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ON THE REDUCTION OF OBSERVATIONS WHEN USING A RADIOINTERFEROMETER WITH A LARGE BASE

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SUMMARY

This note discusses the use of radiointerferometric systems for the study of angular dimensions and structures of various radio emission sources. The study is based on a proper assignment of antennas' and source's mutual position.

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The investigation of the angular dimension and of the structure of a series of radio emission sources requires the application of angle-measuring devices with high resolution. With this in view radiointerferometric systems are used, whose angular resolution is determined by the relation λ/S, where λ is the wavelength of the received radiation, S is the distance between interferometer antennas. The reduction of observations by interferometer (see, for example, [1-2]) provides the possibility of obtaining the spatial distribution of radiobrightness about the source. To that effect such formation of spatial characteristics of interferometer's antenna characteristics is required, which would allow obtaining the spectrum of spatial radioemission frequencies and investigating by way of inverse Fourier transformation the angular structure of the emission source.

When the distance between antennas is small, in order to investigate the spatial frequency and the position of the plane of radiation pattern's lobe it is sufficient to be aware of the distance between antennas, which can be measured directly, and the position of the source with respect to the center of interferometer antenna system or of one of its antennas. However, when the distance

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(*) O REDUKTSII NABLYUDENIY RADIOINTERFEROMETROM S BOL'SHOY BAZOY between antennas is great, the error on account of such an approximate assignment of the mutual emission source's and system's antenna may be found to be greater than the resolution of the interferometer. In connection with this and in order to fully realize the possibilities of the interferometer, we must assign a precise mutual position of antennas and of the source.

In the present work the spatial characteristics of radiointerferometer's antenna system are expressed by well known geographic coordinates of the points of antenna disposition. The general assignment of radiation pattern may be written in the form (see, for example [1, 2]):

$$A(\Theta) = A_0 A_1(\Theta) \cdot 4\cos^2 \cdot \frac{\pi x(\Theta)}{\lambda}$$

where $x(\Theta)$ is the difference in the course of rays from the investigated point of space to various radiointerferometer antennas, A_0 is a normalizing multiplier, $A_1(\Theta)$ is the radiation pattern of an isolated antenna.

The quantity $x(\Theta)$, where Θ determines the direction at the investigated point of the emission source, may be found as the difference of projections of Earth's radii r_1 and r_2, passing through the points of antenna disposition with coordinates ϕ_1, Λ_1 and ϕ_2, Λ_2 on the radius passing through the "geographic spot" of the investigated point source. The "geographical spot" is the point of the Earth, at which the source is found to be at zenith and which is determined by the coordinates $\phi_S = \delta$, $\Lambda_S = \alpha - S_{Gr}$, where δ is the declination of an elementary source, α is its right ascension, S_{Gr} is the sidereal Greenwich time. Using formulas of spherical trigonometry, we find [3]:

$$x = r_1 \cos\gamma_1 - r_2 \cos\gamma_2,$$

where

$$\cos\gamma_1 = \sin\phi_1 \sin\delta + \cos\phi_1 \cos\delta \cos(\Lambda_1 - \alpha + S_{Gr}),$$
$$\cos\gamma_2 = \sin\phi_2 \sin\delta + \cos\phi_2 \cos\delta \cos(\Lambda_2 - \alpha + S_{Gr}).$$

The radiation pattern of the interferometer with respect to the source is written in the form

$$A(\delta,\alpha) = A_0 A\ (\delta_0 - \Delta\delta,\ \alpha_0 - \Delta\alpha)\ 4\cos^2 \frac{\pi x(\delta_0 - \Delta\delta,\ \alpha_0 - \Delta\alpha,\ D)}{\lambda}$$

where δ_0 and α_0 are the coordinates of the geometric center of the "visible" surface of the emission source, D is Moscow time of the respective calendar date.

The position of the plane of radiation pattern lobe is determined by the position of the radiosignal zone

$$x(\alpha,\delta) = \text{const}.$$

At source tracking by antennas the spatial characteristics of the antenna system according to the source are determined only by the values

$$\frac{x}{\lambda}(\alpha,\ \delta,\ D).$$

The above computations allow us to investigate the variation of x on account of the daily rotation of the Earth for each concrete source and to utilize these variations so as to obtain the source's radioimage.

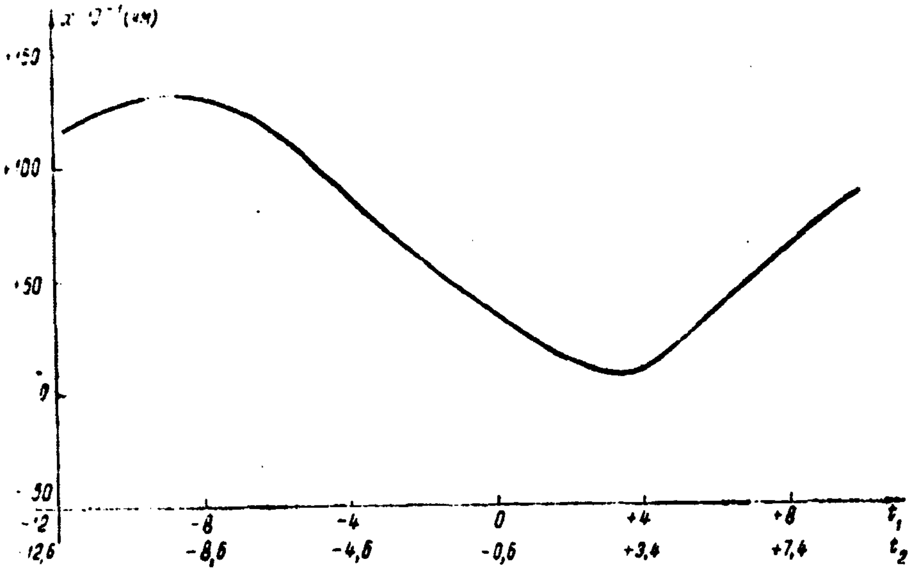

Fig.1. Daily variation of the difference in the course (x) from the source to interferometer antennas. The source is Cassiopea; the antenna coordinates are $\phi_1 = 56°09\ 6'$, $\Lambda_1 = 2°57.1'$, $\phi_2 = 44°55.9'$, $\Lambda_2 = 2°20.9'$; $t_{1,2}$ is the source's hourly angle for the given antenna

The spatial frequency may be determined by the graph x(t) by way of variation of the time interval T as x varies by the quantity $\Delta x = \lambda$, i.e.

$$x(t_0) - x(t_0 + T) = \lambda,$$

and the determination of the angular shift of the source corresponding to this time interval.

The quantity $\frac{dx}{dt} f_0/c = f_u$, where f_0 is the frequency of the received radiation, c is the speed of light, is the frequency of interference of emission signals received by interferometer antennas.

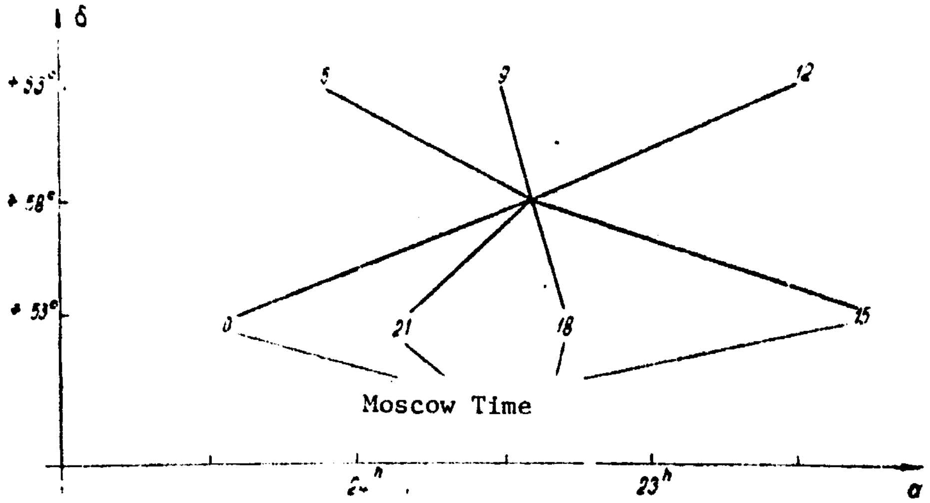

Fig.2. Daily variation in the position of the plane of radiation pattern's lobe plane relative to the source

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*** THE END ***

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