In determining the accuracy of angular measurements carried out with optical-electronic instruments, it is convenient to make use of the "modulation characteristic," i.e., the relation between the output signal and the angular displacement at the input. The modulation (or direction-finding) characteristic provides useful information regarding the accuracy potentialities of the optical-electronic goniometer within the working angle of the field of view [1]. The present method of plotting the modulation characteristics of optical-electronic goniometers lies in successively measuring the output signal for a series of discrete angular displacements $\alpha_1, \alpha_2, \ldots, \alpha_n$ [2].

In order to reduce the effect of random errors on the results of the measurements, repeated settings are made on the emitter (target) for every specified value of $\alpha_i$, and corresponding readings of the output signal are recorded. The number of individual settings on the emitter is chosen in such a way as to ensure a reliable determination of the dispersion of the setting error in each particular case. The actual modulation characteristic of the optical-electronic instrument under consideration is obtained by averaging over the various individual realizations.

The question as to the best interval $\Delta \alpha$ to be taken between two neighboring discrete angular displacements at the input of the optical-electronic instrument, i.e., the "discreteness of the angular specification", still remains to be decided.

The discreteness of angular specification $\Delta \alpha$ clearly depends on the closeness of the relationship between the errors of the optical-electronic instruments corresponding to different displacements. The closeness of the relationship between these errors is in turn determined by the form of the correlation error function characterizing the measurement of angles by means of the optical-electronic devices.

The form of the correlation function $k = \varphi(\alpha)$ characterizing the errors committed in measuring angles with the optical-electronic instruments thus determines the value of the angular range $\Delta \alpha$.

It should be remembered that, in the majority of cases, the factor limiting the accuracy of angular measurements with optical-electronic instruments under laboratory conditions is the turbulence of the medium through which the radiation is propagated, this turbulence arising from the structural instability of the medium [3]. It would therefore be interesting to find an expression for the correlation function $k = \varphi(\alpha)$ governing the errors in angular measurements arising from the instability of the medium carrying the radiation. In order to derive such a relationship under normal laboratory conditions, amplitude devices of different constructions, working on the principle of the alternate comparison of radiant fluxes (already quite widely used in technology), were employed as optical-electronic goniometers. The method adopted was as follows. Using a special emitter placed at a certain distance from the entrance pupil of the optical-electronic goniometer [2], a series of angular displacements was made, and repeated readings of the output signal were recorded for each of these. The discreteness of the angular specification was taken as $\Delta \alpha = 0.02^\circ$. In each series of measurements, some 40 settings were made on the emitter, in order to secure a reliable determination of the error dispersion. In different series of measurements we used optical-electronic instruments of different sizes and different measuring devices; measurements were also carried out at different times of the day and in different laboratories. Some of the results of the experimental measurements of errors arising in optical-electronic instruments as a result of the instability of the medium carrying the radiation under normal laboratory conditions are shown in Table 1.
The results presented in the table show that the dispersion of the setting errors with respect to the emitter is independent of the angular displacement $\alpha$. The random setting-error function relating to the emitter may therefore be regarded as stationary. Allowing for this fact, we may apply certain well-known methods [4, 5] to the experimental data, and so plot curves of $k = \varphi(\alpha)$. The family of these curves may be "averaged" by one particular curve $k_{av} = \varphi(\alpha)$, which may itself be approximated by an expression of the following form

$$k = \sigma^2 e^{-\lambda |\alpha|},$$

where $\sigma^2$ is the relative dispersion of the errors committed in setting on the emitter and $\lambda$ is a constant parameter.

We found that, for the optical-electronic instruments under consideration, under normal laboratory conditions $\sigma^2 \approx 0.95$; $\lambda \approx 7 \cdot 10^5$.

Existing techniques [6] were also applied to Eq. (1) in order to obtain the following relation for the spectral density of the dispersion of the random-error function relating to the angular measurements:

$$S(\omega) = \frac{2.1 \cdot 10^5}{0.49 \cdot 10^{12} + \omega^2},$$

where $\omega$ is the spatial frequency, defined in the present case as $\omega = 1/\alpha_0$.

The maximum value of the spatial frequency $\omega_{\text{max}}$ may be found from existing principles [5, 6]

$$S(\omega_{\text{max}}) = 0.1.$$  \hspace{1cm} (3)

Taking account of Eq. (2), we may analyze Eq. (3) so as to give the following maximum spatial frequency $\omega_{\text{max}}$ of the spectrum representing the dispersion of the random error function for angular measurements by the optical-electronic instruments, arising as a result of the medium carrying the radiation:

$$\omega_{\text{max}} \approx \frac{1}{\left(0.1\right)^\frac{1}{18}}.$$  \hspace{1cm} (4)

We may thus consider that the spectrum representing the dispersion of the random error function for angular measurements by the optical-electronic instruments is limited by a spatial frequency $\omega_{\text{max}} = 1/0.1\omega$, while the remaining harmonics of the spectrum may be neglected, at any rate to an accuracy sufficient for practical purposes. Allowing for the fact that the correlation function $k = \varphi(\alpha)$ has a limited spectrum in the range (correlation interval) $0 \leq \alpha \leq \alpha_{\text{max}}$ (where $\alpha_{\text{max}}$ is the maximum value of the angle for which there is practically no correlational relationship), we see that, in accordance with Kotel'nikov's theorem, the function in question is completely determined by $N = 2\alpha_{\text{max}} \cdot \omega_{\text{max}} \approx 14$ terms, while the discreteness of angular-displacement specification is given by

$$\Delta \alpha = \frac{1}{2\omega_{\text{max}}} \approx 0.05\omega.$$  \hspace{1cm} (5)

Thus, in order to ensure a reliable reproduction of the modulation characteristics of the optical-electronic goniometers under consideration, the discreteness of angular-displacement specification should be equal to $0.05\omega$ over the whole field of view under normal laboratory conditions.