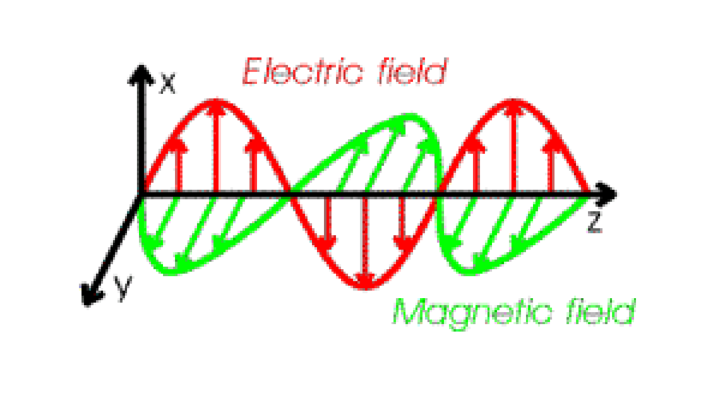
PRODUCTION AND ANALYSIS OF PLANE, CIRCULAR POLARIZATION LIGHT

B.TECH-IST

LIGHT AS AN ELECTROMAGNETIC WAVE

Light is a transverse wave,

an electromagnetic wave



MATHEMATICAL DESCRIPTION OF THE EM WAVE

Light wave that propagates in the z direction:

$$\vec{E}_x(z,t) = E_{0x}\cos(kz - \omega t)\,\vec{x}$$

$$\vec{E}_y(z,t) = E_{0y}\cos(kz - \omega t + \varepsilon)\,\vec{y}$$

GRAPHICAL REPRESENTATION OF THE EM WAVE (I)

One can go from:

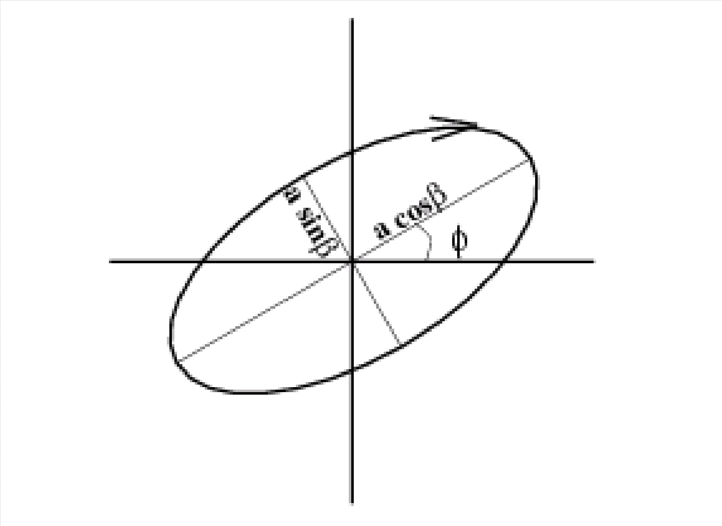
$$\vec{E}_x(z,t) = E_{0x}\cos(kz - \omega t)\,\vec{x}$$

$$\vec{E}_y(z,t) = E_{0y}\cos(kz - \omega t + \varepsilon)\,\vec{y}$$

to the equation of an … c identities, squaring, adding):

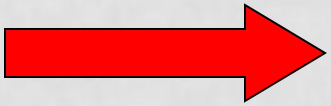
$$\left(\frac{E_x}{E_{0x}}\right)^2 + \left(\frac{E_y}{E_{0y}}\right)^2 - 2\frac{E_x}{E_{0x}}\frac{E_y}{E_{0y}}\cos\varepsilon = \sin^2\varepsilon$$

GRAPHICAL REPRESENTATION OF THE EM WAVE (II)



An ellipse can be represented by 4 quantities:

1. size of minor axis
2. size of major axis
3. orientation (angle)
4. sense (CW, CCW)

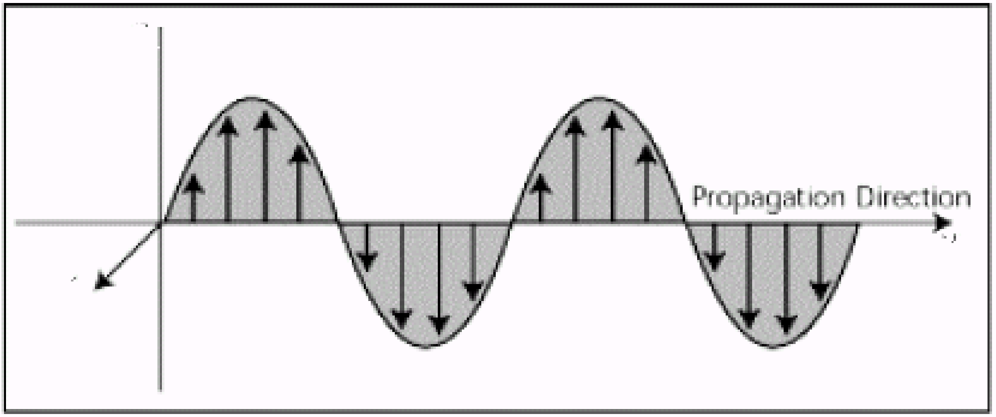


Light can be represented by 4 quantities...

VERTICALLY POLARIZED LIGHT

$$\vec{E}_x(z,t) = E_{0x}\cos(kz - \omega t)\,\vec{x}$$
$$\vec{E}_y(z,t) = E_{0y}\cos(kz - \omega t + \varepsilon)\,\vec{y}$$

If there is no amplitude in x ($E_{0x} = 0$), there is only one component, in y (vertical).

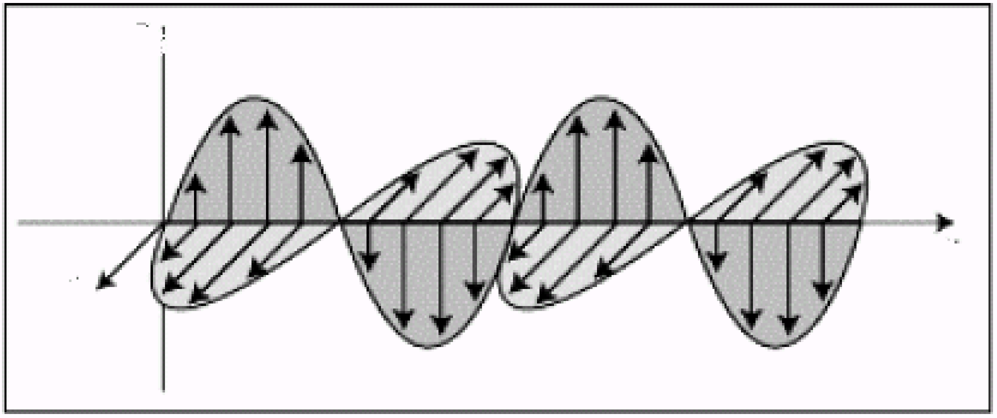


A. Linearly Polarized Light in the Vertical Direction

POLARIZATION AT 45º (I)

$$\vec{E}_x(z,t) = E_{0x}\cos(kz - \omega t)\,\vec{x}$$
$$\vec{E}_y(z,t) = E_{0y}\cos(kz - \omega t + \varepsilon)\,\vec{y}$$

If there is no phase difference (ε=0) and $E_{0x} = E_{0y}$, then $\mathbf{E}_x = \mathbf{E}_y$



B. Linearly Polarized Light at 45 Degrees

POLARIZATION AT 45º (II)

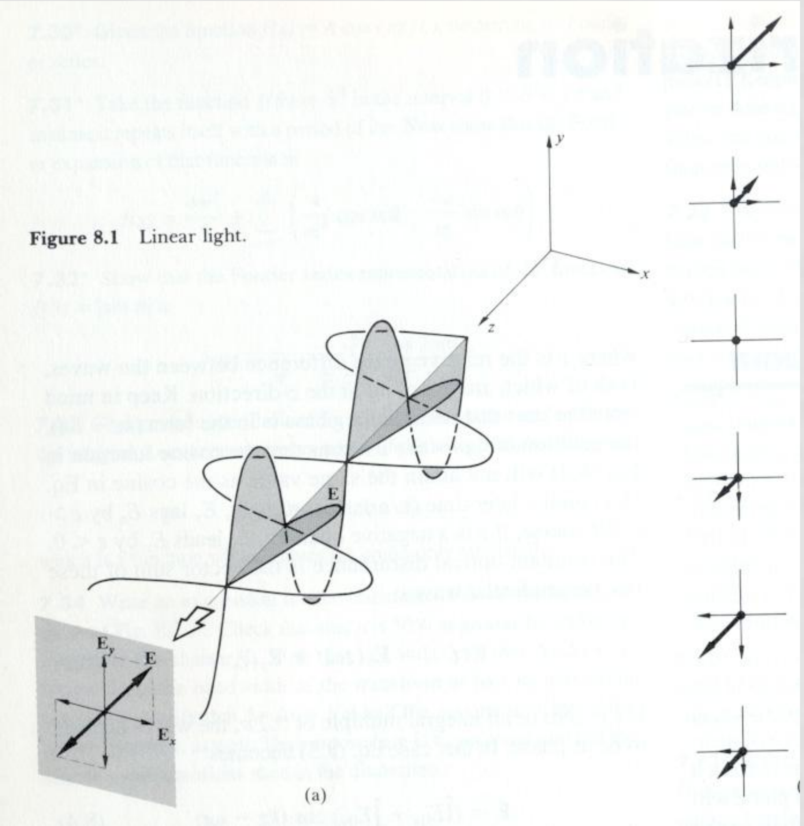


Figure 8.1 Linear light.

CIRCULAR POLARIZATION (I)

$$\vec{E}_x(z,t) = E_{0x}\cos(kz - \omega t)\,\vec{x}$$
$$\vec{E}_y(z,t) = E_{0y}\cos(kz - \omega t + \varepsilon)\,\vec{y}$$

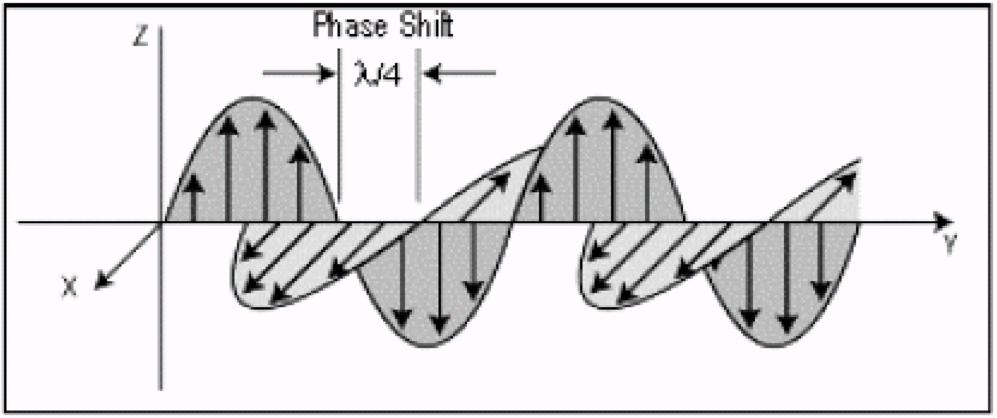
If the phase difference is $\varepsilon = 90°$ and $E_{0x} = E_{0y}$

then: $\mathbf{E}_x / \mathbf{E}_{0x} = \cos\Theta$, $\mathbf{E}_y / \mathbf{E}_{0y} = \sin\Theta$

and we get the equation of a circle:

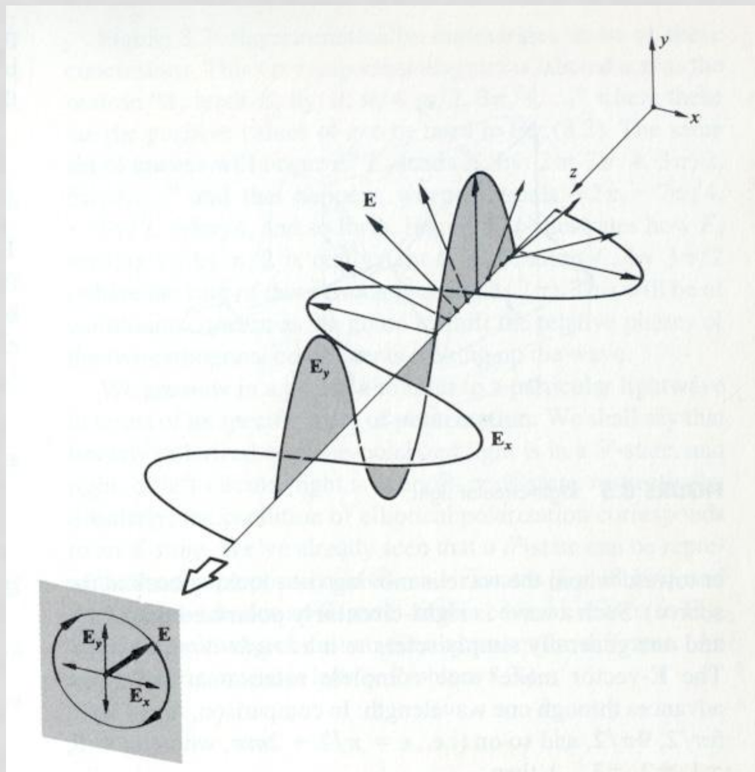
$$\left(\frac{E_x}{E_{0x}}\right)^2 + \left(\frac{E_y}{E_{0y}}\right)^2 = \cos^2\Theta + \sin^2\Theta = 1$$

CIRCULAR POLARIZATION (II)

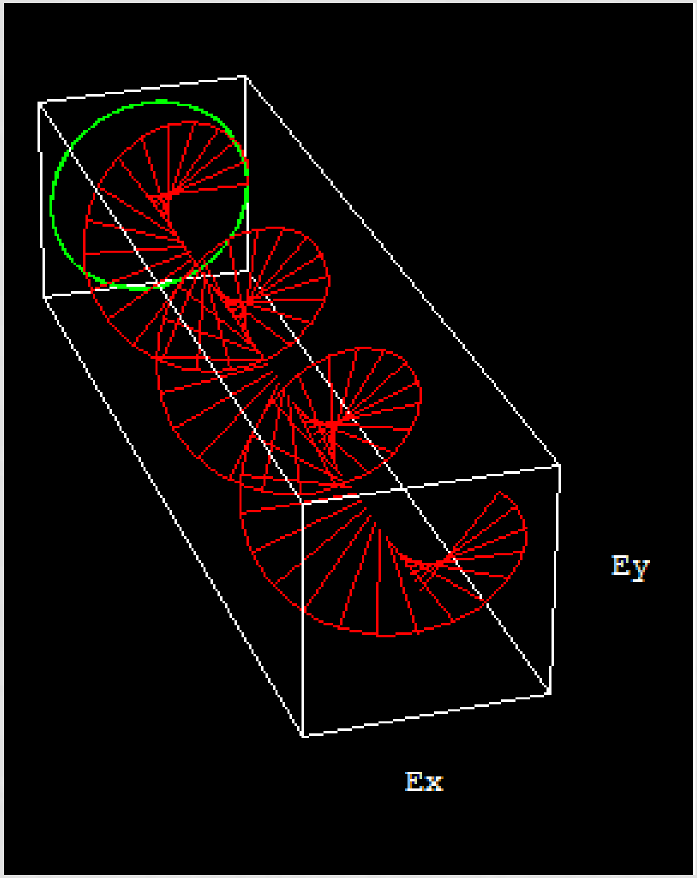


C. Circularly Polarized Light

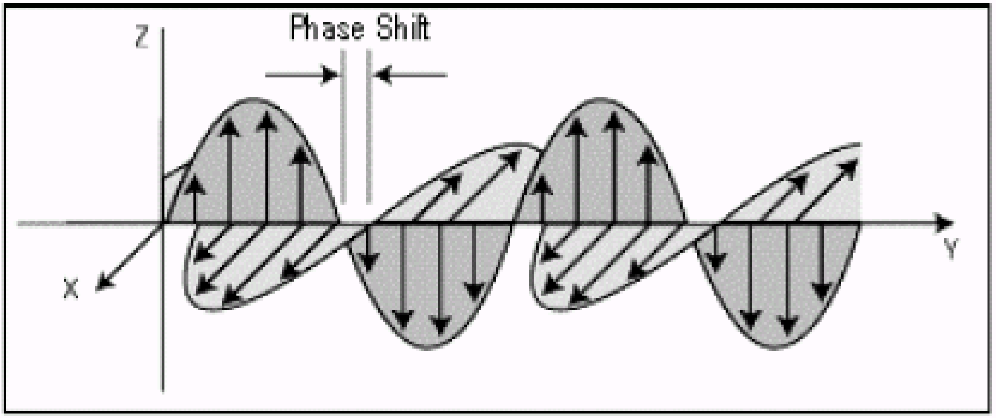
CIRCULAR POLARIZATION (III)



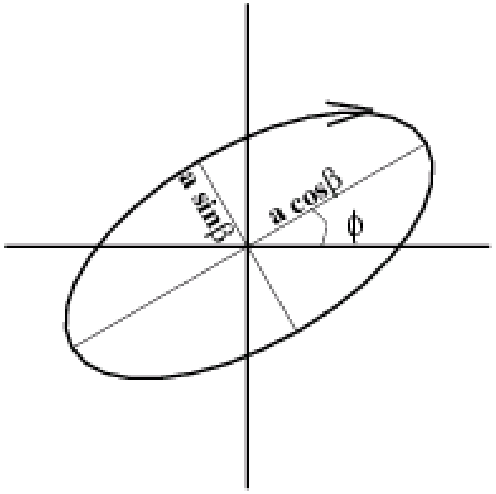
CIRCULAR POLARIZATION (IV)



ELLIPTICAL POLARIZATION



D. Elliptically Polarized Light



- Linear + circular polarization = elliptical polarization

UNPOLARIZED LIGHT (NATURAL LIGHT)