Kotelnikov Institute of Radio Engineering and Electronics of the Russian Academy of Sciences

2. Completed space missions. Results obtained by Russian scientists in 2014-2015

2.1 Radar observations of Venus and Mars

In 2012, Kotelnikov IRE RAS, after 20-year break, resumed radar observations of planets via modernized planetary radar based on RT-70 radiotelescope in Yevpatoria. Radar observations of planets were conducted during preparation phase of the space mission “Phobos-Grunt” in cooperation with (M.V. Keldysh IPM RAS) and “JSC Russian Space Systems”.

Modernization of the radar, made by JSC RSS, implied in creation of principal new forming, receiving and processing paths of planetary radar signals, which allowed to create a powerful system with the ability to change the probing signal parameters over a wide range, pre-processing of the received signal and recording scientific data flow up to 10 Mbit/s rate.

Recording of the reflected signal in a wide band was possible as a result of the modernization of the registration system, enabling to conduct the radar research in a new environment and new modes. In particular, it was possible to conduct the radar signal radiation with fixed parameters, and remove all Doppler deformations of the carrier and waveform at the stage of digital processing by the computer, after registration of the echo signal in a wide band. It made possible to record and process the echo signal of all the informative bands, to build radar images of the surface of the planet Venus. This radar mode is used for all later sessions of radar measurements of Venus and Mars in 2012.

The powerful algorithmic software for processing planetary radar data, providing highly accurate measurements of parameters of planetary motion,

created in Kotelnikov IRE RAS for the work with the help of modernized radar.

In June 2012, it was conducted over 30 sessions of radar observations of Mars and Venus, allowing to measure distance and speed of these planets. In these radar sessions of Venus observations S/N ratio exceeded 30 dB, which allowed to perform reliable measurements of distance to the planet. It was found that the distance to the planet in June 2012 was 3.8 km more than the forecast.

In 2012, the results of the planetary exploration showed the readiness of radar equipment and mathematical software for the regular work in planetary radar modes.

2.1 Characteristics of the ground and relief of two new areas in the southern polar region of Venus obtained from reanalysis of results of the "Venera-15" bistatic radar measurements at wavelength of 32 cm

At the first time the distributions of the reflection coefficient η^2 and the rms values of the small-scale slopes of surface γ^0 (expressed in degrees) have been obtained in two southern polar regions located in the Shelikhova Patera. The results have been found by reanalysis of bistatic radar experiments carried out by "Venera-15" satellite installed in the orbit around the Venus in 1983. According to the altimetry measurements provided by the "Magellan" (USA) orbiter, the height of long-scale relief in these plain regions varies in the range from 0 to -500 m relative to the average spherical planetary surface with radius of 6051.8 km [1].

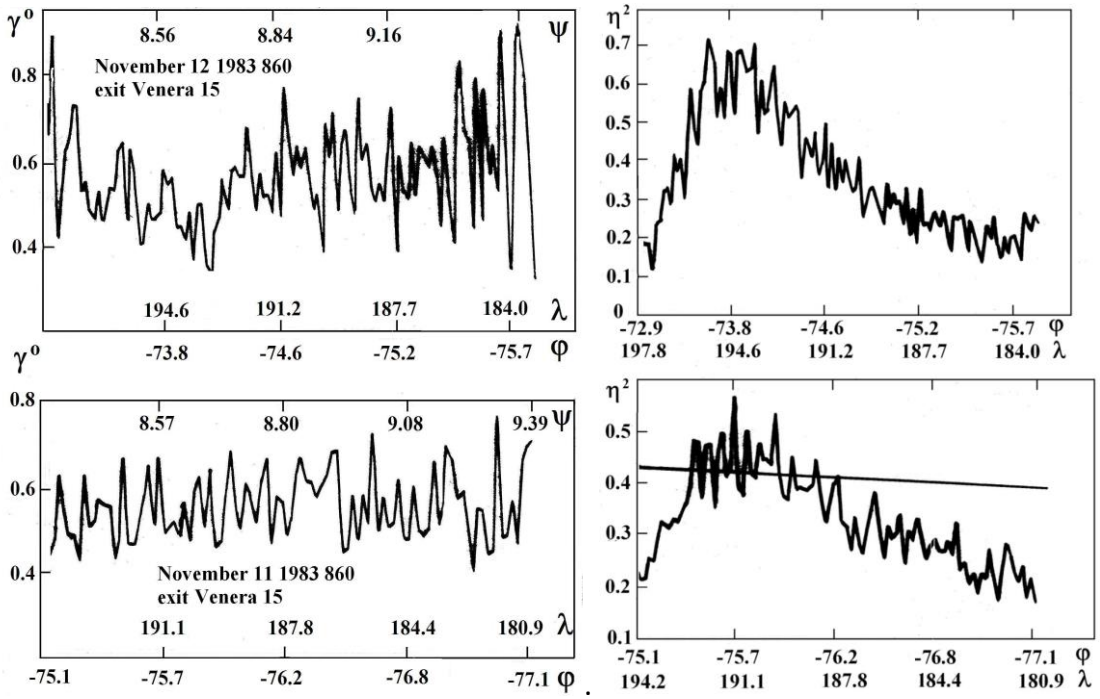

Fig. 1. The reflection coefficient η^2 (right) and values of the rms roughness slopes of the micro-relief γ^0 (left) on horizontal bases from a few meters to a kilometer measured using of the unmodulated radar signal of the "Venera-15" satellite in two regions of the south polar region of the planet. The lower horizontal axes represent the latitude φ and longitude λ in venerocentric coordinate system. The values of radio waves grazing angle in degrees are marked on the top horizontal axis. The straight line in the lower part of the figure 1 (right) shows the theoretical dependence of the reflection coefficient of the circularly polarized the radio waves for smooth, non-conductive surface with a dielectric constant of 5.1.

In accordance with Figure 1, the roughness of the investigated regions is more than 1.5 times greater as compared with previously value measured by the bistatic radar in the northern polar plains of Venus [2]. Changes in the reflectivity correspond to results of the measurements made with the help of apparatus "Magellan" [3,4] and the RSA "Venera-15, 16" [5] - in the case of low soil conductivity, having a density of about 3 g / cm3.

Up until now, research carried out with the help of apparatus "Venera-15, 16", are the single and unique bistatic radar experiments conducted in the polar regions of Venus.

A.G. Pavelyev, S.S. Matyugov, A.A. Pavelyev, R.R. Salimzjanov
Kotelnikov' IRE RAS
pvlv@ms.ire.rssi.ru

References

1. Lazarev E.N., J.F. Rodionova, V.V. Shevchenko. Venus Relief Map. MSU Sternberg State Institute. 2010.
2. Pavelyev A.G., O.I. Yakovlev, O.I. Rzhiga, A.I.Kucherjavenkov, R.A. Andreev, A.I. Zaharov, C.G. Rubashkin, R.R. Salimzjanov. Bistatic radar investigation of the northern polar region of Venus using the «Venus-15» satellite. Cosmic research 1990. V. 28, No. 1. Pp.125-133.
3. Johnson W.T.K. Magellan imaging radar mission to Venus. Proc. IEEE, 1991, V. 79, No. 6, P. 777–790.
4. Pettengill G.H., P.G. Ford, and R.A. Simpson Electrical Properties of the Venus Surface from Bistatic Radar Observations. Science.1996. Vol. 272, pp. 1628-1631.
5. Rzhiga O.N. A new era of Venus investigation. Radar imagery using satellites «Venera-15» and «Venera-16».,News in life, science, technology. «Space and Astronomy» 1988. № 3. P. 1-64. Moskow, Znanie Ed. (In Rusian).