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DECOMPOSITION OF ELECTROMAGNETIC WAVE INTO ORTHOGONALLY POLARIZED COMPONENTS BY AN ANTENNA SYSTEM

L. Ya. Il'nitskii and A. V. Fetsun

National Aviation University, Kiev, Ukraine

The paper gives theoretical substantiation of the possibility for usage of a turnstile antenna for representing the incident wave with circular polarization in an arbitrary polarization basis by two orthogonal waves with elliptical polarization and with ellipticity factors specified beforehand.

To investigate the polarization properties of electromagnetic waves, the linear orthogonal basis is most often used, when a wave with arbitrary polarization is represented in the form of two linearly polarized components, whose polarization planes are mutually perpendicular. It permits to employ a relatively simple mathematical apparatus, to deduce analytical expressions convenient for further transformations, and to interpret informatively the analysis results. Moreover, there is a large number of linear polarization antennas, which can be used for decomposition of electromagnetic wave into orthogonally polarized components and for experimental check of some or other analysis results [1]. However, in the linear polarization antennas we may encounter considerable errors arising from inaccurate orientation of the antenna.

The purpose of the paper is to prove theoretically the possibility of usage of turnstile antennas for representing a falling wave with circular polarization, set in an arbitrary polarization basis, by two orthogonal waves with elliptic polarization with a priori known ellipticity factors.

Let us substantiate some theoretical provisions used subsequently. Assume that the canonical representation of a wave with elliptic polarization has the form

$$\dot{\vec{E}} = \vec{x}_0 a \pm \mathrm{i}\vec{y}_0 ar \tag{1}$$

where $\dot{\vec{E}}$ is the vector of the electric field intensity, $\vec{x}_0$ and $\vec{y}_0$ are unit vectors of the rectangular coordinate system; a is the maximal amplitude of a component at decomposition of the wave in the linear orthogonal basis (represents the major semiaxis of the polarization ellipse); and $\pm r$ is the ellipticity factor. The plus sign corresponds to the right-hand direction of rotation of the vector $\dot{\vec{E}}$ while the minus sign — to the left-hand direction.

Let us prove several important assertions.

Theorem 1. The expression describing any circular polarization can be reduced to canonical form (1) by changing the instant of initial time counting and by rotating the coordinate system.

Let the electric field intensity of circular polarization be described by expression [1]

$$\dot{\vec{E}} = \vec{x}_0 \dot{g} + \vec{y}_0 \dot{h} \mathrm{e}^{\mathrm{i}\alpha} \tag{2}$$

where $\dot{g}$ and $\dot{h}$ are complex-valued amplitudes of intensities of the linearly polarized components, and α is the phase shift between the intensities of the orthogonal components. The angle α depends on the initial moment of time counting.

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