## Concerning the Orientation of the Antenna of an Ionosphere Station

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In a number of cases it is important to know how the orientation of an antenna system will affect the relative intensity of the magnetoionic components reflected from the ionosphere. Let us base an examination of this question on the fact that in the incidence of an electromagnetic wave upon the lower boundary of the ionosphere, two waves appear therein; the sum of their intensities yields that of the incident wave.

In magnetoionic theory, owing to the effect of the earth's magnetic field, the ionosphere is considered as anisotropic medium. In the general case, regardless of the orientation of the incident wave, the latter separates into two waves in the ionosphere; each of these waves is polarized elliptically.

In normal incidence of a plane-polarized wave upon the ionosphere, the lower boundary of which is located in the plane $xy$ (Fig. 1) and the direction of the earth's magnetic field $H^{(0)}$ is in the plane $yz$, the equation defining the state of polarization of the magnetoionic components is known to be:

$$K_{1,2}=\frac{E_{y;\,1,2}}{E_{x;\,1,2}} \tag{1}$$

$$=-i\,\frac{2\sqrt{u}\,(1-v-is)\cos\alpha}{u\sin^2\alpha\mp(u^2\sin^4\alpha+4u\,(1-v-is)^2\cos^2\alpha)^{1/2}},$$

where $K_{1,2}$ = the "polarization factors" of the extraordinary and ordinary waves

$E_{y;\,1,2}$ and $E_{x;1,2}$ = the components of the vector of the electric field strength for each type of wave.

$$\sqrt{u}=\omega_H/\omega=|e|H^{(0)}/mc\omega;$$

$$v=4\pi e^2N(z)/m\omega^2;$$

$$s=\nu/\omega;$$

$\omega_H$ = gyromatic frequency
$\omega$ = wave frequency
$m$ = electron mass
$e$ = electronic charge
$c$ = velocity of light in vacuo
$N$ = electron concentration
$\nu$ = effective electron collision frequency
$\alpha=\pi/2\pm I$ = the angle between the direction of wave propagation and the vector of geomagnetic field strength $H^{(0)}$ (the plus sign corresponds to an incident wave in the northern hemisphere.)
$I$ = the magnetic dip.

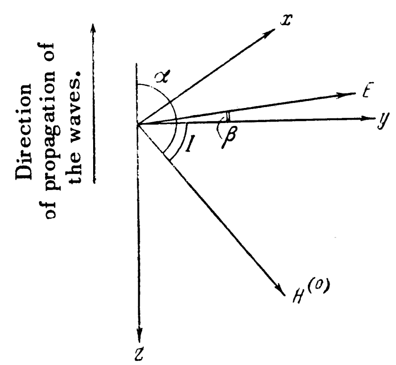


FIG. 1.

The upper sign before the radical in Eq. (1) refers to the ordinary wave, a wave of type 2; the lower sign refers to the extraordinary wave, a wave of type 1. At the lower boundary of the ionosphere we can assume $N\sim 0$; the equation for the polarization factors then reduces to the following (absorption neglected):

$$K_{1,2}=-i\,\frac{2\sqrt{u}\cos\alpha}{u\sin^2\alpha\mp(u^2\sin^4\alpha+4u\cos^2\alpha)^{1/2}}. \tag{2}$$

From this it is seen that at the magnetic pole ($I=90°$) the polarization of the magnetoionic components is circular and at the magnetic equator ($I=0°$) it is plane. At any other magnetic dip the polarization of the two magnetionic components approaches the circular as a function of their separation from the gyromagnetic frequency. For example, at frequencies of 1.5 – 5.0 mc the polarization is close to plane only in the vicinity of the magnetic equator. In high and middle latitudes ($I\gtrless 55°$) the moduli of the polarization factors differ from unity by not more than 10%. Equation (2) defines the state of polarization of the magnetoionic components corresponding to $H^{(0)}$ and $I$ for any given place, but it fails to give an answer for the distribution of energy between the magnetoionic components. Suitable data for this can be obtained from the following calculation.

Let the wave incident upon the ionosphere have, as usual, plane polarization and let the vector of the electric field strength $E$ of the wave form an angle $\beta$ with the axis $Oy$, coinciding with the magnetic meridian (Fig. 1). Let us examine the field at point $z = 0$. The incident wave can be represented in the form:

$$e_x = C \sin\beta \cos(\omega t - \gamma), \quad e_y = C \cos\beta \cos(\omega t - \gamma).$$

For the ordinary wave we can write:

$$e_{x_2} = A_2 \sin(\omega t - \delta), \quad e_{y_2} = B_2 \cos(\omega t - \delta).$$

For the extraordinary wave:

$$e_{x_1} = -A_1 \sin(\omega t - \varphi), \quad e_{y_1} = B_1 \cos(\omega t - \varphi).$$

It is necessary to find the relation between the major and minor semiaxes of the ellipses of polarization of the magnetoionic components ($|B_2/A_1|$ or $|A_2/B_1|$). Solving the equation given above (using the condition of continuity of the field vectors, we find:

$$\left|\frac{B_2}{A_1}\right| = \left(\frac{|K_2|^2 + \mathrm{tg}^2\beta}{1 + |K_2|^2 \mathrm{tg}^2\beta}\right)^{1/2}. \tag{3}$$

Now, using Eq. (3), we can compute how the energy is distributed between the magnetoionic components in the splitting of the plane-polarized wave. For this we must compare the average time values of the streams of the energies $S_{1,2}$ of the two waves:

$$S_2 = (c/4\pi)(A_2^2 + B_2^2), \quad S_1 = (c/4\pi)(A_1^2 + B_1^2).$$

In Fig . 2 we have plotted the graphs of $S_2/S_1 = f(\beta)$ for several values of $|K_2|$. From the plot it is seen that with circular polarization, $|B_2/A_1| = 1$ regardless of the angle $\beta$. The maximum dependence of the relative intensity of the components on the angle takes place with plane polarization. With $|K_2| = 1.05$, $S_2/S_1$ does not exceed 1.1. In other words, with $I \gtrsim 70°$, at the frequencies mentioned above, the average time values of the streams of the energies of the magnetoionic components at the lower boundary of the ionosphere do not differ by more than 10%. With $\beta = 45°$, which corresponds to antenna location in a NE-SW or SE-NW (magnetic direction, the ellipses of polarization and the average time values of the streams of the energies of the magnetoionic components are equal to each other.

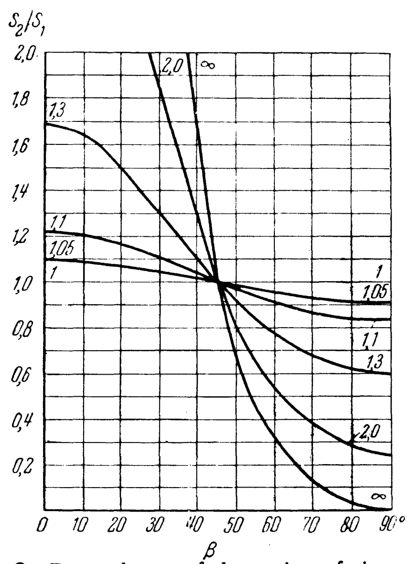


FIG. 2. Dependence of the ratios of time average values of energy flow of the magnetoionic components on the orientation of the transmitting antenna for various $|K_2|$.

The data obtained shows that if, for example, it is desired to have the magnetoionic components excited to the same degree in the ionosphere, which is sometimes important in the measurement of attenuation, the antennas should be disposed in a NW-SE or NE-SW direction. In case it is desired to "invest" the greatest possible energy in the ordinary component, the antenna should be located in a N-S direction.

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## Comparison of Stability of Nuclear Shells and Subshells

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An attempt is made in the present work to compare the stability of various nuclear shells and subshells on the basis of experimental data. To this end, the values of jumps in the curves of the separation energy $e_\alpha$ of an $\alpha$-particle in light and medium nuclei are studied.

Figure 1a shows a typical curve, first given by Elsasser[1], of the dependence of the energy of $\alpha$-decay on the number of neutrons in the nucleus, or the separation energy $e_\alpha$ of $\alpha$-particles on the number of neutrons in nuclei with equal Z. It should be noted that, if the decay energy $E_\alpha$ is in the positive direction of the $Y$ axis, the value of $e_\alpha$, having the opposite sign, increases in the negative direction of the $Y$ axis. There is a jump $\Delta e_\alpha$ of the curve $E = f(N)$, mainly in the interval from $N_m$ to $N_m + 2$,