In the present preliminary communication some results are given which, in the authors' opinion, are of independent interest.

2. $N(h)$- profiles and Non-stationarity of the Ionosphere

Fig. 1 gives vertical distributions of electron concentration ($N(h)$ - profiles). The curve (a) is plotted on the basis of the data of the dispersion interferometer obtained during the rocket's descent on 20 September, 1965, the curve (c) represents similar distribution obtained on October 1, 1965.

The curve (b) portrays the distribution of electron concentration obtained during the rocket's descent on September 20, 1965, by means of the Langmuir probe. The N value from the probe data at all heights are somewhat lower than from the data of the radiomethod. Therefore the curve (b) is normalized from the value N_{max} on the curve (a).

The curve (b) gives N values up to the maximum height reached by the rocket. At the same time the upper parts of the curves (a) and (c) above h=430 km are not presented due to considerable errors caused by the nonstationary character of electron concentration, that is, by the value $\frac{\partial}{\partial t}\int_0^h N\,dh$ During the rocket's vertical launching this value can be determined from the speed of the change in the phase difference recorded by the ground receiving phasometric instrument while the rocket is at the upper point of its trajectory [5]. In the experiments described the value $\frac{\partial}{\partial t}\int_0^{h=480} N\,dh$ thus measured turned out to be equal to $10^9 cm^{-2} sec^{-1}$. Let us note that similar (and greater) values $\frac{\partial}{\partial t}\int_0^h N\,dh$ in the period close to the solar activity minimum were observed repeatedly, as can be seen, for instance, from the measurements of the Faraday rotation of the polarization plane of the signals obtained from the American "Syncom-3" satellite [6, 7]. Let us note also that during the day-time launching of the geophysical rocket in 1958 the value $\frac{\partial}{\partial t}\int_0^{h=470\,km} N\,dh \sim 5\cdot 10^9 cm^{-2} sec^{-1}$ was observed [5].

3. Height Distribution of Electron Temperature

Fig. 2 gives the values of electron temperature obtained by means of the Langmuir probe during the rocket's descent on September 20. The dots of the graph correspond to the values averaged by the height intervals $\Delta h \sim 50$ km. Despite a considerable spread of the measured values, the general trend is evident toward the growth of T_e with the increase of height while the transition is made from the region E to the region lying above the main ionization maximum. A similar tendency for early morning time is observed also from the data of noncoherent scattering of radio waves (see, for example, Fig. 1 in [7]).

4. Absorption of Solar Ultraviolet Radiation

Fig. 3 gives three volt-ampere characteristics taken by means of the analyzer of photoelectrons at different heights during the rocket's ascent on September 20 (current of the photocathode is given along the ordinate, and voltage between the photocathode and the inner grid of the analyzer is given along the abscissa). A comparison of these characteristics has shown that during measurements at the above-mentioned altitudes different portions of the spectrum of solar ultraviolet radiation were absorbed differently. It is evident that with the increase of height no only saturation current grows (it corresponds to the zero potential on the inner grid), that is, the integral intensity throughout the spectrum which creates photoemission (that is, with the wave-length $\lambda \leq 2000$ Å), but also the increase is recorded in the relative intensity of the shortwave portion of this spectrum which produces photoelectrons with maximum energy $E > 3,5$ ev.

Fig. 4 represents the height distribution of the integral (by the spectrum) absorption coefficient of solar ultraviolet radiation determined from the magnitudes of the saturation current of the analyzer of photoelectrons measured during the rocket's ascent on September 20, and Fig. 4 a represents on an increased scale portion of the same graph relating to the main ionization maximum and to the region lying above it.

Since, as it was mentioned measurements were carried out early in the morning, at the solar zenith distance of $\sim 80^\circ$, during the calculation of the absorption coefficient of solar ultraviolet radiation the atmosphere's sphericity was taken into account. It was supposed that concentric layers of the spherical atmosphere 10 km thick each can be regarded as a uniform absorbing medium for which the ratio $\varkappa_i = \frac{1}{l_i} \ln \frac{J_0}{J_i}$ is valid. The values of the absorption coefficient $\varkappa_i$ were determined consecutively for each such layer similarly to the procedure taken in [4]. The $\varkappa$ values at heights $\sim 300 \div \sim 500$ km are somewhat lower than those obtained from the data of measurements performed from the Cosmos-2 satellite [4]. Probably this is accounted for by the change in the density of the neutral atmosphere (among other factors at the expense of diurnal variations, as measurements from Cosmos-2 refer to 16-18 hours local time). Besides, during the determination based on the data of Cosmos-2 in [4] we had to ignore the latitudinal variations of the atmospheric density while processing the results of measurements conducted during the vertical launching of the rocket there is no need to ignore them.

s-2 refer
etermination
ignore the
while pro-
ing the ver-
ignore them.

References

1. K.I.Gringauz. Doklady Akademii Nauk SSSR, 120, 1264, 1958.
2. K.I.Gringauz, A.V.Kaporsky, V.A.Rudakov. Iskusstvennye Sputniki Zemli (Artificial Earth Satellites), issue 6, 33, 1962.
3. V.V.Afonin, T.K.Breus, G.L.Gdalevich, B.N.Gorozhankin, K.I.Gringauz, R.E.Rybchinsky, N.M.Shutte. Issledovania Kosmicheskogo Prostranstva (Space Investigations), 151, Moscow, Nauka, 1965.
4. B.N.Gorozhankin, K.I.Gringauz, N.M.Shutte. A paper submitted to the Seventh International Space Science Symposium sponsored by COSPAR in Vienna, 1966.
5. K.I.Gringauz, V.A.Rudakov. Iskusstvennye Sputniki Zemli, issue 6, 48, 1962.
6. Y.Nakata. Report of Ionosphere and Space Research in Japan, 19, 51, 1965.
7. O.K.Garriott, F.J.Smith III and P.C.Yuen. Planetary Space Sci., 13, 829, 1965.
8. H.C.Carlson and J.B.Nisbet. Electron Density Profiles in Ionosphere and Exosphere, J.Frihagen (ed.), 470, North-Holland, 1966.

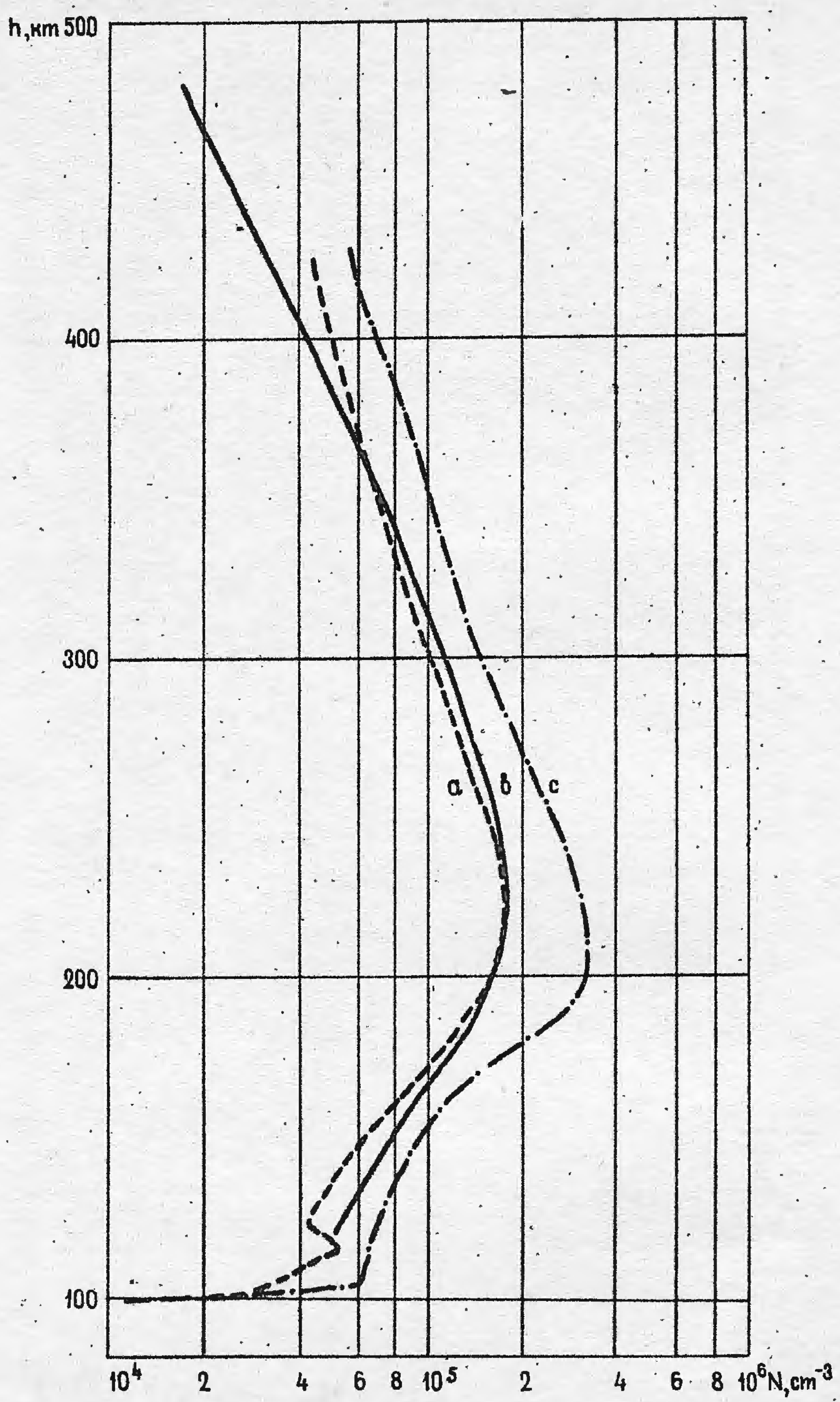
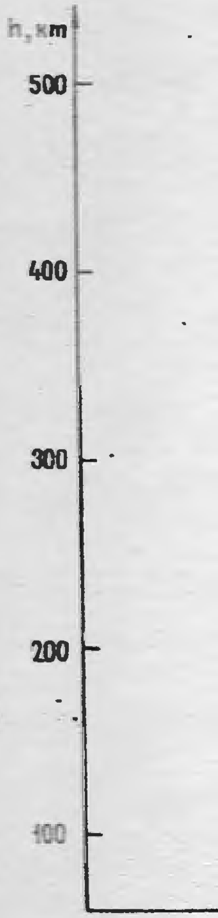
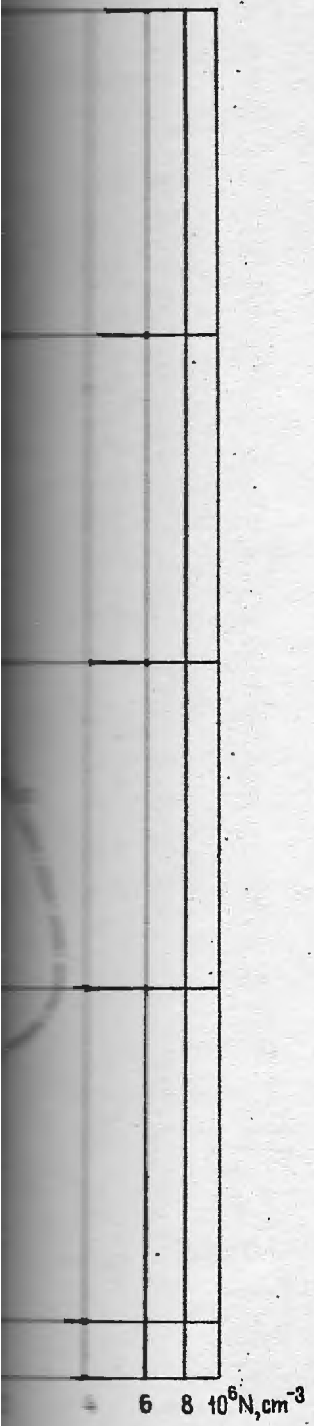

h,км 500
400
300
200
100
10^4
2
4
6
8
10^5
2
4
6
8
10^6 N,cm^-3
a
b
c

Fig.1


h, км
500
400
300
200
100



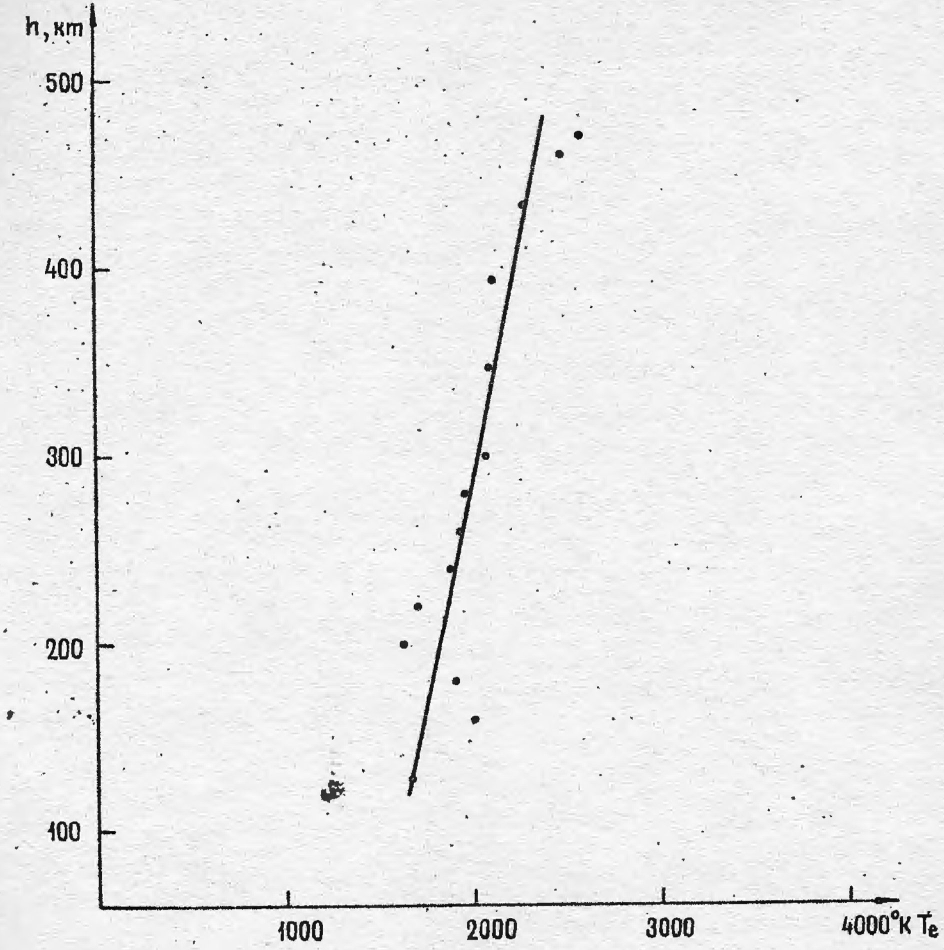


Fig. 2

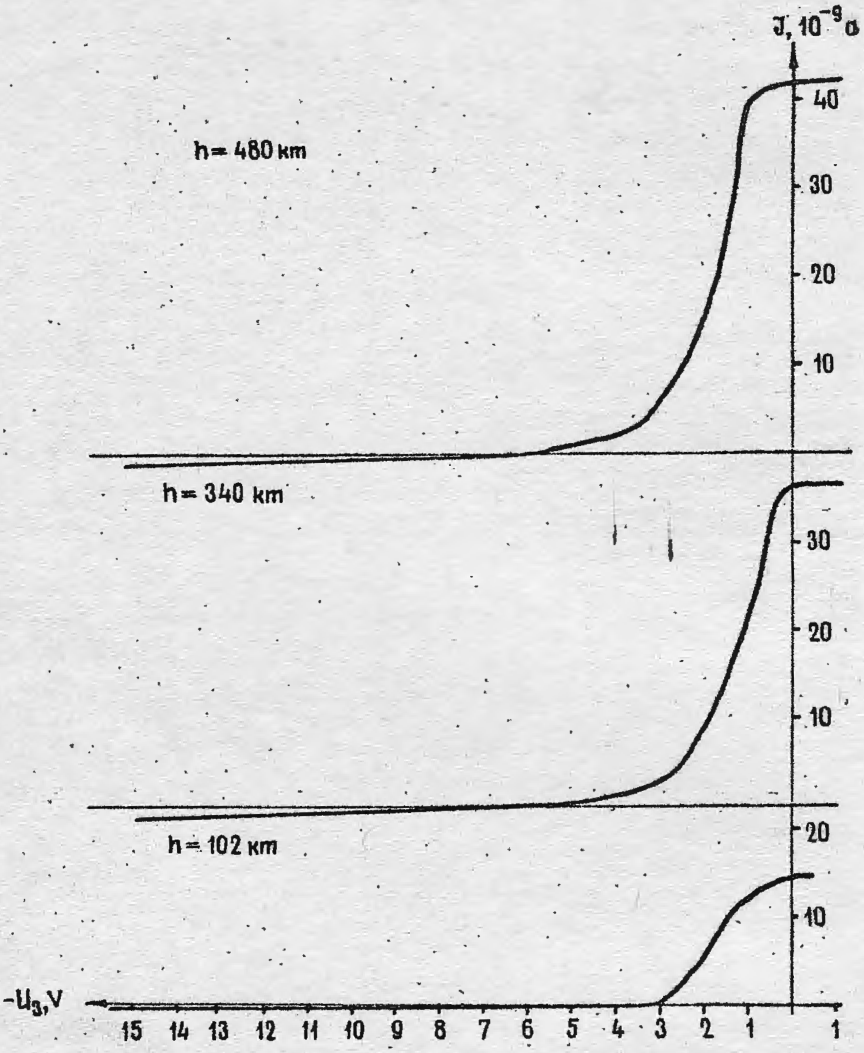
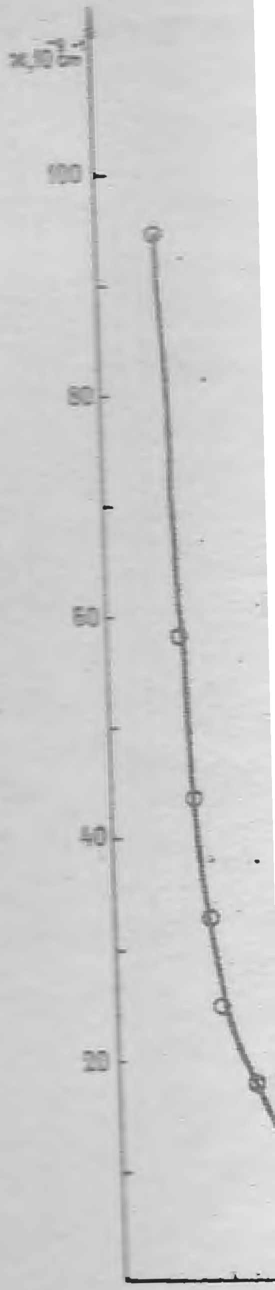
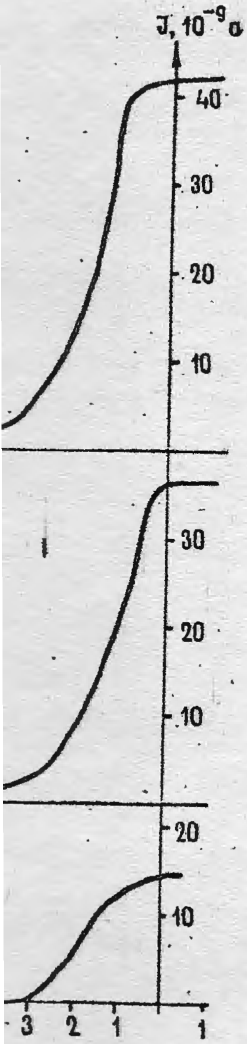


Fig.3



Заказ № П509



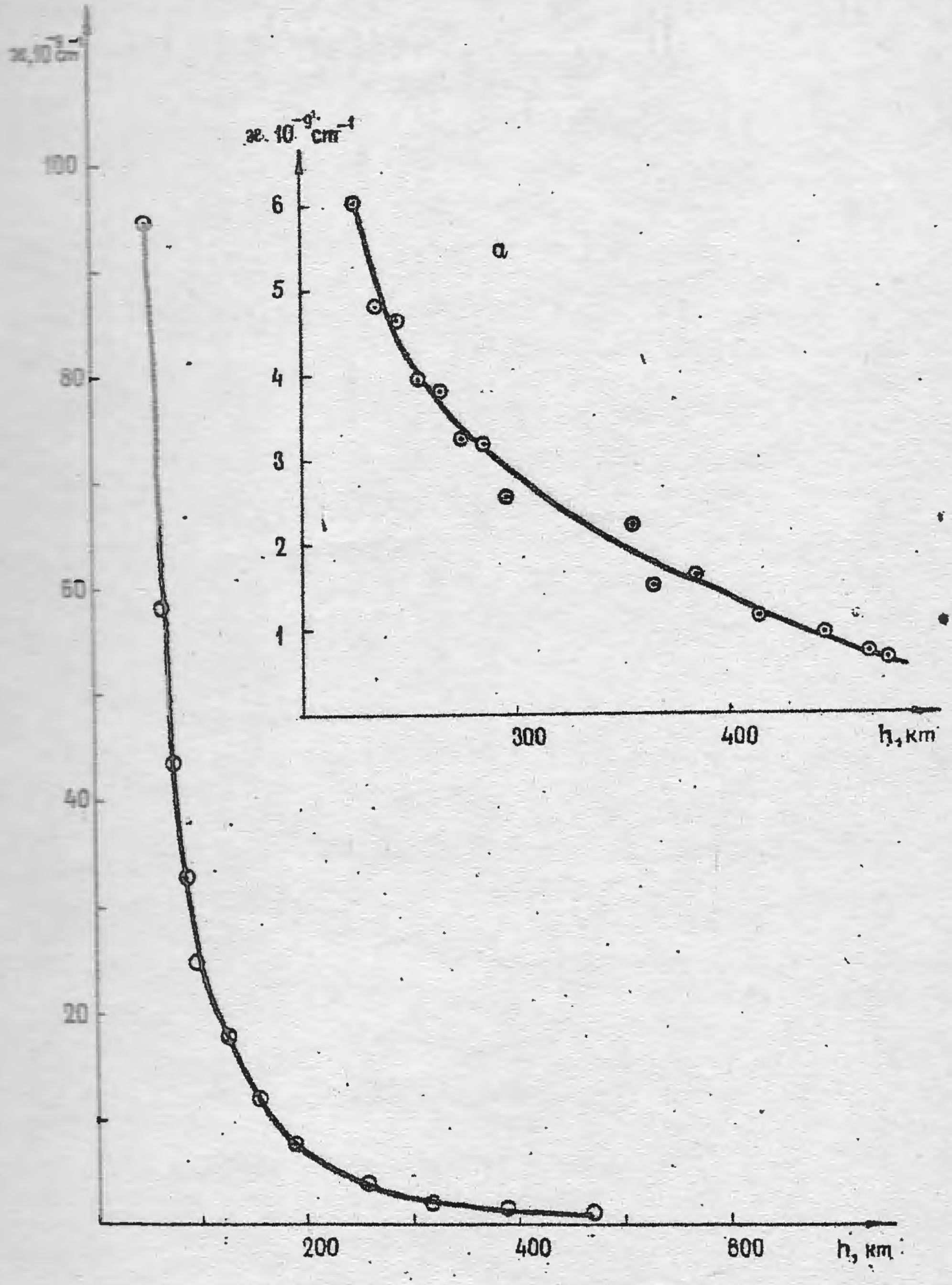


Fig. 4

Заказ № П509

Тираж 100 экз.