Polarização Linear
Circular
Elíptica

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

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

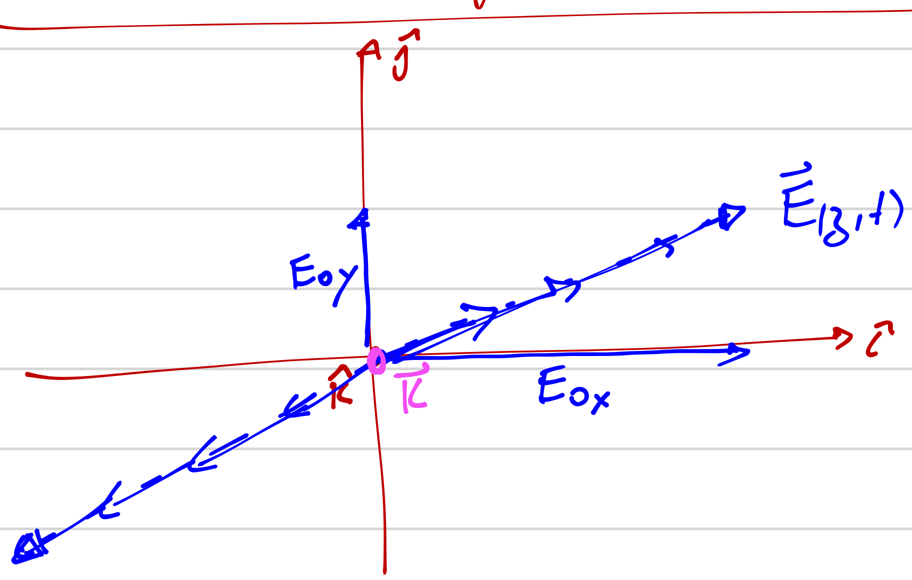
$$\vec{E}(z,t) = \vec{E}_x + \vec{E}_y = \hat{i}E_{0x}\cos(kz - \omega t) + \hat{j}E_{0y}\cos(kz - \omega t + \varepsilon)$$

p/ um OEM (feixe de radiação) polarizado Linear

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

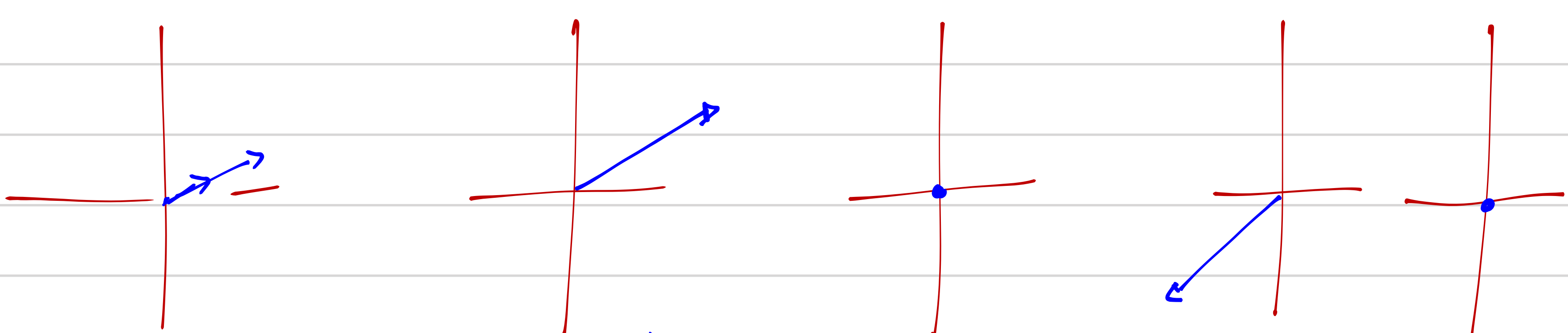
p/ ⇒ $m = 0$

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



$\vec{K}$ = Vetor de onda

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



$t = 0$ $\qquad (kz_0 - \omega t) = 0$ $\qquad = -\frac{\pi}{2}$ $\qquad -\pi$ $\qquad -\frac{3\pi}{2}$

$\vec{E} = (\hat{i}E_{0x} + \hat{j}E_{0y})\cos kz_0$ $\qquad \Rightarrow t = \frac{kz_0}{\omega}$

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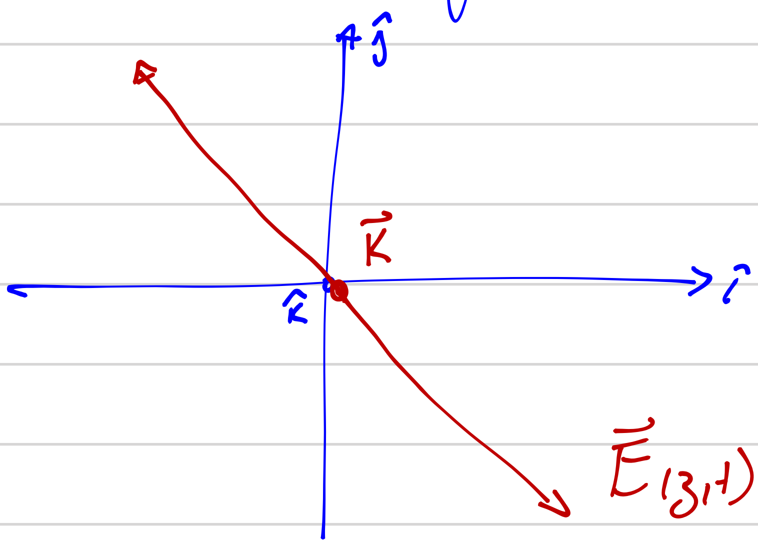
ainda

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

$$\vec{E}(z,t) = \hat{i} E_{ox} \cos(kz - \omega t) + \hat{j} E_{oy} \cos(kz - \omega t + \pi)$$

$$\cos(kz - \omega t + \pi) = \cos(kz - \omega t) \cdot \underbrace{\cos\pi}_{-1} - \operatorname{sen}(kz - \omega t) \cdot \cancel{\operatorname{sen}\pi}^{0}$$

$$E(z,t) = (\hat{i} E_{ox} - \hat{j} E_{oy}) \cos(kz - \omega t)$$



Caso $E_{ox} = E_{oy} = E_o$

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

Polarização circular

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

$$\vec{E}(z,t) = \hat{i} E_{ox} \cos(kz - \omega t) + \hat{j} E_{oy} \cos(kz - \omega t \overset{+\pi/2}{-\pi/2})$$

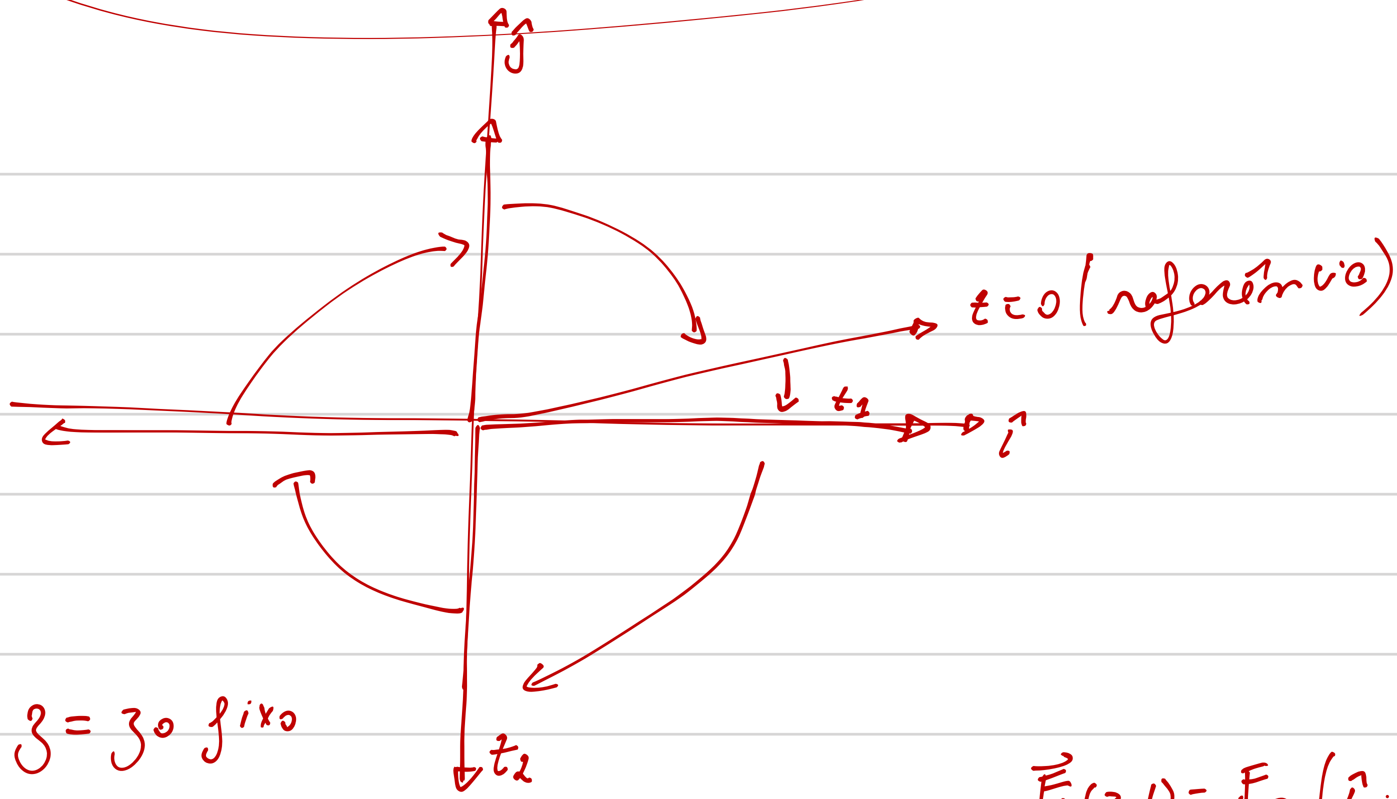
$$\cos(kz - \omega t - \pi/2) = \cos(kz - \omega t) \cdot \cos\overset{+\pi/2}{\frac{-\pi}{2}} - \operatorname{sen}(kz - \omega t) \cdot \underbrace{\operatorname{sen}\left(\frac{-\pi}{2}\right)}_{\substack{-1 \\ +1}}^{+\pi/2}$$

$$\vec{E}(z,t) = \hat{i} E_o \cos(kz - \omega t) \mp \hat{j} E_o \operatorname{sen}(kz - \omega t)$$

$$E(z,t) = E_o \left[\hat{i} \cos(kz - \omega t) + \hat{j} \operatorname{sen}(kz - \omega t) \right]$$

$t = 0$

$$\vec{E}(z,t) = E_o [\hat{i} \cos kz_o + \hat{j} \operatorname{sen} kz_o]$$



$z = z_0$ fixo

$(K z_0 - \omega t) \Rightarrow 0$ $\boxed{t_1 = \dfrac{K z_0}{\omega}}$

$\vec{E}_{(z,t)} = E_0 (\hat{i} \cdot 1 + \hat{j} \cdot 0)$

$\boxed{\vec{E}_{(z,t)} = \hat{i} E_0}$

$(K z_0 - \omega t) = \dfrac{-\pi}{2}$ $\vec{E} = E_0 (\hat{i} \cdot 0 + \hat{j} \cdot -1)$ $\boxed{\vec{E} = -\hat{j} E_0}$

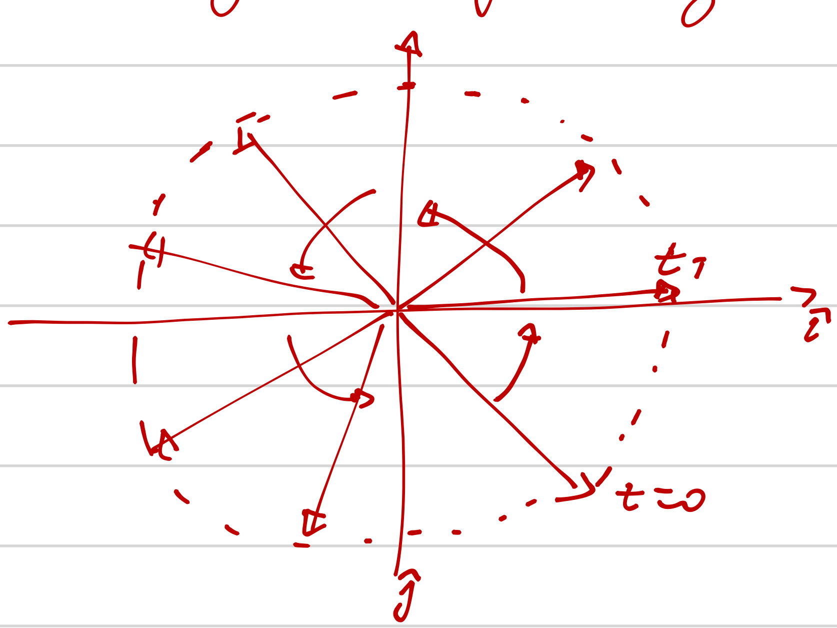
z_0 fixo representa q estou observando o comportamento da onda em z_0 e no tempo $t > 0$

Polarização Circular Horária (ou Direita)

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

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

$t = 0$



Polarização Circular anti-Horária

$(K z_0 - \omega t) = 0$ $t_1 = \dfrac{K z_0}{\omega}$ $\vec{E} = E_0 (\hat{i} \cdot 1 - \hat{j} \cdot 0)$ $\vec{E} = \hat{i} E_0$

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

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

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

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

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

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

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

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

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

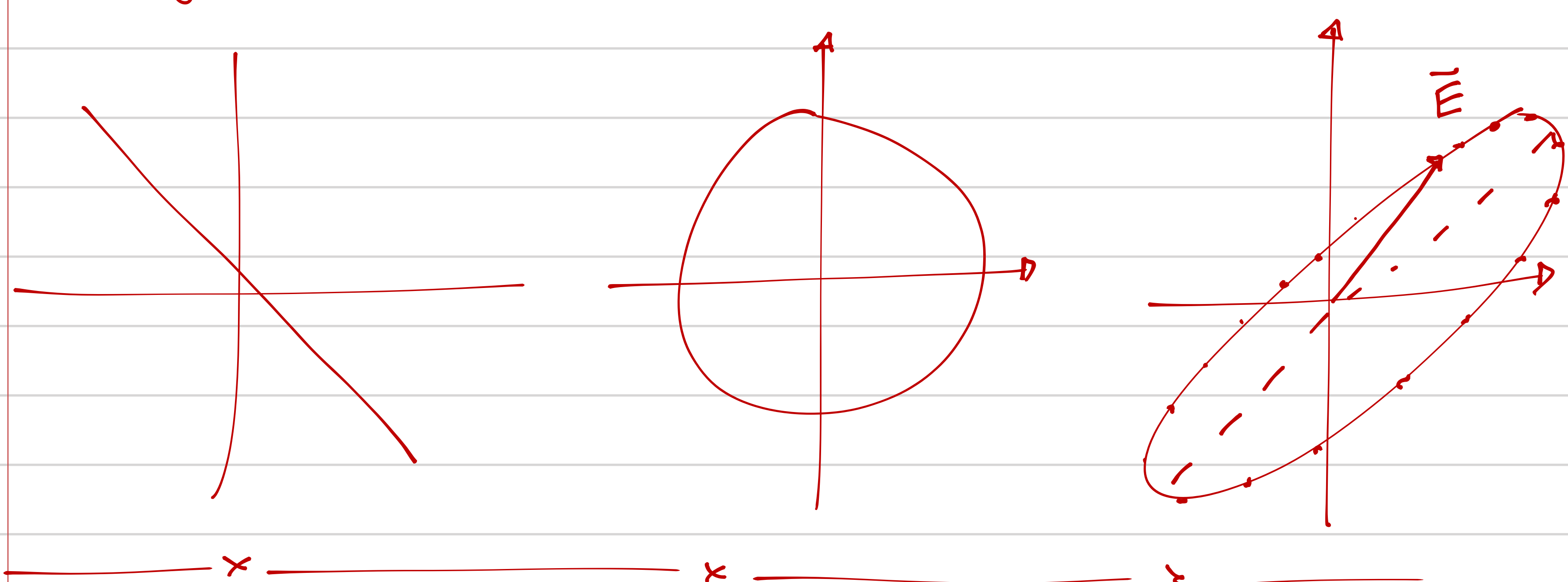
$$\left(\frac{E_y}{E_{0y}\cos\varepsilon}\right)^2 - \frac{2E_yE_x}{E_{0y}E_{0x}\cos\varepsilon} + \left(\frac{E_x}{E_{0x}}\right)^2 = tg^2\varepsilon - tg^2\varepsilon\left(\frac{E_x}{E_{0x}}\right)^2$$

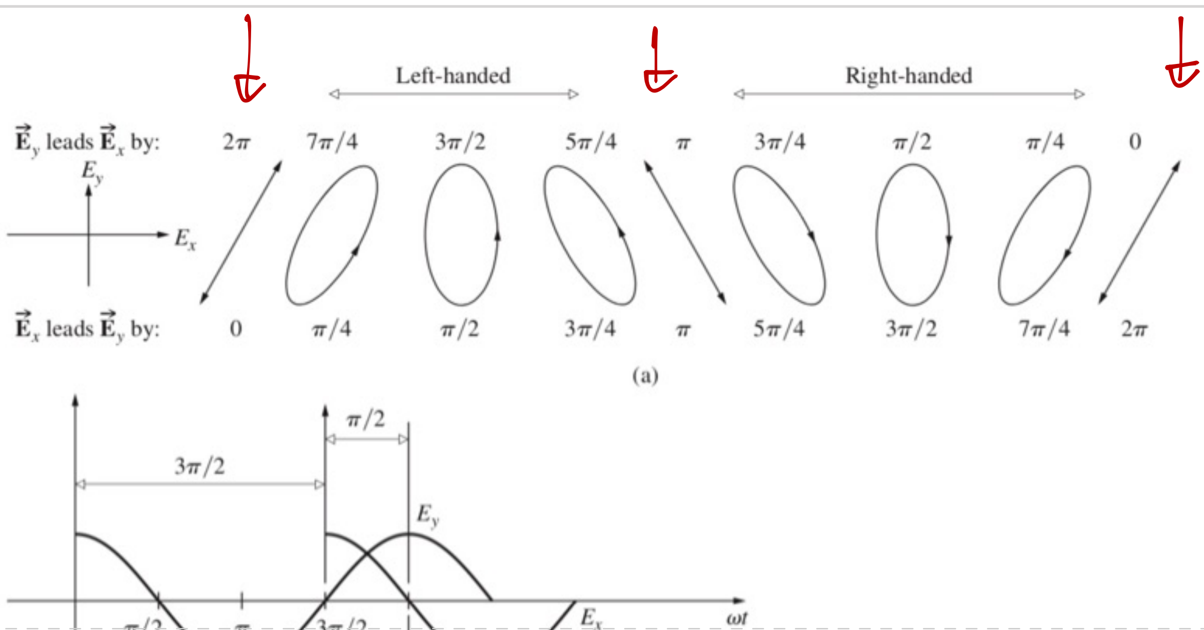
$\times \cos^2\varepsilon$

$$\left(\frac{E_x}{E_{0y}}\right)^2 - \frac{2E_yE_x\cos\varepsilon}{E_{0y}E_{0x}} + \left(\frac{E_x}{E_{0x}}\right)^2\cdot\cos^2\varepsilon = \text{Sen}^2\varepsilon - \text{Sen}^2\varepsilon\left(\frac{E_x}{E_{0x}}\right)^2$$

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

↳ forma uma elipse





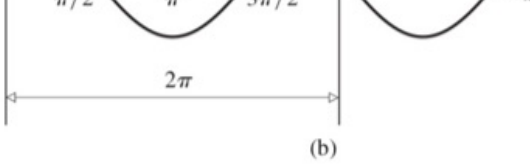


Figure 8.9 (a) Various polarization configurations. The light would be circular with $\varepsilon = \pi/2$ or $3\pi/2$ if $E_{0x} = E_{0y}$, but here for the sake of generality E_{0y} was taken to be larger than E_{0x}. (b) E_x leads E_y (or E_y lags E_x) by $\pi/2$, or alternatively, E_y leads E_x (or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

POLARIZADOR

⟹ feixe polarizado ou não polarizado ⟹

polarizador = altera o estado de polarização do feixe incidente

→ tipos:
↳ são definidos pelo processo físico envolvido

→ Absorção (Dicroismo)

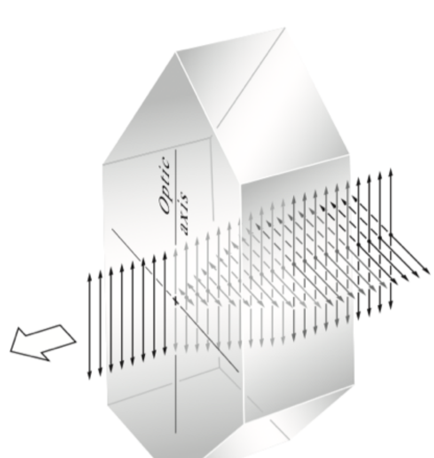
→ Reflexão (no ângulo de Brewster)

→ Espalhamento

→ Birrefringência (2 índices de refração)

Absorção seletiva

$\vec{E}_i = \hat{i}E_x + \hat{j}E_y$



$\boxed{\vec{E}_o = \hat{j}E_y}$

Figure 8.16 A dichroic crystal. The *E*-field parallel to the optic axis is transmitted without any diminution. The naturally occurring ridges evident in the photograph of the tourmaline crystals correspond to the optic axis. (E.H.)

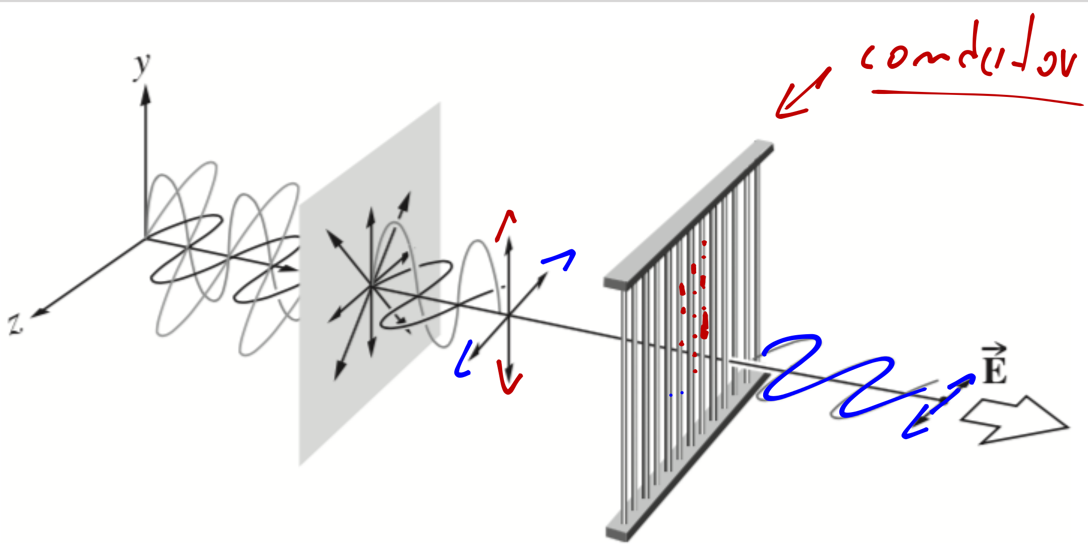


Figure 8.15 A wire-grid polarizer. The grid eliminates the vertical component (i.e., the one parallel to the wires) of the *E*-field and passes the horizontal component.

Birrefringência (2 índices de refração)

→ Calcita

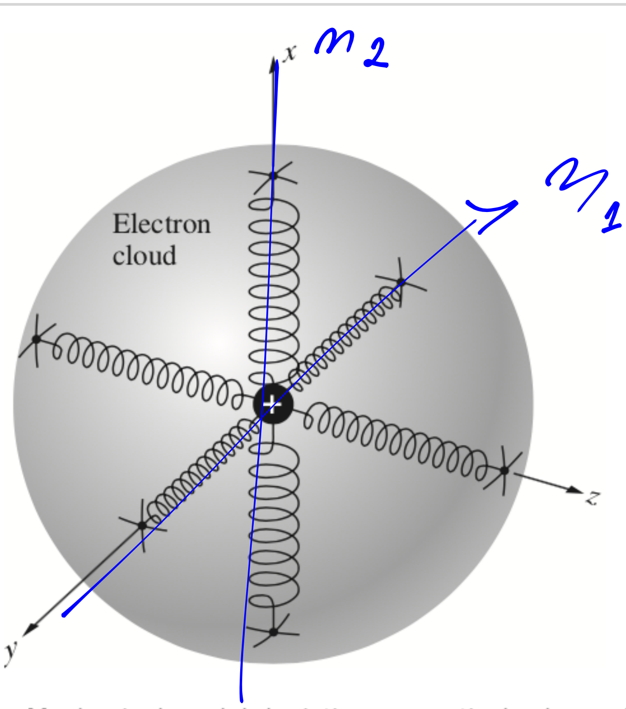


Figure 8.17 Mechanical model depicting a negatively charged shell bound to a positive nucleus by pairs of springs having different stiffness.

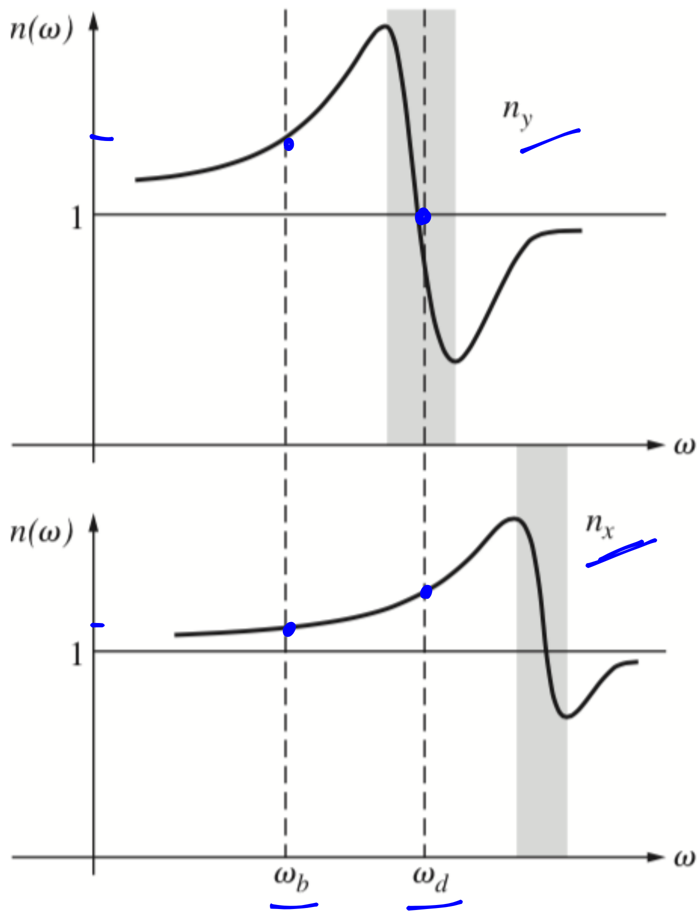
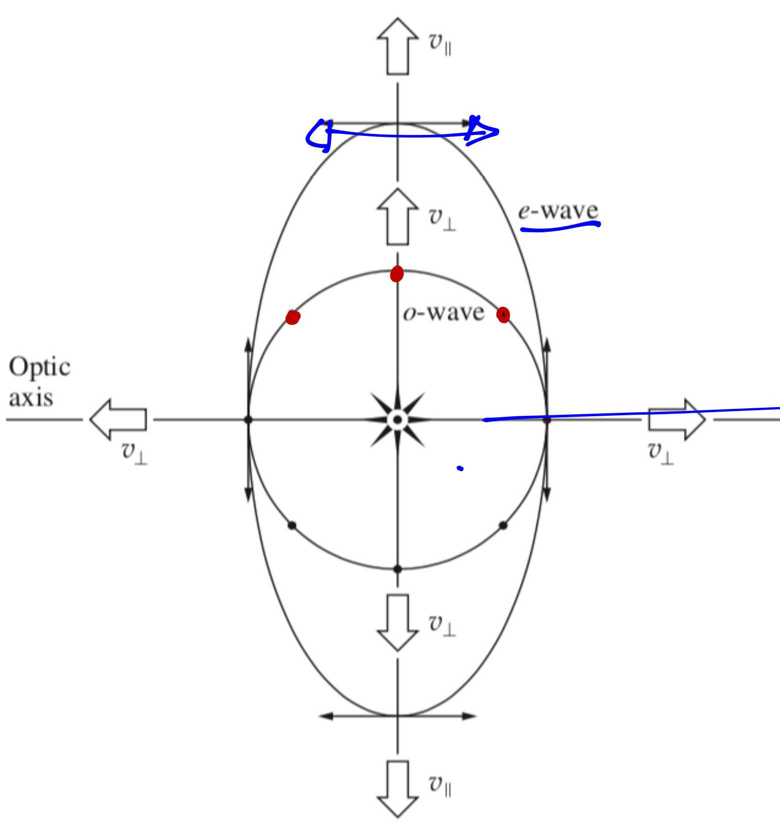


Figure 8.18 Refractive index versus frequency along two axes in a crystal. Regions where $dn/d\omega < 0$ correspond to absorption bands.



eixo óptico

Figure 8.28 Wavelets in a negative uniaxial crystal (their differences much exaggerated). The arrows and dots represent the $\vec{\mathbf{E}}$-fields of the extraordinary and ordinary waves, respectively. The $\vec{\mathbf{E}}$-field of the *o*-wave is everywhere perpendicular to the optic axis. At these particular locations on the wavelets the $\vec{\mathbf{E}}$- and $\vec{\mathbf{D}}$-fields are parallel. A line from the center point to the ellipse corresponds to a ray in that direction whose length indicates the wave's speed in that direction. A tangent to the ellipse at the point where that ray intersects the *e*-wave is the direction of $\vec{\mathbf{D}}$. And the same is true for the *o*-wave where $\vec{\mathbf{E}}$ and $\vec{\mathbf{D}}$ are parallel and perpendicular to the plane of the drawing.

Pol. por espalhamento

$I_E \propto \frac{1}{\lambda^4}$

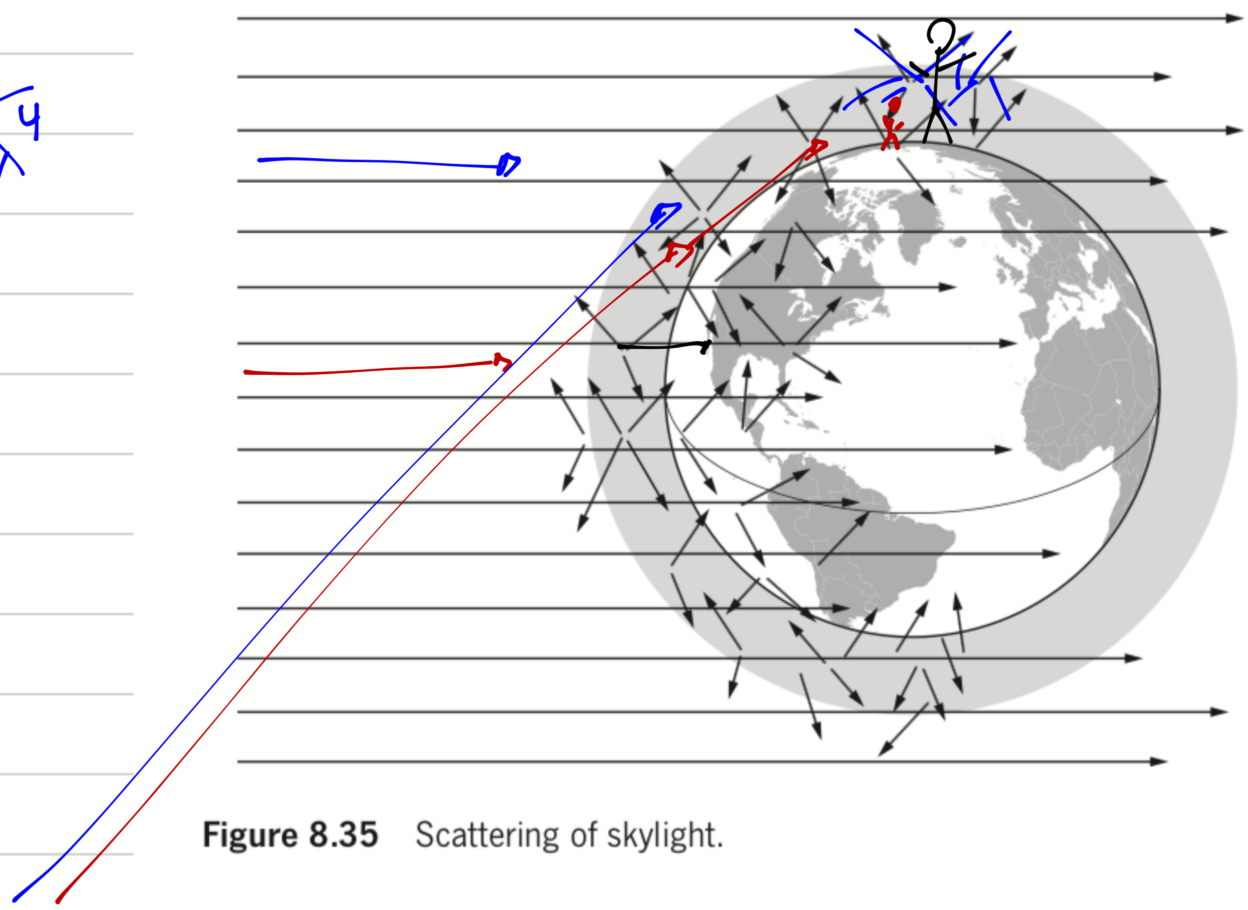


Figure 8.35 Scattering of skylight.

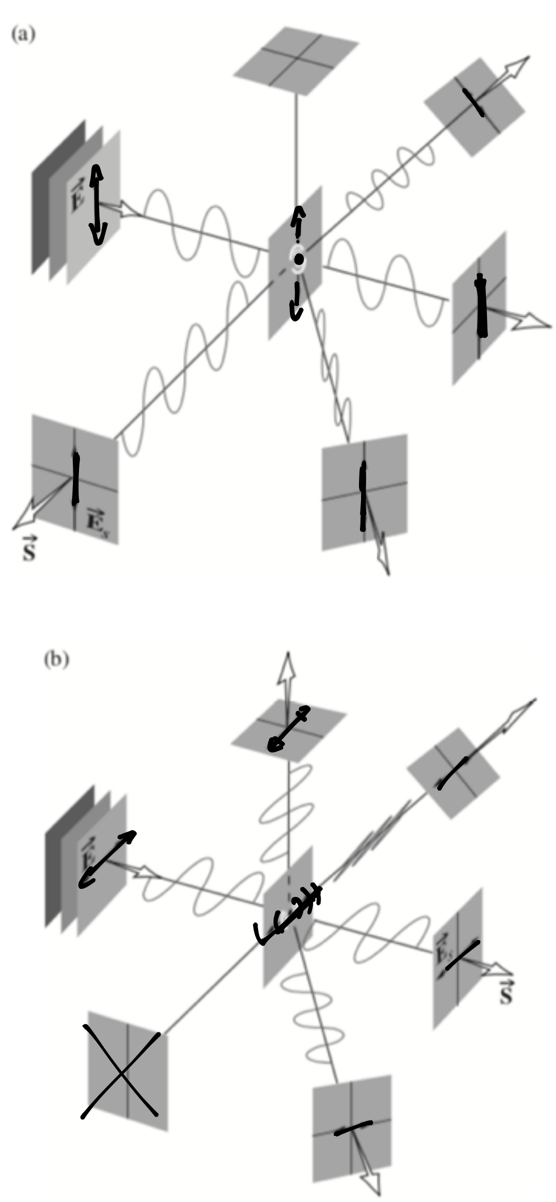


Figure 8.36 Scattering of polarized light by a molecule.

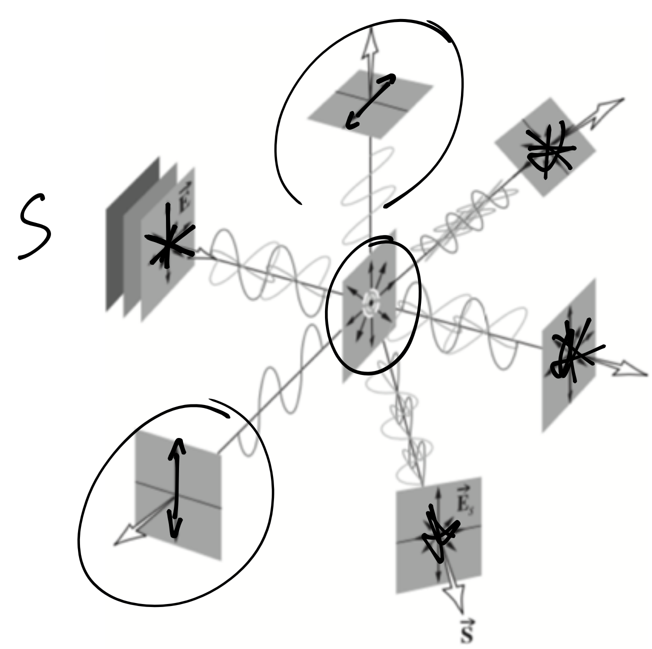
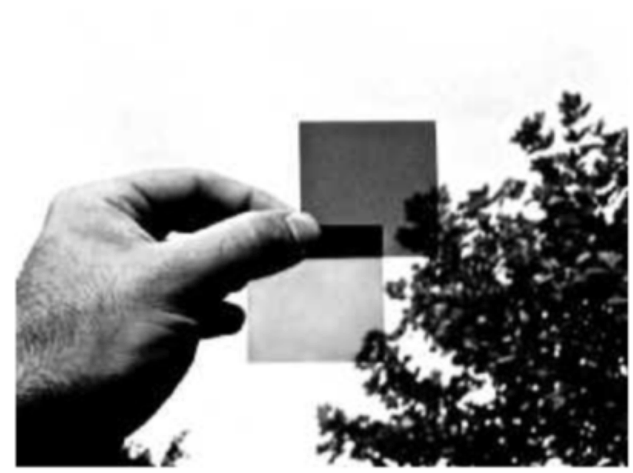


Figure 8.37 Scattering of unpolarized light by a molecule.



A pair of crossed polarizers. The upper polaroid is noticeably darker than the lower one, indicating the partial polarization of sky light. (E.H.)

Pol. por Reflexión.

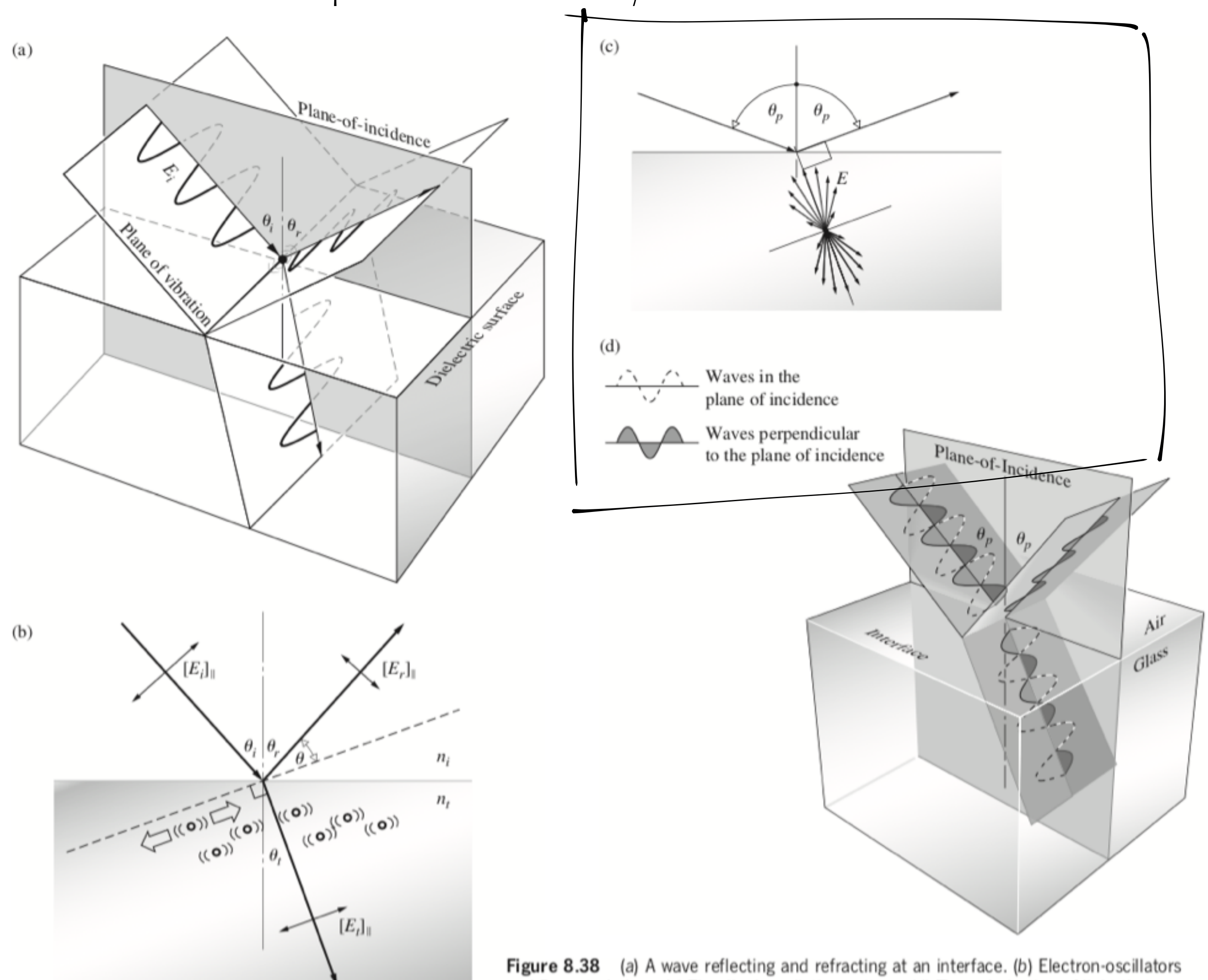


Figure 8.38 (*a*) A wave reflecting and refracting at an interface. (*b*) Electron-oscillators and Brewster's Law. (*c*) The dipole radiation pattern. (*d*) The polarization of light that occurs on reflection from a dielectric, such as glass, water, or plastic. At θ_p, the reflected beam is a $\mathcal{P}$-state perpendicular to the plane-of-incidence. The transmitted beam is strong in $\mathcal{P}$-state light parallel to the plane-of-incidence and weak in $\mathcal{P}$-state light perpendicular to the plane-of-incidence—it's partially polarized.