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STUDY OF THE PROPAGATION OF DECIMETER RADIOWAVES IN THE ATMOSPHERE OF VENUS WITH THE AID OF AIS "VENERA-4"

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SUMMARY

This study is based on the approximate estimates of the inhomogeneity of Venus tropsphere's index of refraction. It is found that in the troposphere of Venus the latter's fluctuations are greater by a factor of 10 than in the Earth's troposphere. It is emphasized that the data presented here have the character of approximate estimates.

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During the motion of AIS "VENERA-4" radiotranslucence was achieved of the entire planet's atmosphere thickness by radiowaves of $\lambda = 0.3$ m wavelength. At the same time, it was found to be possible to determine the intensity of the field and the fluctuations of radiowaves' amplitudes for transmitter positions at various heights above Venus' surface. The signal reception is achieved along two independent channels, which allowed us to eliminate the influence of ground apparatus on the measurements of field intensity. To register the field intensity the signal registration on the movie film was conducted with tape transport rate of 1 cm/sec.

No field intensity variations were observed in the 6000 - 100 km altitude range above the surface of the planet that would be due to Venus' ionosphere. During the motion of the descending apparatus through planet's troposphere an insignificant decrease of mean field intensity was registered.

The results of measurements of the the ratio E/E_0 , i.e., the field intensity E averaged for 6-minute intervals, normalized to intensity E_0 for the altitude of 26 km are plotted in Fig.1a. At time of surface contact E/E_0 constituted 0.76. The telemetric data on feeding voltages and the temperature conditions inside the descending apparatus have shown that they were within prescribed limits; because of this the field intensity could have varied insignificantly, to 0.83 - 0.91. Taking into account this correction, we shall obtain that the real value of field intensity is $E/E_0 = 0.92 - 0.84$. The value $E/E_0 = 0.92$ being more probable,results in an attenuation of radiowaves having passed the troposphere of Venus by 8 5% of intensity.

In order to investigate the fluctuations of radiowaves signal registrations were subject to statistical processing. At the same time the influence of noises and the receiving routing variations were eliminated in the course of the careful analysis. Besides rapid fluctuations of signal level, slow variations were observed, which were due to Venus' troposphere. As a result of blinking analysis, the value

$$\eta_1 = \sqrt{\langle (E_i - E_{av})^2 \rangle / E_{av}^2}$$

was obtained was different heights h of the source above the planet's surface. Parameter η_1 characterizes the average digression of instantaneous values E_i of field intensity from the average values E_{av} found for 5-second intervals. The found combination of values η_1 was further averaged for 2-5 minute intervals.

Fig.1b shows the dependence of η_1 on the height h. It follows therefrom that the blinking depth increases as the radiowave source sinks into the Venus' troposphere, being equal on its surface to 0.12. The bliniking period is close to 1 sec. The depth of blinkings, characterized by the quantity η_1 yields somewhat underrated values of field intensity fluctuations, for during processing short realizations of dependences E(t) were taken.

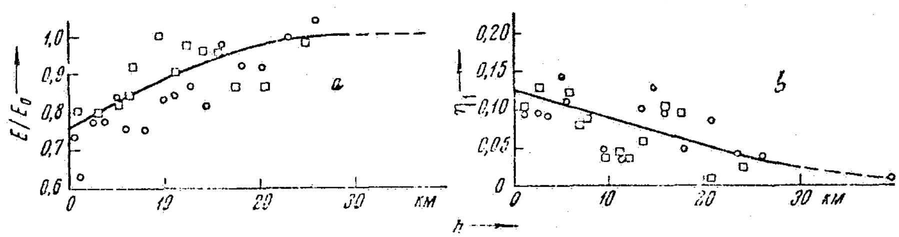

Fig.1. Dependence of field intensity (a) and blinking depth (b) on altitude above the surface of Venus

In order to estimate the influence of the interplanetary medium and of the Earth's atmosphere, the value of η_1 was determined during the pre-landing radiocomuunication session; the depth of blinkings then constituted ~ 0.02. In Fig.1b this value is conditionally shown for h = 40 km. The presence of radiowave blinkings points to the turbulence of Venus' troposphere. to data of Fig.1b, the troposphere of the planet is turbulent to altitudes of the order of 20 km. The slow variations of field intensity may be by influence of Venus' atmosphere as well as by the swinging of the descending apparatus. The average depth of slow blinkings on planet's surface is

$$\eta_2 = \Delta E / E_{av} = 0.24.$$

The value of η_2 yields somewhat overrated values of the depth of slow fluctuations caused by planet's troposphere, for their determination may have been influenced by the swinging of the descending apparatus. The subdivision of fluctuations into rapid and slow variations is conditional, and since the fading periods are of the order of 40 sec, it is more objective to assume for the depth of fadings the average value $\eta = 0.18 \pm 0.05$.

The measured parameter fluctuations allow us to conduct approximate estimates of the inhomogeneity of the refraction index of Venus' troposphere. During radiowave propagation through statistically inhomogenous layer of thickness L, the depth η of fadings is determined by the relation [1]

$$\eta^2 = \frac{\sqrt{\pi}}{2} k^2 \overline{\mu^2} aL \left(1 - \frac{1}{D} \operatorname{arc\,tg} D\right).$$

Here $\underline{k}$ is the wave number, $\underline{a}$ is the mean scale of inhomogeneities, $\overline{\mu^2}$ is the mean square of fluctuations of the index of refraction, $D = 4L/ka^2$. If we neglect the diffraction of a random field on the path from Venus to Earth, the expression (1) provides the possibility to estimate the parameter of refractive index's $\overline{\mu^2}$ inhomogeneities by the found values of η and L. In order to determine the numerical value of $\overline{\mu^2}$ it is necessary to make an assumption on the magnitude of the scale o inhomogeneities $\underline{a}$. The average scale of inhomogeneities of the refractive index of the Earth's troposphere, causing the fluctuations and scattering of ultra-short waves is of the order of 50 m. Admitting the value a = 50 m for the troposphere of Venus, and assuming also on the basis of the experiment that L = 20 km and $\eta = 0.18$, we shall find $\sqrt{\overline{\mu^2}} = 15 \cdot 10^{-6}$. In the Earth's troposphere $\sqrt{\overline{\mu^2}} = 10^{-6}$. Consequently, in the troposphere of Venus the fluctuations of the index of refraction is, as an average, greater by a factor of 10 than in the Earth's atmosphere.

In conclusion the remark should be made that the data presented here on the degree of inhomogeneity of the index of refraction of the atmosphere of Venus have the character of approximate estimates. For a more precise determination of parameter $\sqrt{\overline{\mu^2}}$ it is necessary to consider the fluctuations taking into account the turbulence having the Kolmogorova-Obukhov spectrum, and also take into account the sphericity of the wave. Taking these factors into account results in immaterial differences in the determination of parameters of refactive index's inhomogeneities

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

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