Polarização Linear
Circular
Elíptica

→ ① $\vec{E}_x(z,t) = \hat{i} E_{0x} \cos(Kz - \omega t)$

→ ② $\vec{E}_y(z,t) = \hat{j} E_{0y} \cos(Kz - \omega t + \varepsilon)$

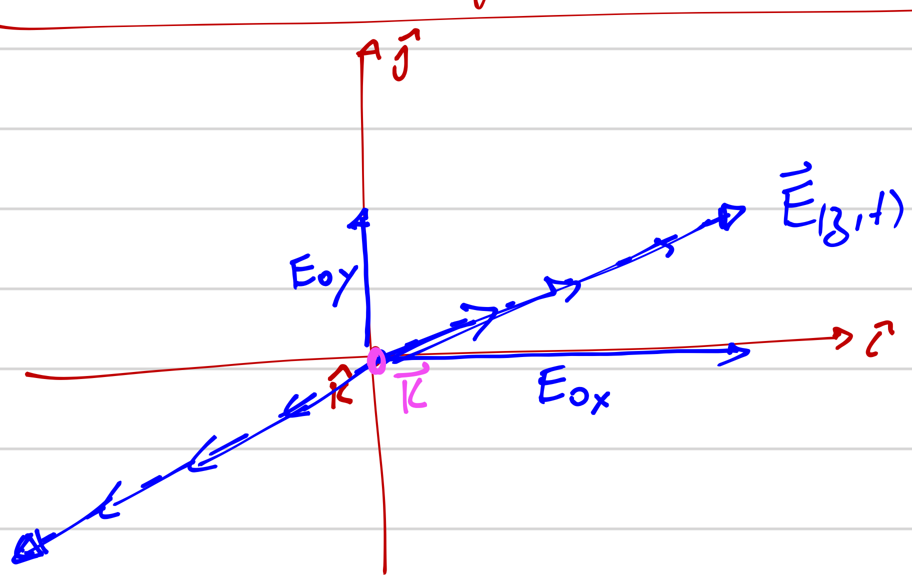
$$\vec{E}(z,t) = \vec{E}_x + \vec{E}_y = \hat{i} E_{0x}\cos(Kz - \omega t) + \hat{j} E_{0y}\cos(Kz - \omega t + \varepsilon)$$

p/ um OEM (feixe de radiação) polarizada Linear

$\varepsilon = 0, \pm 2\pi, \pm 4\pi$ ou $\varepsilon = 2\pi m$ $\quad m = 0, \pm 1, \pm 2, \ldots$

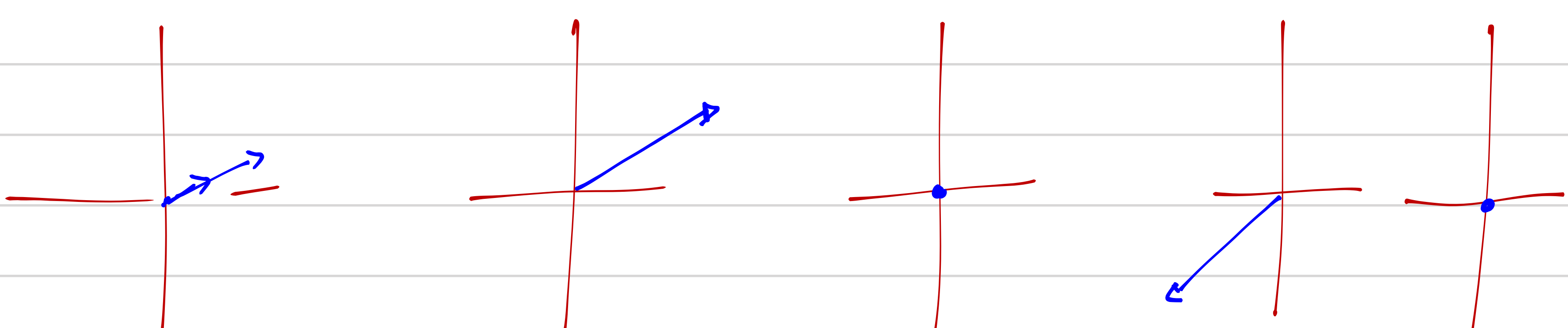
p/ $\Rightarrow m = 0$

$$\boxed{\vec{E}(z,t) = (\hat{i} E_{0x} + \hat{j} E_{0y}) \cos(Kz - \omega t)}$$



$\vec{K}$ = Vetor de onda

Plano de vibração é formado pelos vetores $\vec{E}(z,t)$ e $\vec{K}$



$t = 0$ $\qquad (Kz_0 - \omega t) = 0 \qquad = -\frac{\pi}{2} \qquad -\pi \qquad -\frac{3\pi}{2}$

$\vec{E} = (\hat{i} E_{0x} + \hat{j} E_{0y}) \cos Kz_0 \qquad \hookrightarrow t = \frac{Kz_0}{\omega}$

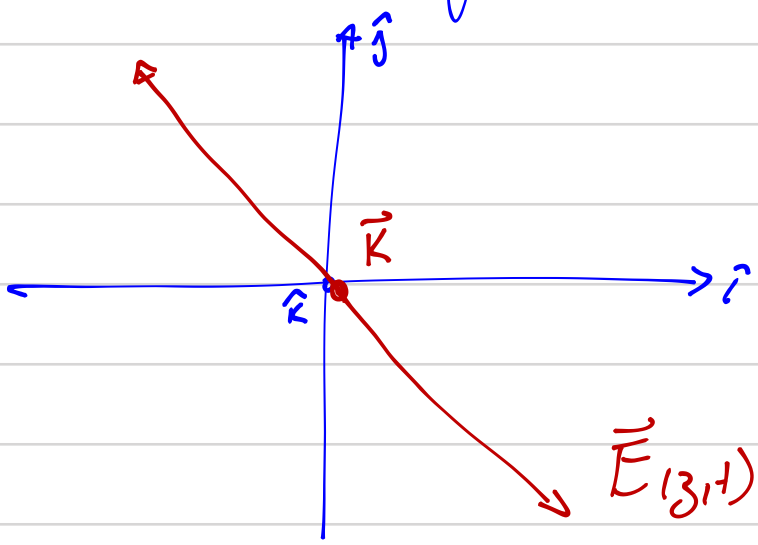
ainda

Pol: linear $\boxed{\varepsilon = \pm\pi}$

$$\vec{E}(z,t) = \hat{i}\, E_{0x} \cos(Kz-\omega t) + \hat{j}\, E_{0y} \cos(Kz-\omega t+\pi)$$

$$\cos(Kz-\omega t+\pi) = \cos(Kz-\omega t)\cdot\underbrace{\cos\pi}_{-1} - \text{Sen}(Kz-\omega t)\cdot\cancel{\text{Sen}\,\pi}^{\,0}$$

$$E(z,t) = (\hat{i}\, E_{0x} - \hat{j}\, E_{0y}) \cos(Kz-\omega t)$$



Caso $E_{0x} = E_{0y} = E_0$

$$\varepsilon = -\frac{\pi}{2} + 2\pi m \qquad m = 0, \pm 1, \pm 2, \dots$$

Polarização circular

Considere $\varepsilon = -\pi/2$ $\quad \varepsilon = \pi/2$

$$\vec{E}(z,t) = \hat{i}\, E_{0x} \cos(Kz-\omega t) + \hat{j}\, E_{0y} \cos(Kz-\omega t - \overset{+\pi/2}{\pi/2})$$

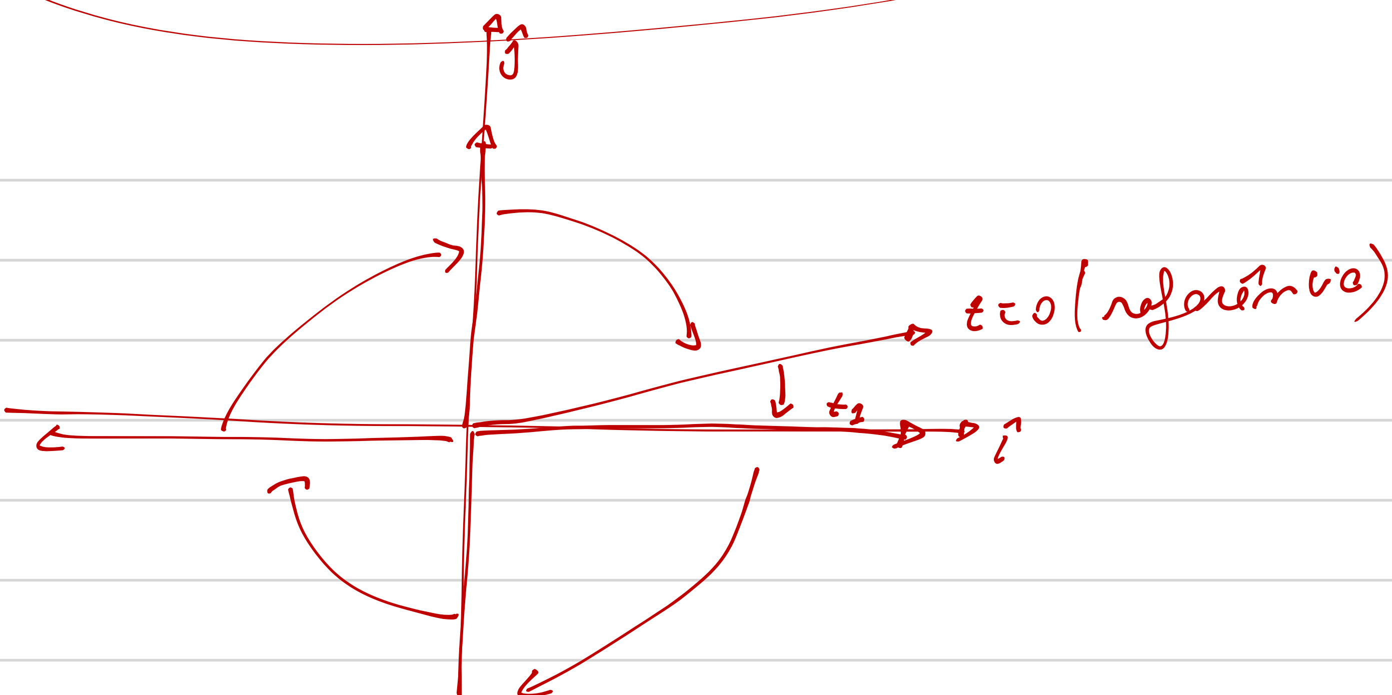
$$\cos(Kz-\omega t-\pi/2) = \cos(Kz-\omega t)\cdot \cos\overset{+\pi/2}{\frac{-\pi}{2}} - \text{Sen}(Kz-\omega t)\cdot\underbrace{\text{Sen}\left(\overset{+\pi/2}{\frac{-\pi}{2}}\right)}_{\substack{-1 \\ +1}}$$

$$\vec{E}(z,t) = \hat{i}\, E_0 \cos(Kz-\omega t) \mp \hat{j}\, E_0\, \text{Sen}(Kz-\omega t)$$

$$E(z,t) = E_0 \left[\hat{i} \cos(Kz-\omega t) + \hat{j}\, \text{Sen}(Kz-\omega t)\right]$$

$t = 0$

$$\vec{E}(z,t) = E_0\left[\hat{i}\cos Kz_0 + \hat{j}\, \text{Sen}\, Kz_0\right]$$



$z = z_0$ fixo

$(Kz_0 - \omega t) \Rightarrow 0$ $\boxed{t_2 = \frac{Kz_0}{\omega}}$ $\vec{E}_{(z,t)} = E_0(\hat{i}\cdot 1 + \hat{j}\cdot 0)$ $\boxed{\vec{E}_{(z,t)} = \hat{i}E_0}$

$(Kz_0 - \omega t) = -\frac{\pi}{2}$ $\vec{E} = E_0(\hat{i}\cdot 0 + \hat{j}\cdot -1)$ $\boxed{\vec{E} = -\hat{j}E_0}$

z_0 fixo representa a gente observando o comportamento da onda em z_0 e no tempo $t>0$

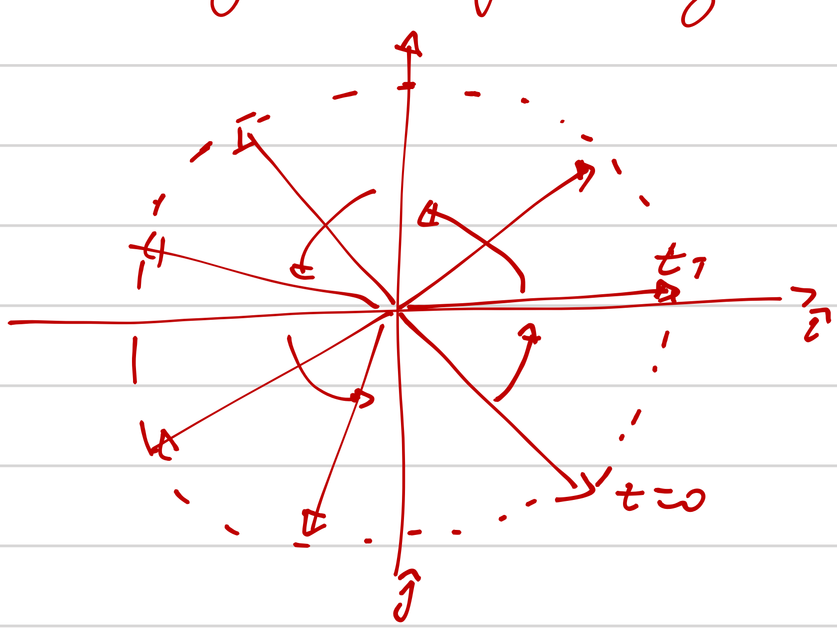
Polarização Circular Horária (ou Direita)

x — x — x

$E_{0x} = E_{0y} = E_0$ $\varepsilon = \pi/2 + 2\pi m$

$\vec{E}_{(z,t)} = E_0[\hat{i}\cos(Kz - \omega t) - \hat{j}\sin(Kz - \omega t)]$

$t = 0$



Polarização Circular anti-Horária

$(Kz_0 - \omega t) = 0$ $t_1 = \frac{Kz_0}{\omega}$ $\vec{E} = E_0(\hat{i}\cdot 1 - \hat{j}\cdot 0)$ $\vec{E} = \hat{i}E_0$

x — x — x

Polarização Elíptica

→ Pol. Circular e Linear são casos particulares da pol. elíptica.

$E_{0x} \neq E_{0y}$ $\qquad E_x = E_{0x} \cos(kz - \omega t)$

$\varepsilon =$ qualquer $\qquad E_y = E_{0y} \cos(kz - \omega t + \varepsilon)$

$\boxed{E_x, E_y, E_{0x}, E_{0y}, \varepsilon}$ → levam a um perfil elíptico

$$\boxed{\frac{E_x}{E_{0x}} = \cos(kz - \omega t)}$$

$$\frac{E_y}{E_{0y}} = (\cos kz - \omega t + \varepsilon) = \cos(kz - \omega t) \cdot \cos\varepsilon - \operatorname{Sen}(kz - \omega t) \cdot \operatorname{Sen}\varepsilon$$

$$\frac{E_y}{E_{0y}} \cos^{-1}\varepsilon = \cos(kz - \omega t) - \operatorname{Sen}(kz - \omega t)\, tg\,\varepsilon$$

$$\frac{E_y \cos^{-1}\varepsilon}{E_{0y}} - \frac{E_x}{E_{0x}} = -\operatorname{Sen}(kz - \omega t)\, tg\,\varepsilon$$

$$\left(\frac{E_x}{E_{0x}}\right)^2 = \cos^2(kz - \omega t) = 1 - \operatorname{Sen}^2(kz - \omega t)$$

$$\boxed{\operatorname{Sen}(kz - \omega t) = \sqrt{1 - \left(\frac{E_x}{E_{0x}}\right)^2}}$$

$$\frac{E_y \cdot \cos^{-1}\varepsilon}{E_{0y}} - \frac{E_x}{E_{0x}} = -tg\,\varepsilon \sqrt{1 - \left(\frac{E_x}{E_{0x}}\right)^2}$$

$$\left(\frac{E_y}{E_{0y}} - \frac{E_x}{E_{0x}}\right)^2 = tg^2\varepsilon\left(1-\left(\frac{E_x}{E_{0x}}\right)^2\right)$$

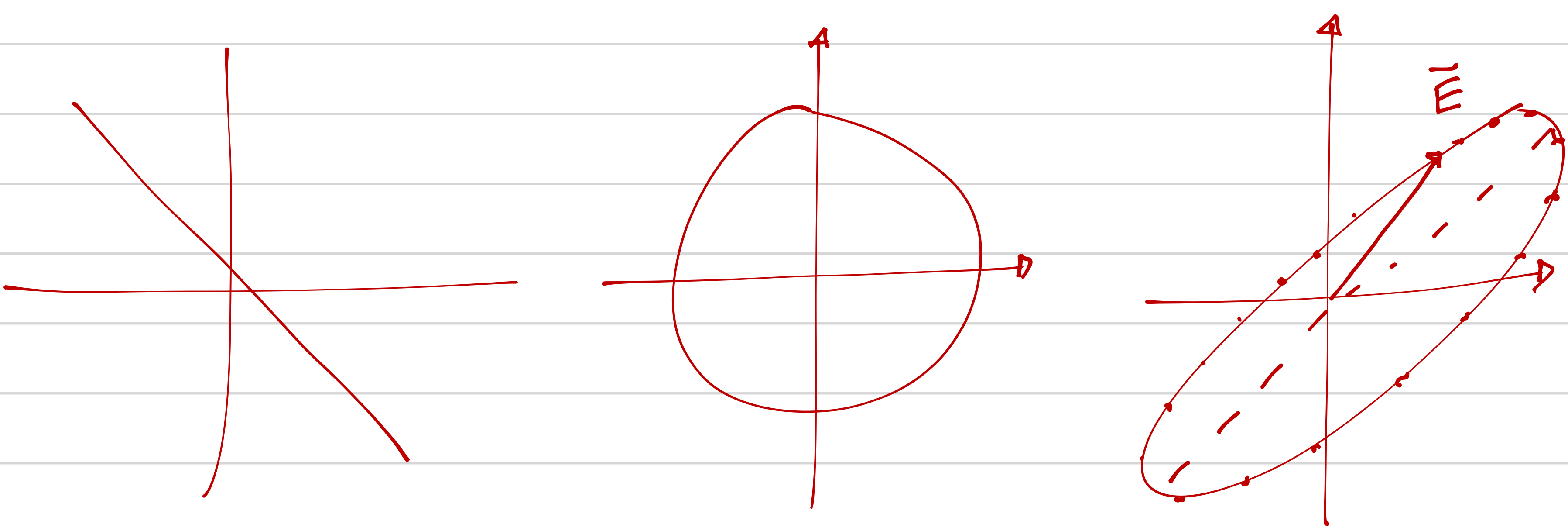
$$\left(\frac{E_y}{E_{0y}\cos\varepsilon}\right)^2 - \frac{2\,E_y E_x}{E_{0y}E_{0x}\cos\varepsilon} + \left(\frac{E_x}{E_{0x}}\right)^2 = tg^2\varepsilon - tg^2\varepsilon\left(\frac{E_x}{E_{0x}}\right)^2$$

$\times \cos^2\varepsilon$

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

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

↳ forma uma elipse



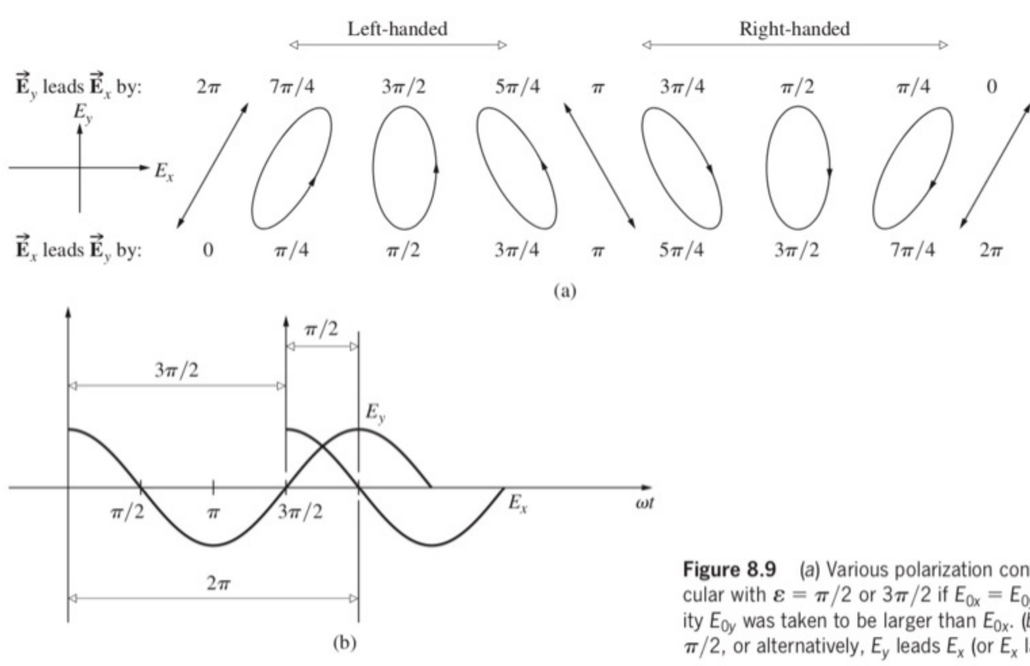


Figure 8.9 (a) Various polarization configurations. The light would be circular with $\varepsilon = \pi/2$ or $3\pi/2$ if $E_{0x} = E_{0y}$, but here for the sake of generality E_{0y} was taken to be larger than E_{0x}. (b) E_x leads E_y (or E_y lags E_x) by $\pi/2$, or alternatively, E_y leads E_x (or E_x lags E_y) by $3\pi/2$.