INVESTIGATION OF REFLECTIONS OF METER RADIO WAVES BY THE SURFACE OF THE MOON

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Fig. 1

Figure 1: Fig. 1

Abstract

Full Text

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INVESTIGATION OF REFLECTIONS OF METER RADIO WAVES BY THE SURFACE OF THE MOON

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Analysis of the reflection and scattering of radio waves was previously carried out by means of lunar ranging; these studies made it possible to determine the effective cross section and the angular spectrum of backscattering of radio waves ([1]). A new possibility for investigating another characteristic of the lunar surface is provided by artificial satellites of the Moon; in this case it becomes possible to determine the dependence of the reflection coefficient η on the grazing angle ψ. When radio waves emitted by a lunar satellite are received on the Earth, two field components are observed, corresponding to the direct and reflected rays. Because of the difference in the Doppler frequency shift of these components, their separate recording is possible and, consequently, determination of the dependence $\eta(\psi)$.

From 30 VIII to 27 IX 1966 we measured the reflection and scattering of meter radio waves $\lambda \approx 1.7$ m emitted by the Luna-11 satellite. This satellite had an orbit inclined by 27° relative to the plane of the lunar equator, and a period of revolution close to 3 hours ([2]). An orbit close to equatorial made it possible to measure reflection coefficients as the grazing angle varied from 0 to 80°. In all, 65 reliable measurements of the reflection coefficient were made. These measurements were combined into groups, each of which included values of the reflection coefficient at close grazing angles. The final value of the reflection coefficient was determined by averaging the measurement results within the group. The maximum reflected signals corresponding to horizontal polarization of the radio waves were recorded. During the measurements, the distance from the satellite to the region significant for reflection was within the limits of $500 \div 1200$ km.

Fig. 1

Figure 1 shows the obtained dependence of the voltage reflection coefficient on the grazing angle. The reflection coefficient at $\psi = 90^\circ$ is plotted according to lunar ranging data ([1]). It follows from the figure that the reflection coefficient depends only weakly on the grazing angle for $\psi = 40 \div 90^\circ$; thus, at $\psi = 40^\circ$ we have $\eta = 0.40$, and at $\psi = 75^\circ$ we have $\eta = 0.30$. When the grazing angle decreases from 15 to 0°, a rapid increase of the reflection coefficient is observed; at $\psi = 7^\circ$ we have $\eta = 0.69$.

We also carried out a preliminary analysis of the spectrum of the reflected and scattered field. This analysis showed that, in the main, a specular field component is observed with a frequency bandwidth of less than 20 Hz; a diffuse component, covering a larger frequency range, is recorded irregularly.

Investigation of the dependence of the reflection coefficient on the grazing angle makes it possible to obtain data on the dielectric permittivity of lunar rocks. Comparison of the curve in Fig. 1 with the theoretical dependence $\eta(\psi)$ for a plane surface shows that $\varepsilon \approx 3$. We note that the value of the dielectric permittivity estimated in this way is an average for the range of depths that are significant in the reflection of meter radio waves. Below the surface rocks with $\varepsilon \approx 3$ there are, apparently, rocks with a higher value of the dielectric permittivity.

It must be emphasized that the results of the measurements may have been influenced by the roughness and curvature of the lunar surface. A detailed presentation of the results of investigations of the reflection and scattering of radio waves by the surface of the Moon will be given elsewhere.

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2. *Pravda*, No. 237 of 25 VIII 1966; No. 242 of 30 VIII 1966.

Note: Figure translations are in progress. See original paper for figures.