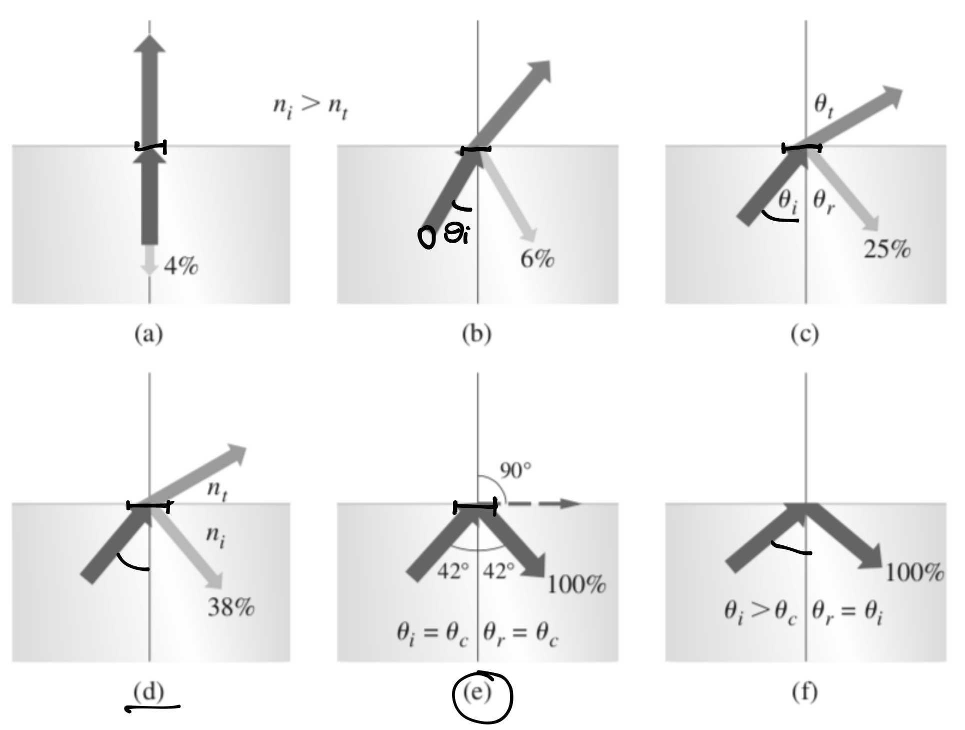
Reflexão Interna Total

• Onda Evanescente ⇒

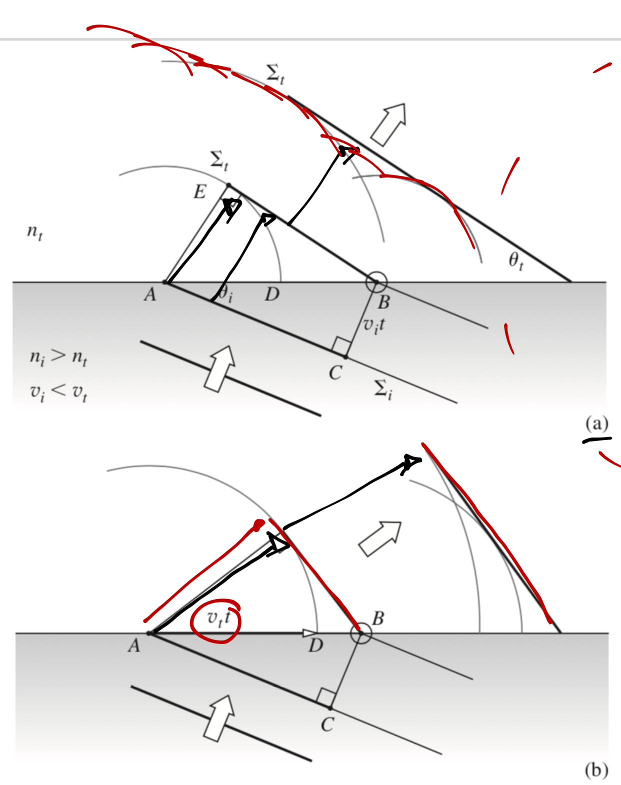
↳ Desvanecente

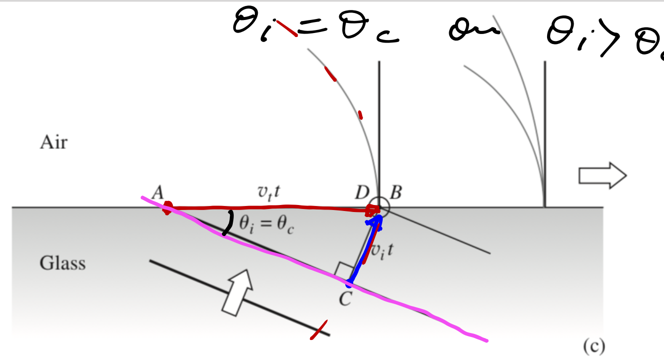
↳ decai rapidamente



$\theta_i < \theta_c$

$\theta_i = \theta_c$ ou $\theta_i > \theta_c$





$\theta_i < \theta_c$

Figure 4.61 An examination of the transmitted wave in the process of total internal reflection from a scattering perspective. Here we keep θ_i and n_i constant and in successive parts of the diagram decrease n_t, thereby increasing v_t. The reflected wave ($\theta_r = \theta_i$) is not drawn.

$\theta_i = \theta_c \qquad v_i = \frac{c}{n_i}$

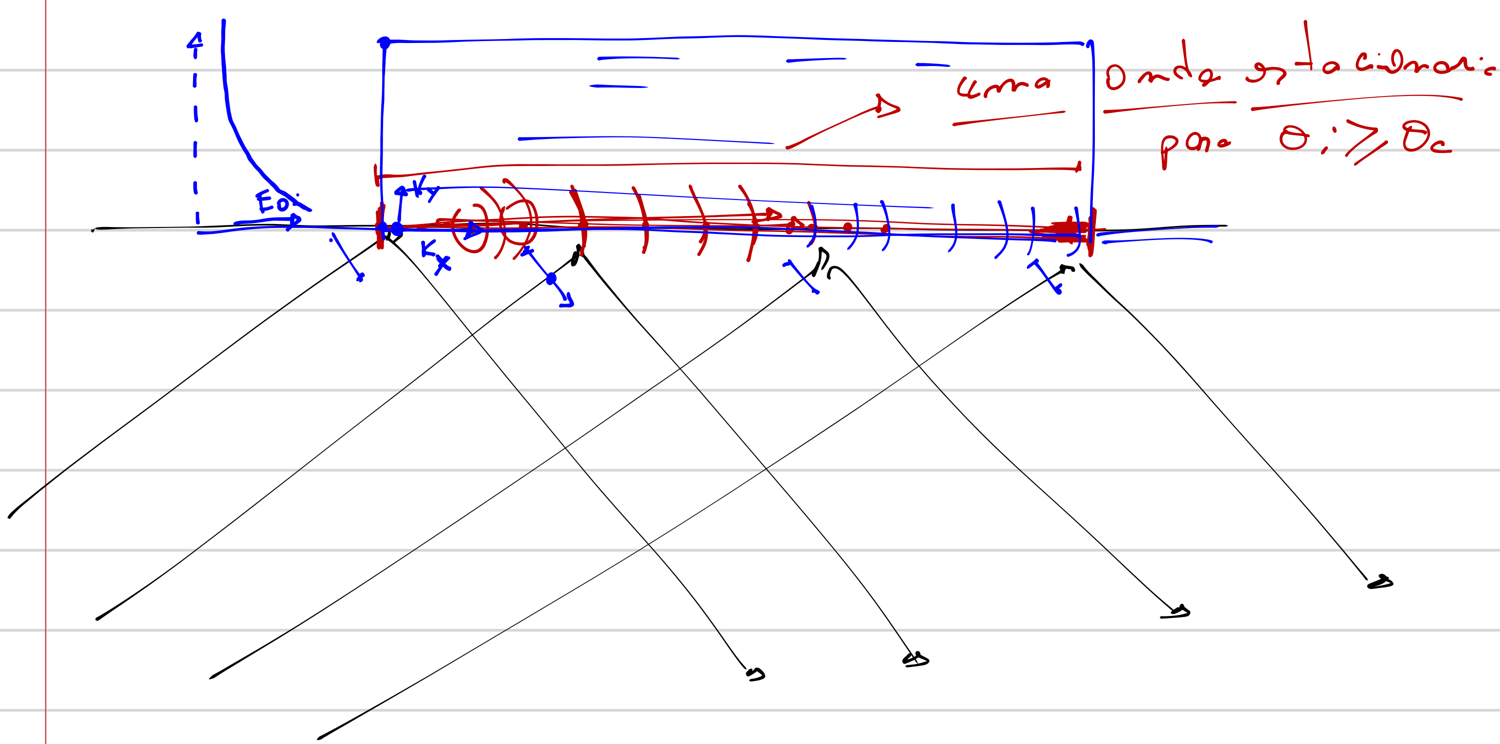
$$\text{Sen}\,\theta_c = \frac{v_i \cancel{t}}{v_t \cancel{t}} = \frac{\cancel{c}/n_i}{\cancel{c}/n_t}$$

$$\boxed{\text{Sen}\,\theta_c = \frac{n_t}{n_i}}$$

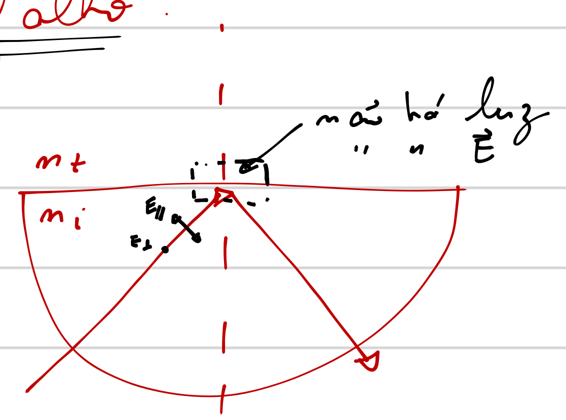
$$\frac{n_t}{n_i} \equiv n_{ti}$$

$$\boxed{\text{Sen}\,\theta_c = n_{ti}}$$

Explicação para isto:



Ponto falho:



$n_i > n_t$

→ Há campo elétrico no meio transmitido

Onda ⟶ evanescente

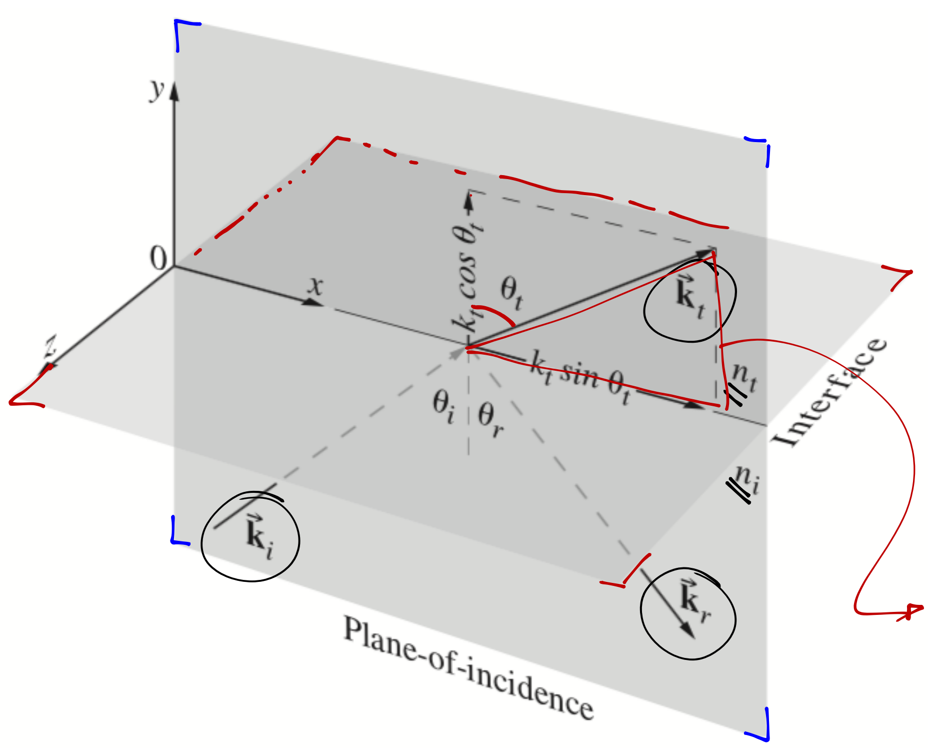


Figure 4.62 Propagation vectors for internal reflection.

$\theta_i \geq \theta_c$

Onda se propagando no meio(t)

$$\boxed{\vec{E}_t = \vec{E}_{0i} \exp\left[i \vec{K}_t \cdot \vec{r} - \omega t \right]}$$

$$\vec{K}_t = K_{tx}\hat{i} + K_{ty}\hat{j}$$

$$\vec{r} = x\hat{i} + y\hat{j}$$

$$\begin{cases} K_{tx} = K_t \sin\theta_t \\ K_{ty} = K_t \cos\theta_t \end{cases}$$

$$K_{ty} = K_t \cos\theta_t$$

$$n_i \operatorname{sen}\theta_i = n_t \operatorname{sen}\theta_t \;\to\; \operatorname{sen}\theta_t = \frac{\operatorname{sen}\theta_i}{n_{ti}}$$

$$\cos^2\theta_t + \operatorname{sen}^2\theta_t = 1$$

$$\cos\theta_t = \left[1 - \frac{\operatorname{sen}^2\theta_i}{n_{ti}^2}\right]^{1/2}$$

válido p/ $\theta_i > \theta_c$

$$K_{ty} = K_t \underbrace{\left[1 - \frac{\operatorname{sen}^2\theta_i}{n_{t1}^2}\right]^{1/2}}_{\text{número complexo p/ } \theta_i > \theta_c}$$

$$\boxed{\operatorname{sen}\theta_c = n_{ti}}$$ condição do ângulo crítico

$$\boxed{K_{ty} = \pm i K_t \left[\frac{\operatorname{sen}^2\theta_i}{n_{t1}^2} - 1\right]^{1/2}}$$

$$K_{tx} = K_t \operatorname{sen}\theta_t \qquad \operatorname{sen}\theta_t = \frac{\operatorname{sen}\theta_i}{n_{ti}}$$

$$\boxed{K_{tx} = K_t \frac{\operatorname{sen}\theta_i}{n_{ti}}}$$

$$\vec{E}_t = \vec{E}_{0i}\, e^{i(K_x x + K_y y - \omega t)}$$

$$= \vec{E}_{0i}\, e^{i\left(\frac{K_t \operatorname{sen}\theta_i}{n_{ti}} x \pm i K_t \left[\frac{\operatorname{sen}^2\theta_i}{n_{ti}^2} - 1\right]^{1/2} y - \omega t\right)}$$

$$= \vec{E}_{0i}\, e^{\mp \underbrace{K_t \left(\frac{\operatorname{sen}^2\theta_i}{n_{ti}^2} - 1\right)^{1/2}}_{} y} \cdot e^{i\left(\frac{K_t \operatorname{sen}\theta_i}{n_{ti}} x - \omega t\right)}$$

$$\beta = K_t \left(\frac{\operatorname{sen}^2\theta_i}{n_{ti}^2} - 1\right)^{1/2} = \frac{2\pi}{\lambda_0 / n_t}\left[\left(\frac{n_i}{n_t}\right)^2 \operatorname{sen}^2\theta_i - 1\right]^{1/2}$$

$$\boxed{\vec{E}_t = \vec{E}_{0i}\, e^{\mp \beta y} \cdot e^{i\left[\frac{K_t \operatorname{sen}\theta_i}{n_{ti}} x - \omega t\right]}}$$

→ Interpretando → Onda no meio transmitido

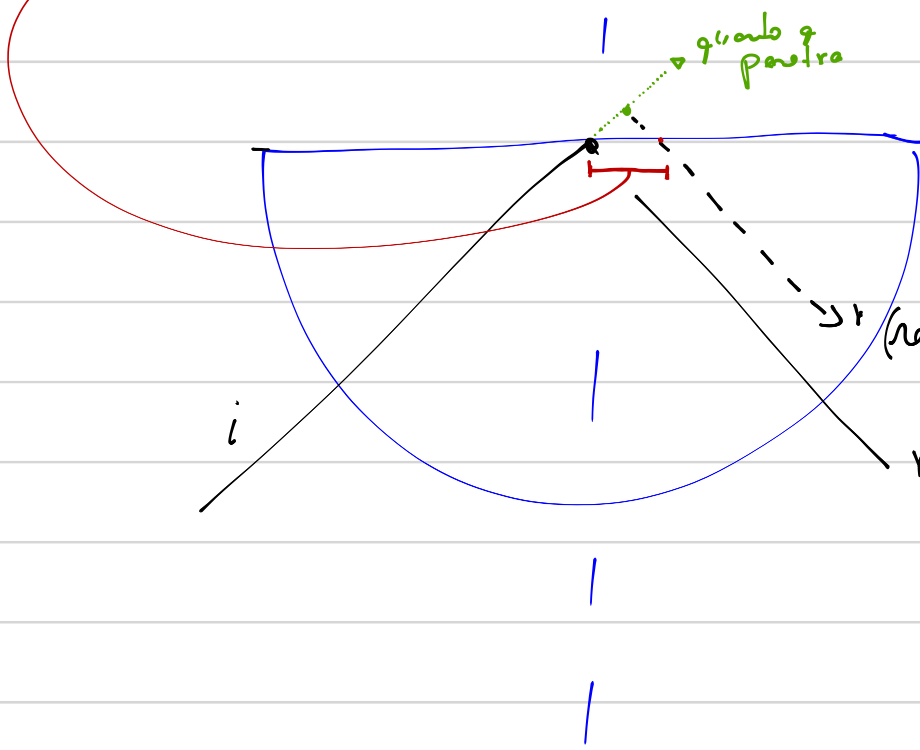
→ Se propaga, mas somente na direção $\hat{x}$

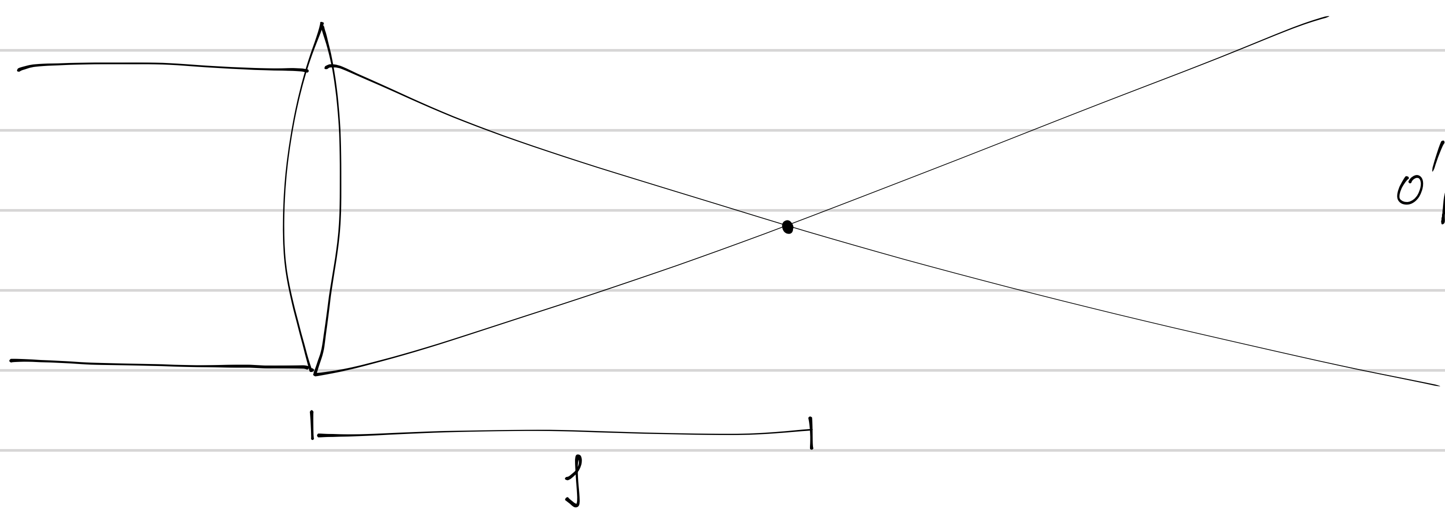
→ Se Desvanescendo na direção $\hat{j}$

↳ Onda evanescente → não se propaga!!

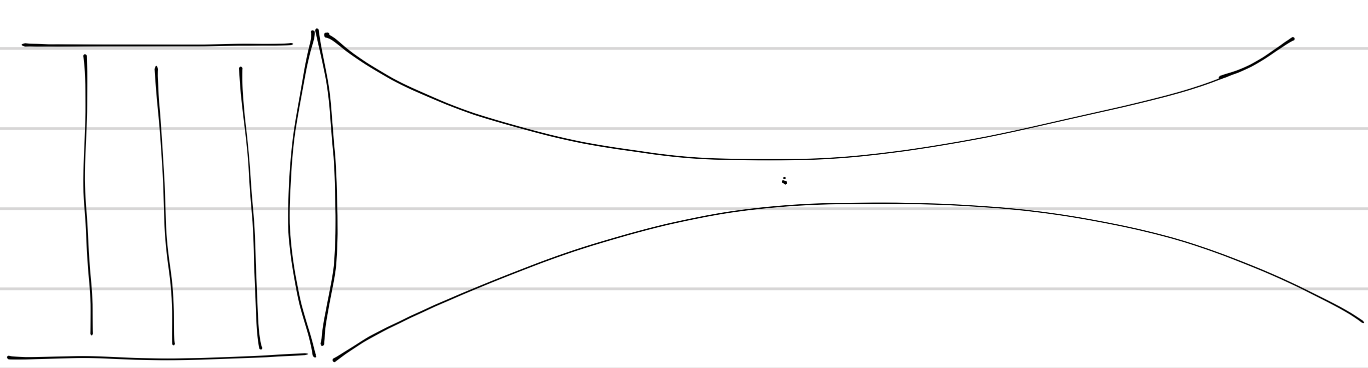
▷ (+) não tem significado físico

→ Deslocamento Goos-Hanchen





óptica geométrica



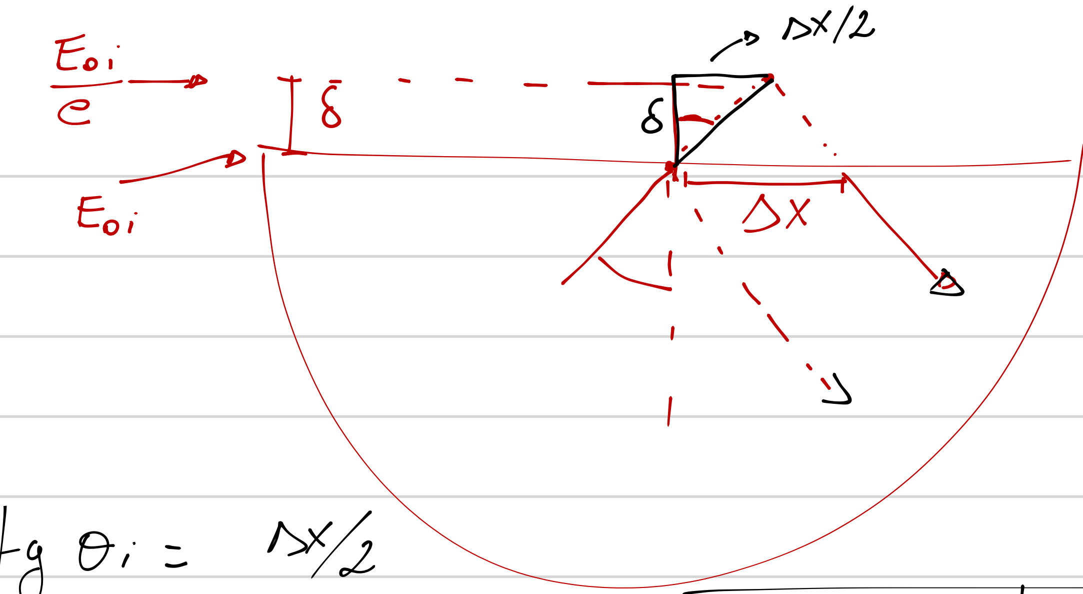
óptica ondulatória ou óptica física

$$\delta = \frac{1}{\beta}$$

δ = profundidade de penetração óptica

$$E(y) = E_{0i}\, e^{-\beta y}$$

$$y = \frac{1}{\beta} \Rightarrow E(\beta) = \frac{E_{0i}}{e} \qquad \boxed{\frac{1}{e}}$$

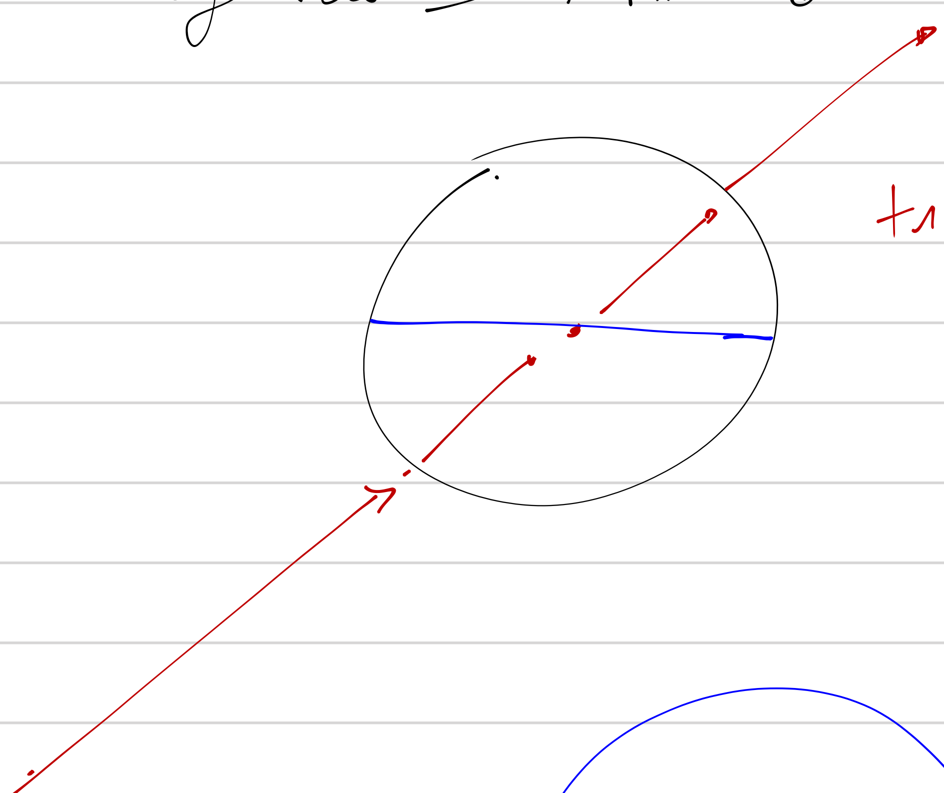


$\Delta x =$ deslocamento Goos-Hanchen

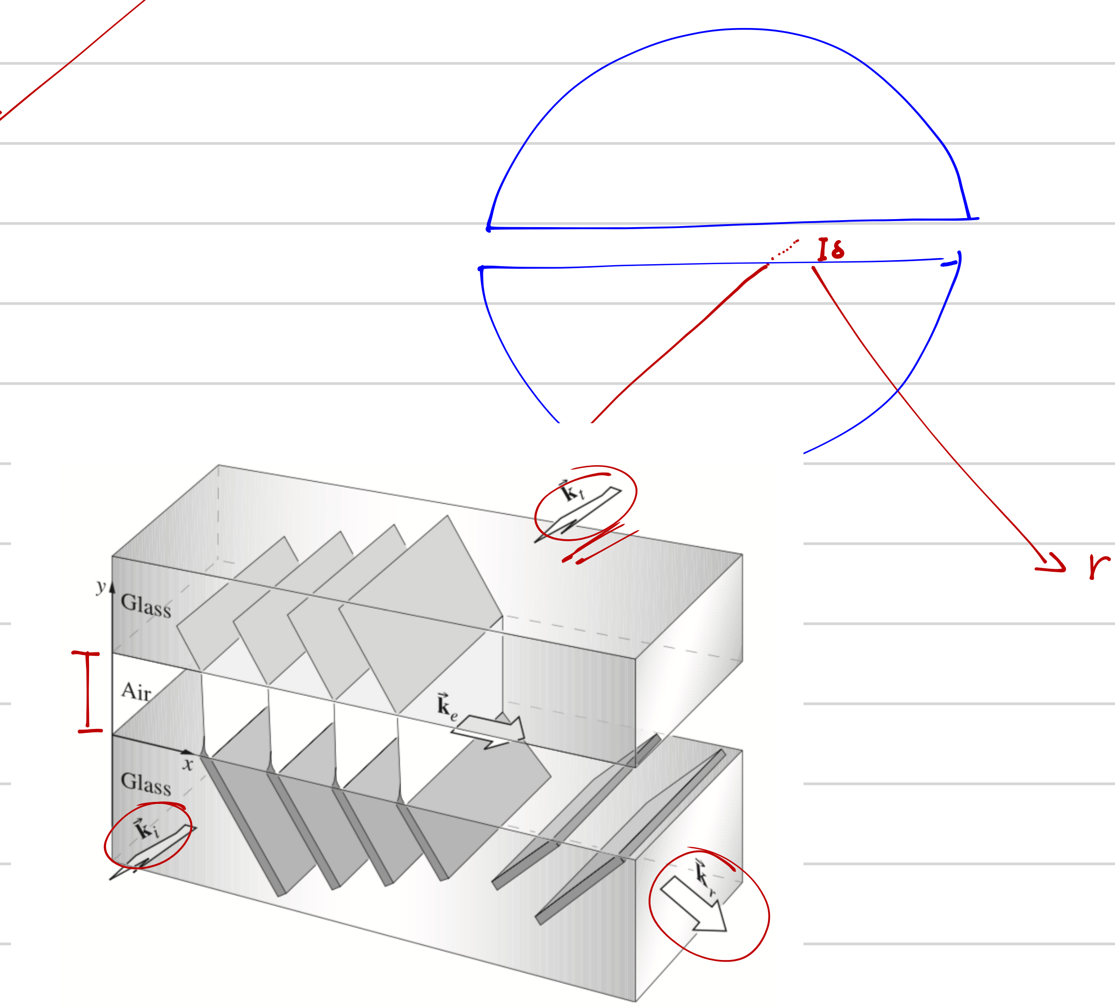
$$\operatorname{tg} \theta_i = \frac{\Delta x / 2}{\delta}$$

$$\boxed{\Delta x = 2 \delta \operatorname{tg} \theta_i}$$

Reflexão Interna Total Frustrada



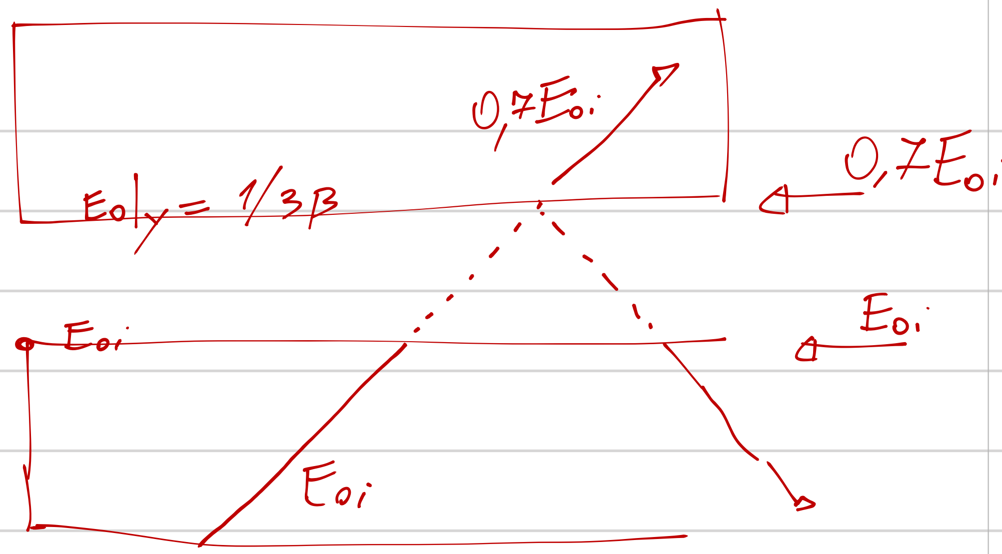
transmissão



$\theta_i > \theta_c$

Figure 4.65 Frustrated total internal reflection.

ma interface



$\delta = \frac{1}{\beta}$ $\quad \Delta y = \frac{\delta}{3}$

$\Delta y = \frac{1}{3\beta}$

$E = E_{oi}\, e^{-\beta y}$ $\quad$ so $y = \frac{1}{3\beta}$

$E = E_{oi}\, e^{-\cancel{\beta}/3\cancel{\beta}} = \frac{E_{oi}}{e^{1/3}} = 0,7\, E_{oi}$

---x---x---x---