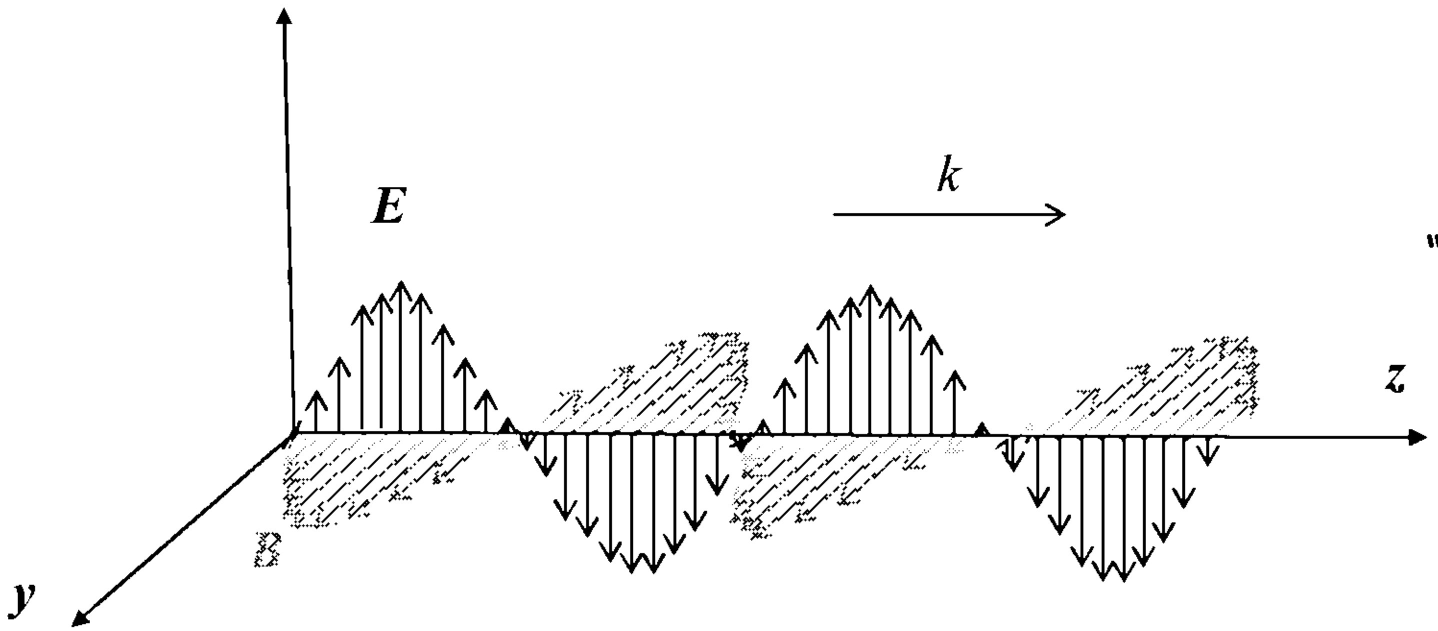
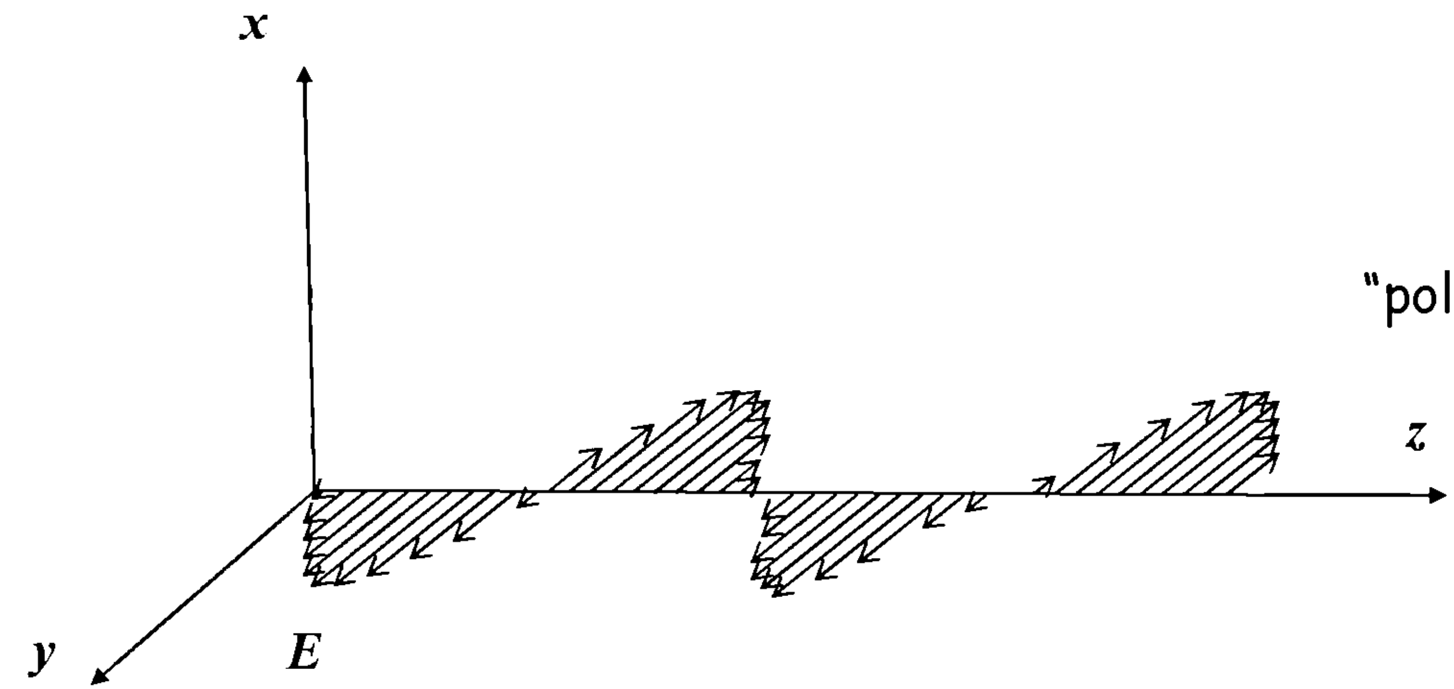
Polarization: direction of the E field

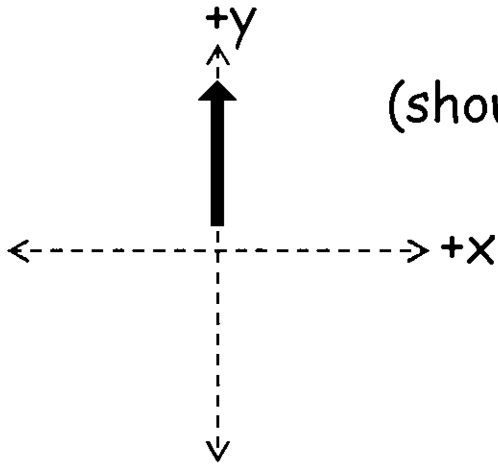


"polarized along x"

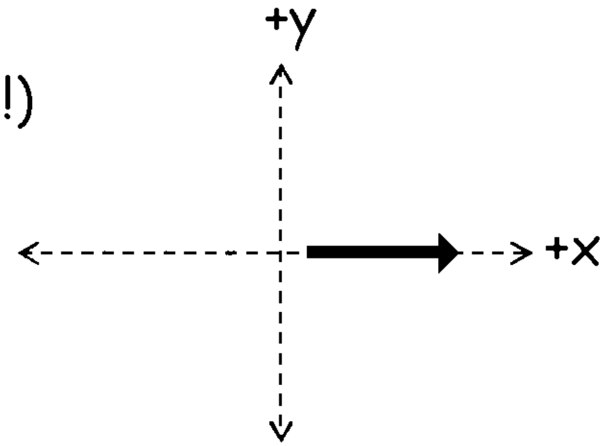


"polarized along y"

Looking down the barrel of a plane wave:



(showing E fields!)

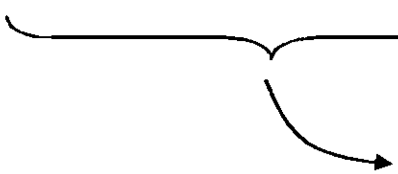


Any polarization state can be described as combination of these two:

$$\vec{\mathbf{E}} = E_{ox} e^{j(kz-\omega t+\phi_x)} \hat{x} + E_{oy} e^{j(kz-\omega t+\phi_y)} \hat{y}$$

(phase only matters when you need a specific origin, or if you have two sinusoids)

$$\vec{\mathbf{E}} = \left(E_{ox} e^{j\phi_x} \hat{x} + E_{oy} e^{j\phi_y} \hat{y}\right) e^{j(kz-\omega t)}$$



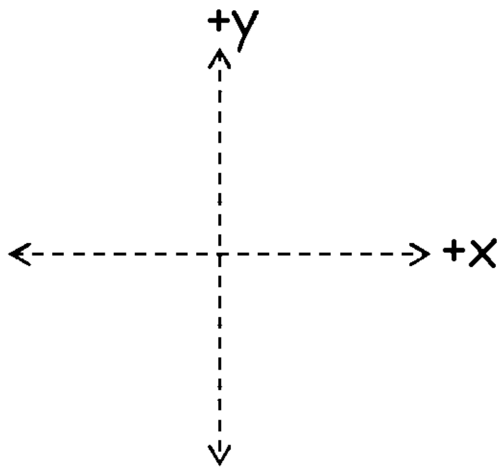
"Complex Amplitude"
contains all polarization info.

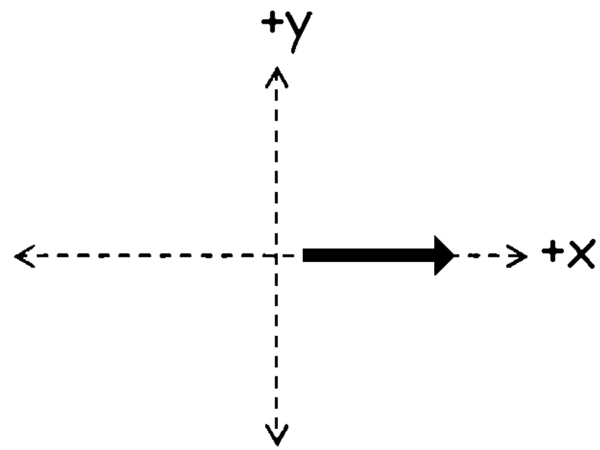
Jones Vectors: $\begin{bmatrix} E_{ox} e^{j\phi_x} \\ E_{oy} e^{j\phi_y} \end{bmatrix}$

Vertical polarization	Horizontal polarization	Linear, α from x-axis
$\begin{bmatrix} 0 \\ E_{oy} \end{bmatrix}$	$\begin{bmatrix} E_{ox} \\ 0 \end{bmatrix}$	$\begin{bmatrix} E_o \cos\alpha \\ E_o \sin\alpha \end{bmatrix}$
$\begin{bmatrix} 0 \\ 1 \end{bmatrix}$	$\begin{bmatrix} 1 \\ 0 \end{bmatrix}$	$\begin{bmatrix} \cos\alpha \\ \sin\alpha \end{bmatrix}$
(normalized)		

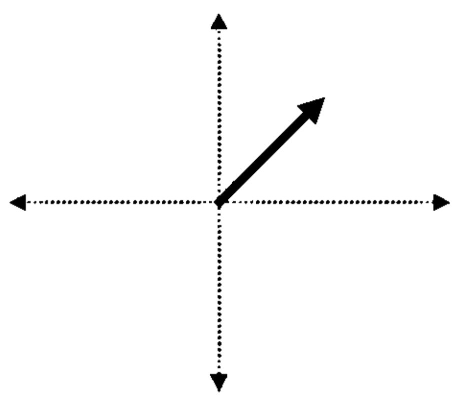
all linear…. all phases set to 0.

Phase difference = pi/2:

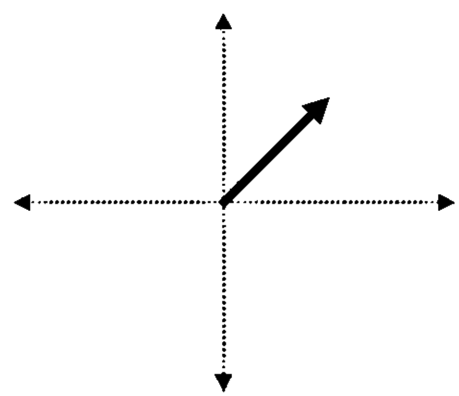




Circular polarization:



Right Circ. Pol.



Left Circ. Pol.

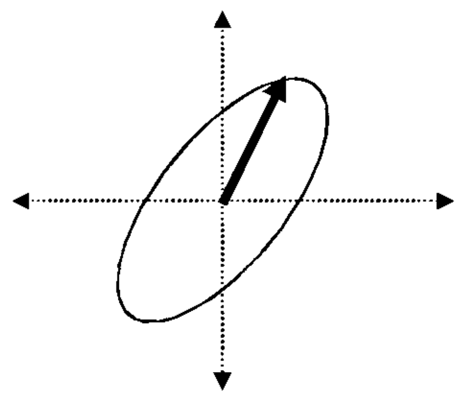
Circular polarization: $\Delta\phi = \pm\pi/2$

$$\begin{bmatrix} E_{ox} e^{j\phi_x} \\ E_{oy} e^{j\phi_y} \end{bmatrix}$$

$$\begin{bmatrix} E_{ox} e^{j0} \\ E_{oy} e^{j\frac{\pi}{2}} \end{bmatrix} \qquad \begin{bmatrix} 1 \\ e^{j\frac{\pi}{2}} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 + j \end{bmatrix} = \begin{bmatrix} 1 \\ j \end{bmatrix} \xrightarrow{\text{normalize}} \frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ j \end{bmatrix} \quad \text{LCP}$$

$$\begin{bmatrix} E_{ox} e^{j0} \\ E_{oy} e^{-j\frac{\pi}{2}} \end{bmatrix} \qquad \begin{bmatrix} 1 \\ e^{-j\frac{\pi}{2}} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 - j \end{bmatrix} = \begin{bmatrix} 1 \\ -j \end{bmatrix} \xrightarrow{\text{normalize}} \frac{1}{\sqrt{2}} \begin{bmatrix} 1 \\ -j \end{bmatrix} \quad \text{RCP}$$

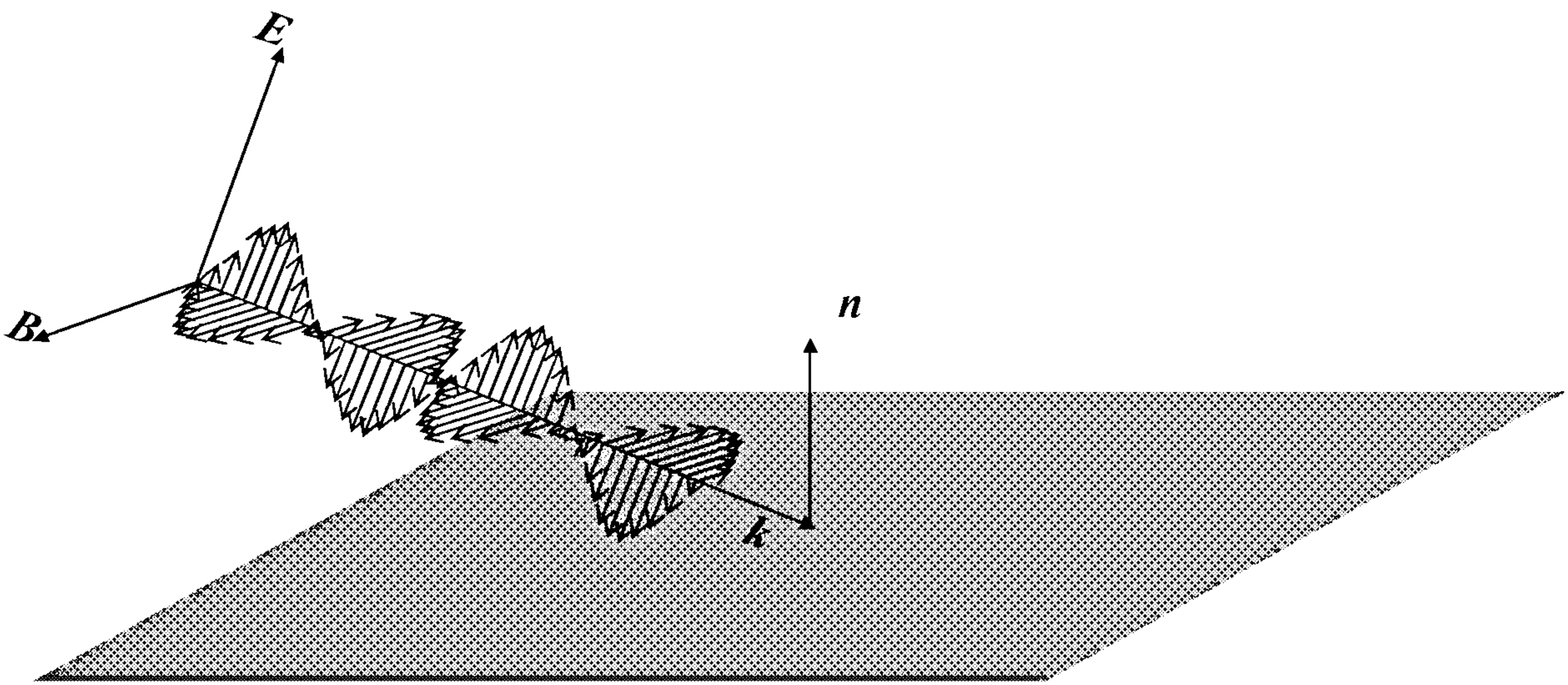
Elliptical polarization:
arbitrary phase difference (ε) and amplitudes (E_{ox}, E_{oy})



$$\frac{1}{\sqrt{A^2+B^2+C^2}}\begin{bmatrix} A \\ B \pm jC \end{bmatrix}$$ Elliptical

$$E_{ox} = A \qquad E_{oy} = \sqrt{B^2+C^2} \qquad \varepsilon = \tan^{-1}\left(\frac{C}{B}\right)$$

Polarization relative to a plane interface:



Plane of incidence: plane formed by ***n*** and ***k***.

Transverse Electric
(TE)

Senkrecht Polarized
(s)

Transverse Magnetic
(TM)

Plane Polarized
(p)