A STUDY OF IONOSPHERIC REFRACTION OF RADIO WAVES FROM OBSERVATIONS OF COSMIC RADIO SOURCES USING THE RADIO TELESCOPE URAN-4

V.V. Galanin[1], Ya.V. Derevyagin[2], V.G. Derevyagin[1]

[1] URAN-4 Observatory, Institute of Radioastronomy NASU
Pushkinskaya str. 37, Odessa 65011 Ukraine, *uran@paco.net*
[2] Radiotechnical department, Odessa National Polytechnic University
Shevchenko av. 1, Odessa 65044 Ukraine, *rtu@rtf.ospu.odessa.ua*

ABSTRACT. The questions of the ionosphere refraction account at radiosources observation on the radiotelescope URAN-4 at 20-25 MHz are considered. The experimental data are received which will be coordinated to results of ionosphere refraction modeling.

Key words: Radiosource, refraction, ionosphere

The radiotelescope, RT, URAN-4 (Galanin et al., 1989) is one of elements of the radio interferometer long baseline system. The operating frequency range of system is 10-30 MHz. The antenna of the instrument consists of 128 crossed dipoles forming the phased array with dimensions of 232.5 x 22.5 m. The hardware of telescope provides receiving of the radio signals with two linear polarizations. The instrument as part of the radio interferometer with a very long baseline (radiotelescopes UTR-2 and URAN-4) and to perform research in a single regime as well is used. The instrument antenna pattern HPBW at frequency 25 MHz is 2.7°x22°.

Simultaneously at two frequencies 20 and 25 MHz the space radiosources observations carry out by modulation radiometers. The computer saves received information on the disk and operates orientation of directional pattern in the space. The information about sources and the current time synchronized by digital clock standard in the computer are entered.

The ionosphere provides the essential influence on the space radiosources radiowave propagation in the HF band. The variations of its electronic density create heterogeneities, which cause refraction as shift of a seen location of the radiosource.

It is known, that were are a right ascension refraction Δt and a declination refraction $\Delta\delta$. Refraction carries regular and not regular character. Usually it's value depends from a ionosphere condition, Sun zenithal corner, time of day.

The given work is devoted to an opportunity of an experimental research of the refraction with using of the radiotelescope URAN-4.

The technique of measurement of the refraction value is known. It is based on measurement of the refraction angle, using comparison of a radiosource location to its true calculated coordinates. For an illustration of this method figure 1 is given. In this figure the record of a source 3C-144, received at June 20 in 1998 year in day time on the frequency 25 MHz is represented. In the experimental directional pattern, DP, is entered calculated DP with determined width. The measured and calculated DP position value is marked and the shift Δt by right ascension is determined. Also seen, that the source passes through DP before calculated time and the refraction carries positive character.

It is necessary to notice the RT URAN-4 have wide directional pattern by declination. The signal value change for the account influence of the refraction will be less than 0.5% at the shift value 20 angular minutes. Therefore the experimental investigation was carried out only on a right ascension.

The regular refraction dependences from time of day were given by Megn and Antonov (1973). From this work follows, that the refraction by right ascension Δt is minimal at night, and at forenoon and in the afternoon is maximal. Its character varies from negative to positive. Its minimal value makes units of angular minutes at night, and in the day time comes nearer 20 angular minutes.

Therefore the most suitable time for measurement of the refraction on RT URAN-4 is first and second half of day, when the refraction is maximal.

For refraction researches the source 3C-144 with the flux of radiation in 3300 jan was chosen. The measurements were carried out during Mays – Junes, when the source had the culmination in middle of day. The record 3C-144 was carried out by scans of 20th minutes in the hour angles range from -160 to +160 minutes on two frequencies 20 and 25 MHz simultaneously. It is necessary to note, that the character of record was

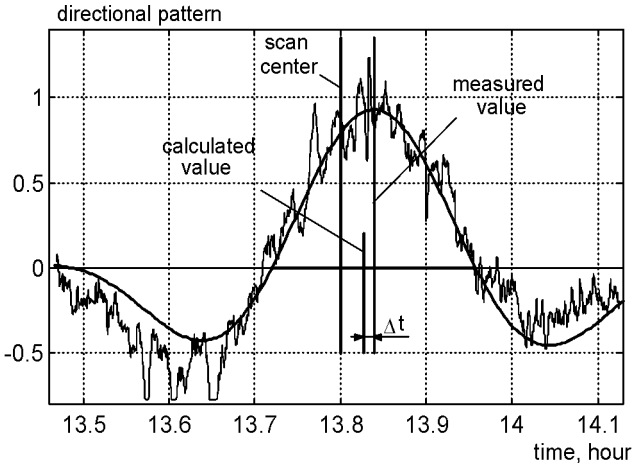

Figure 1: The refraction size definition by directional pattern displacement.

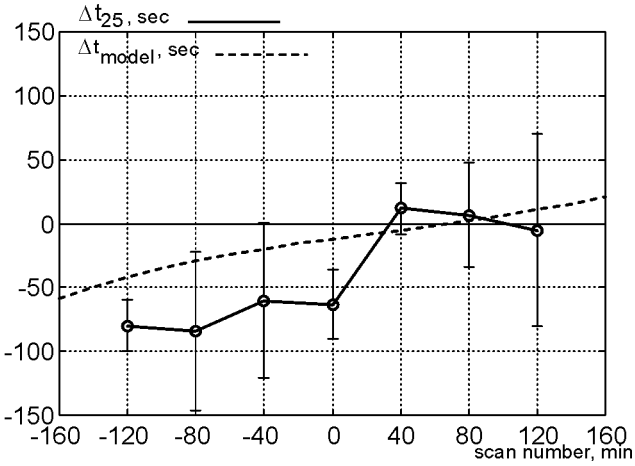

Figure 2: Comparison of the measured and calculated values of the refraction on the 25 MHz.

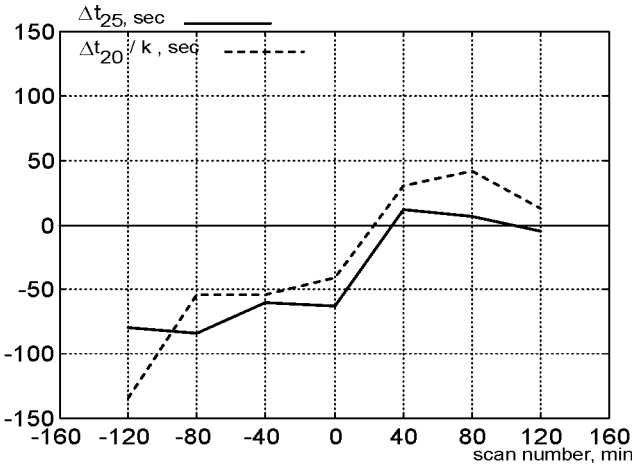

Figure 3: Comparison of the refraction average values $\Delta t_{20}/k$ and Δt_{25}.

affected by radiohandicapes and sporadic solar flares. Therefore the observation not subject to influence of handicapes were selected for processing. The processing included the described above standard procedure. Finally information was averaged and was analyzed.

In figure 2 the diagram of the dependence refraction value from a hour angle is submitted. It contain calculated and measured refraction values for frequency 25 MHz. The measured and average data received for the mentioned above period, are put on figure with confidential intervals. The calculated values of the refraction are received from ionosphere model which was described by Davies (1973) and Antonov (1973). It is submitted by a electronic concentration gradient which appears in consequence of Sun zenithal distance change. The refraction calculation was carried out for ionosphere model received at the square-law equation of recombination. The character of two curves basically is identical also calculated curve is in the field of confidential intervals.

The frequency dependence is important parameter which characterizes the refraction. It is known, that it should be square-law.

The average refraction values Δt obtained at the frequencies 20 and 25 MHz are shown in figure 3. The curve $\Delta t_{20\mathrm{MHz}}$ was drew as $\Delta t_{20\mathrm{MHz}}/k$, where k is a square ratio of 20 and 25 MHz. The curve character on 20 MHz basically repeats measurements on 25 MHz. Their divergence is caused of the unsufficient statistics of measurements.

From told above it is possible to make conclusions. The wide directional pattern and limited sensitivity of the radiotelescope URAN-4 allow to carry out by the specified technique of regular refraction measurement only on a right ascension and in a light time of day. As the directional pattern value of instrument by declination is 22°, its refraction displacement does not render an appreciable influence on measurements.

Acknowledgements. The authors express deep gratitude to O.A. Litvinenko for the valuable remarks and offers at discussion of results of the research.

References

Antonov A.V., *Ph.D.thesis*, Kharkov, 1973.

Davies K., *Ionospheric radio waves*, Moscow: Mir, 1973. (In Russian).

Galanin V.V., Inyutin G.A., Kvasha I.M., et al.: 1989, *Kinemat. Fiz. Nebesnykh Tel*, **5**, 5, 87.

Megn A.V., Antonov A.V.: 1973, *Radiofizika*, **16**, 9, 1434.