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Abstract

Full Text

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DISTRIBUTION OF RADIATION INTENSITY MEASURED BY A WIDE-ANGLE RECEIVER

(Presented by Academician I. V. Obreimov, 11 VII 1962)

Measurement of the brightness distribution along a given almucantar or along some other observing path is usually carried out with apparatus having a wide angle of view. As a result of observations it is often necessary to obtain the distribution of the intensity referred to a sufficiently small solid angle. This proves possible when the angular distribution $K(a)$ of the sensitivity of the radiant-energy receiver is known.

Let us consider, for example, the measured brightness field $\tilde{I}(\psi)$ as a function of the azimuth ψ, using a receiver that cuts out a section of the path from $\psi-\omega$ to $\psi+\omega$.

The observed smoothed intensity $\tilde{I}(\psi)$ is related to the true $I(\varphi)$ by the integral equation

$$\tilde{I}(\psi) = \frac{1}{2\omega}\int_{\psi-\omega}^{\psi+\omega} K(\psi-\varphi)\, I(\varphi)\, d\varphi. \quad (1)$$

The Fourier series expansions of the known functions—the measured intensity and the sensitivity—have the form

$$\tilde{I}(\psi) = \frac{A_0}{2} + \sum_{n=1}^{\infty} A_n \cos n\psi; \quad (2)$$

$$K(\psi-\varphi) = \frac{a_0}{2} + \sum_{n=1}^{\infty} a_n \cos n\frac{\pi}{\omega}(\psi-\varphi). \quad (3)$$

We shall seek the unknown intensity in the form of the expansion

$$I(\varphi) = \frac{\alpha_0}{2} + \sum_{n=1}^{\infty} \alpha_n \cos n\varphi + \sum_{n=1}^{\infty} \beta_m \sin m\varphi. \quad (4)$$

Substitution of (2), (3), (4) into (1) makes it possible to find

Fig. 1

Figure 1: Fig. 1

$$\alpha_n = \frac{2\omega A_n}{\sum_{m=0}^{\infty} a_m \left[\frac{\sin(m\pi/\omega + n)\omega}{m\pi/\omega + n} + \frac{\sin(m\pi/\omega - n)\omega}{m\pi/\omega - n}\right]}; \tag{5}$$

$$\beta_n = \frac{2\omega B_n}{\sum_{m=0}^{\infty} a_m \left[\frac{\sin(m\pi/\omega + n)\omega}{m\pi/\omega + n} + \frac{\sin(m\pi/\omega - n)\omega}{m\pi/\omega - n}\right]}, \tag{6}$$

where for $m = 0$ one should take $a_0/2$, and for $n = 0$, $A_0/2$.

Figure 1 gives the distribution $\tilde{I}$ (curve 1) for $K = 1$ and $\omega = 70°$, and also (curve 2) the corresponding intensity reconstructed

by formulas (5) and (6):

$$\tilde{I} = \frac{1}{2} I^* \left(1 + \frac{\sin 2\omega}{2\omega} \cos 2\psi\right); \tag{7}$$

$$I = \frac{1}{2} I^* (1 + \cos 2\psi). \tag{8}$$

In the case of an open registration path, when $\tilde{I}_\bullet = \tilde{I}(x)$, a particularly simple case is that of a U-shaped sensitivity characteristic $K = b$ for $|x - \xi| \leq a$, when instead of (1) we have

Fig. 1

$$\tilde{I}(x) = \frac{b}{2a} \int_{x-a}^{x+a} I(\xi)\, d\xi. \tag{9}$$

Differentiating (9) with respect to x, it is easy to obtain the formula

$$I(x + a) = I(x - a) + \frac{2a}{b} \tilde{I}'(x). \tag{10}$$

Expression (10) makes it possible to find the intensity values over an interval $2a$ from some initial value of it and from the measured smoothed values.

In conclusion I express my gratitude to K. Ya. Kondrat' ev, who took an active part in discussing the formulation of the present problem.

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named after Patrice Lumumba

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