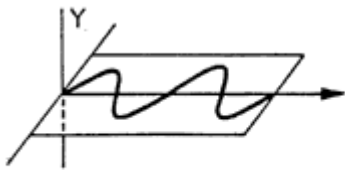
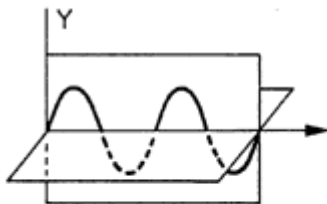


LINEAR POLARIZATION

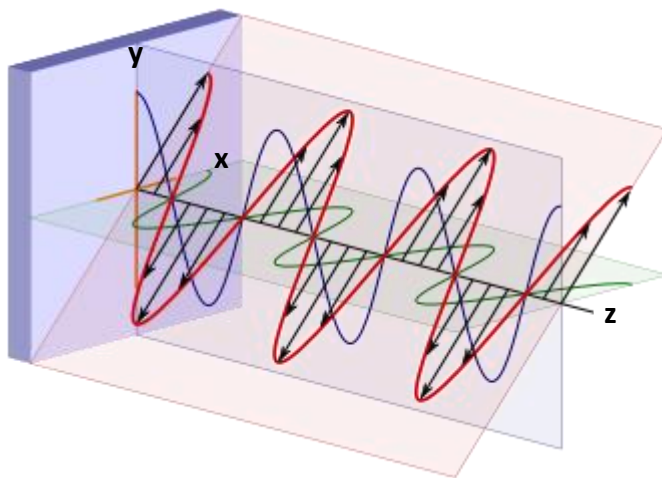


Linearly polarized along the x-axis, horizontal polarization



Linearly polarized along the y-axis, vertical polarization

Linear Polarized



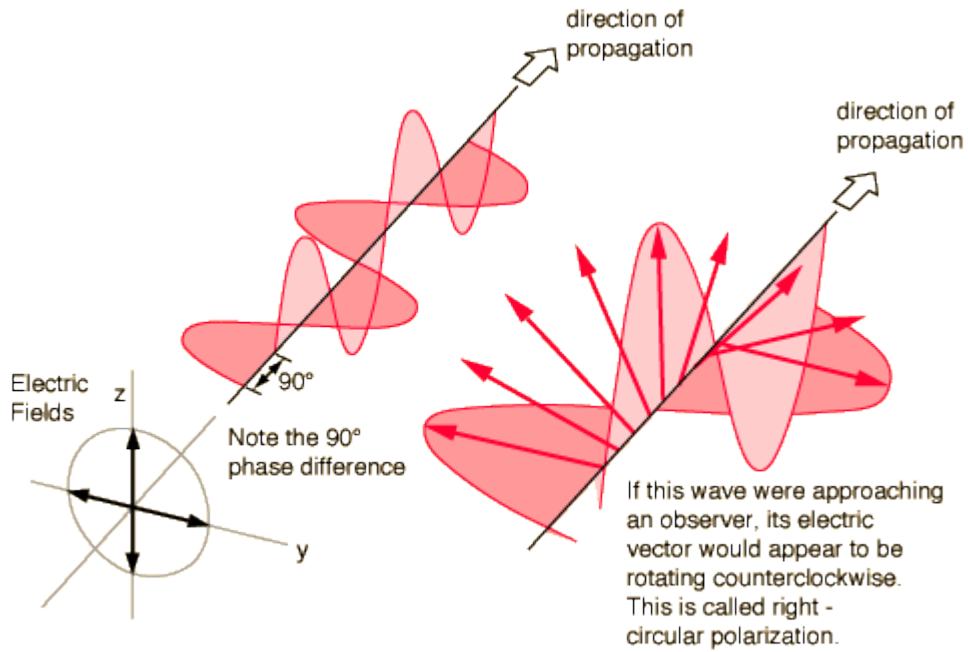
Linearly polarized at 45° to xz plane

For linear polarization to happen, the phase difference $\varphi = \phi_y - \phi_x$ between the two components $\vec{E}_x(z, t) = \hat{i} E_{0x} \cos(kz - \omega t + \phi_x)$ and $\vec{E}_y(z, t) = \hat{j} E_{0y} \cos(kz - \omega t + \phi_y)$ must be:

$$\varphi = 0 \quad \text{or}$$

$$\varphi = m\pi \quad \text{with} \quad m = \pm 1, \pm 2, \pm 3 \dots$$

CIRCULAR POLARIZATION

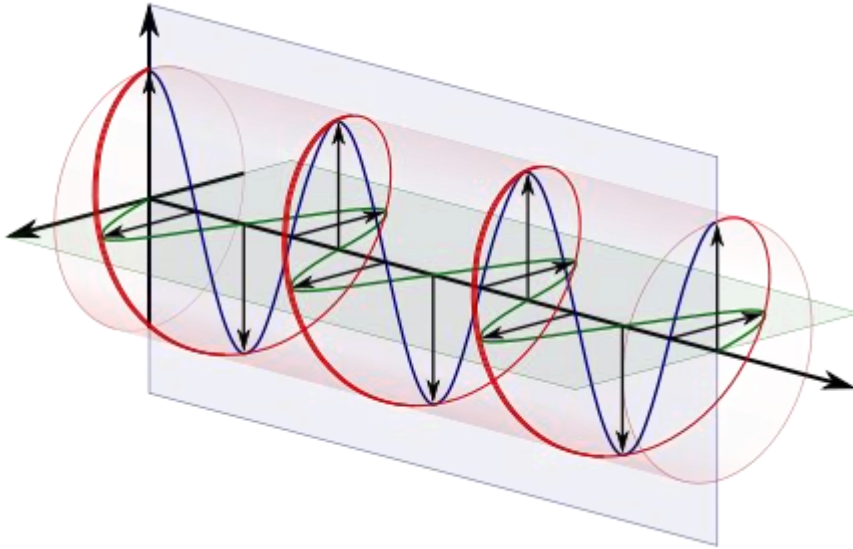


For circular polarization to happen, the amplitude and phase difference $\varphi = \phi_y - \phi_x$ between the two components $\vec{E}_x(z, t) = \vec{i} E_{0x} \cos(kz - \omega t + \phi_x)$ and $\vec{E}_y(z, t) = \vec{j} E_{0y} \cos(kz - \omega t + \phi_y)$ must be:

$$E_{0x} = E_{0y}$$

$$\varphi = \frac{\pi}{2} + m \cdot \pi \quad \text{with} \quad m = \pm 1, \pm 2, \pm 3 \dots$$

ELLIPTICAL POLARIZATION



In the most general case, when the amplitudes of the two components are unequal, the tip of the electric field vector traces out an ellipse.

Indeed the two components

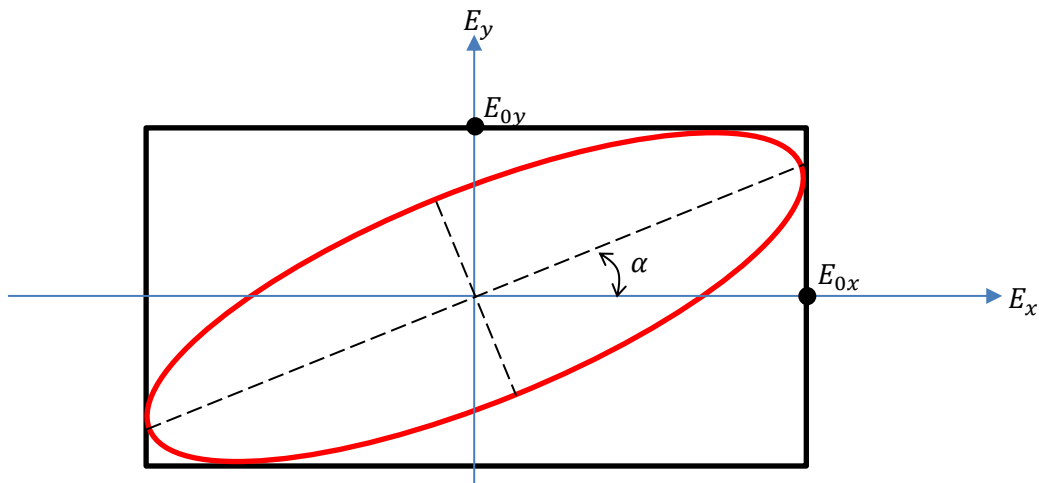
$$\begin{cases} \vec{E}_x(z, t) = \vec{i} E_{0x} \cos(kz - \omega t + \phi_x) \\ \vec{E}_y(z, t) = \vec{j} E_{0y} \cos(kz - \omega t + \phi_y) \end{cases}$$

are the parametric equations of the ellipse

$$\frac{E_x^2}{E_{0x}^2} + \frac{E_y^2}{E_{0y}^2} - 2 \frac{E_x E_y}{E_{0x} E_{0y}} \cos \varphi = \sin^2 \varphi$$

This is the equation of an ellipse tilted at an angle α to the x-axis. The value of α can be obtained from the equation

$$\tan 2\alpha = \frac{2E_{0x}E_{0y}}{E_{0x}^2 - E_{0y}^2} \cos \varphi$$



SUMMARY

