M. A. Kolosov, O. I. Yakovlev, A. I. Efimov, V. M. Razmanov, V. I. Rogal'skiĭ, and V. K. Shtrykov. *Inhomogeneous structure of the plasma near the sun and spreading of the spectrum of the radio waves, as suggested by the results of radio sounding with the aid of the satellites "Venus-9, 10."* It was shown in[1] that the inhomogeneities of the plasma located near the sun and dragged by the solar wind should produce fluctuations in the phase, frequency, and intensity of the field, and consequently a spreading of the energy spectrum of the radio waves. Preliminary investigations of the broadening of the spectral line and of the fluctuations of the frequency were carried out with the aid of the satellites "Mars-2, 7."[2] The satellite "Venera-10" yielded a large volume of data on the fluctuations of the frequency and of the amplitude and on the spreading of the spectrum of the radio waves propagating through the near-solar plasma. Reduction of the obtained data yielded the temporal spectra of the frequency fluctuations and the shapes of the energy spectra of the radio waves at different positions of the line of sight relative to the sun. The spatial spectrum of the plasma inhomogeneities, the dispersion of the fluctuations of the electron density, and the velocity of the solar wind were obtained. Figure 1 shows examples of the spreading of the energy spectrum of radio waves of frequency 928 MHz at different values of the angle ψ between the directions to the center of the sun and to "Venera-10." When the angle ψ is decreased from 6.6° to 0.6°, the width Δf of the spectrum increases by a factor of more than 100. The experimental data on the spreading of the spectrum are described by the approximate relation $\Delta f \propto \psi^{-3.4}$.

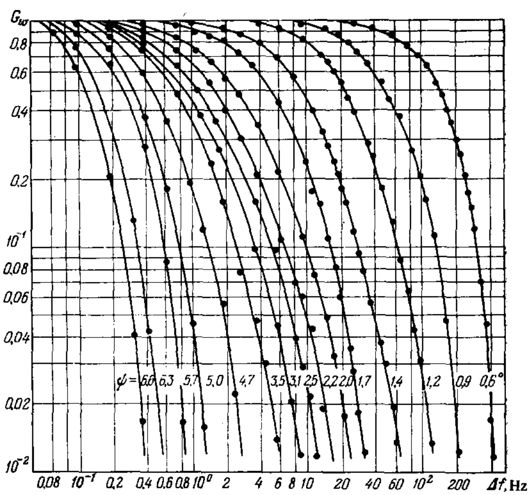

FIG. 1.

The shapes of the wings of the energy spectra of the radio waves yield information on the spatial spectrum of the small-scale inhomogeneities of the electron density, with dimensions $l < 200$ km. It was found that these plasma inhomogeneities are described by the Kolmogorov-Obukhov spectrum.

The width of the radio-wave spectrum is systematically larger when the satellite sets behind the sun than during its rise. This phenomenon was used to determine the velocity v of the solar wind. The obtained dependence of the velocity v on the distance to the center of the sun is shown in Fig. 2 (solid curve 1). The dashed curve in Fig. 2 corresponds to Parker's theory. The dependence of the variance σ_N of the fluctuations of the electron density on the distance R was obtained (curve 2). It is shown that at $R = (1.5-6)\times 10^6$ km the plasma is strongly turbulent, and its small-scale inhomogeneities decrease rapidly, like $\sigma \propto R^{-4}$, when R is

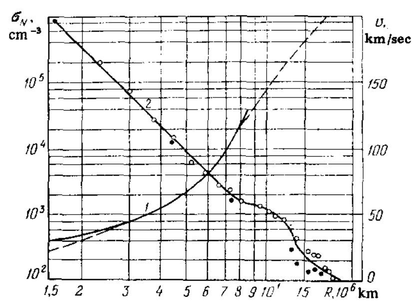

FIG. 2.

increased. In the region $R = (7-12) \times 10^6$ km the velocity of the solar wind is close to the velocity of the plasma waves; the relative inhomogeneity of the plasma, σ_N/N is larger here, possibly as a result of formation of shock waves.

An analysis of the frequency fluctuations yielded information on the larger-scale part of the inhomogeneity spectrum $2 \times 10^2 < l < 10^4$ km. The temporal spectrum of the frequency fluctuations is approximated by a power law with a spectral exponent 0.6. The spatial spectrum of inhomogeneities having the indicated dimensions is therefore likewise close to a Kolmogorov-Obukhov spectrum. However, the change of the intensity of the large-scale inhomogeneities with changing radial distance is much slower than that of the small-scale part of the turbulence spectrum.

[1]M. A. Kolosov, O. I. Yakovlev, and A. I. Efimov, in: Issledovaniya kosmicheskogo prostranstva (Investigations of Outer Space), Nauka, 1965, p. 227. O. I. Yakovlev, Rasprostranenie radiovoln v Solnechnoĭ sisteme (Radio Wave Propagation in the Solar System), Moscow, Sov. Radio, 1974.

[2]O. I. Yakovlev, B. P. Trusov, V. A. Vinogradov, A. I. Efimov, Yu. M. Kruglov, S. S. Matyugov, and V. M. Razmanov, Kosm. Issled. **12**, 600 (1974). O. I. Yakovlev, E. P. Molotov, Yu. M. Kruglov, A. I. Efimov, V. M. Razmanov, T. S. Timofeeva, and V. K. Shtrykov, Radiotekh. Élektron. **22**, 260 (1977).