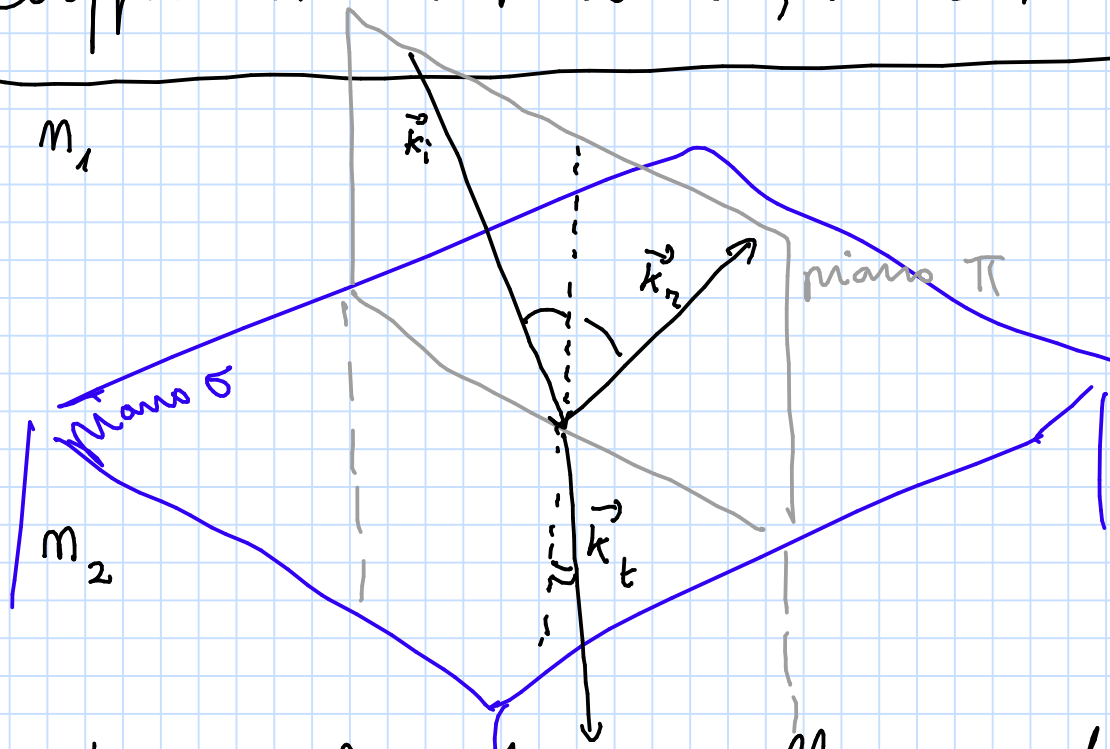


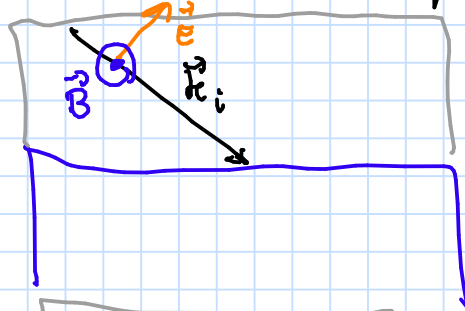
Coefficienti di Fresnel, incidenza obliqua



$\vec{k}_i, \vec{k}_r, \vec{k}_t$
nel piano π

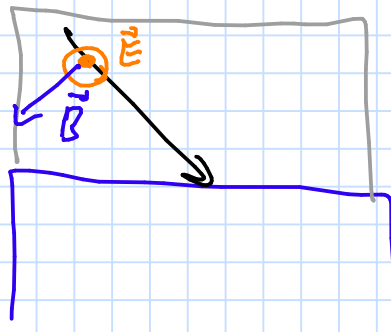
condizioni al contorno sulla superficie dip.
da orientazione del campo $\vec{E}$

a) π



π, TM
(transverse magnetic)

b) σ



σ, TE
(t. electric)

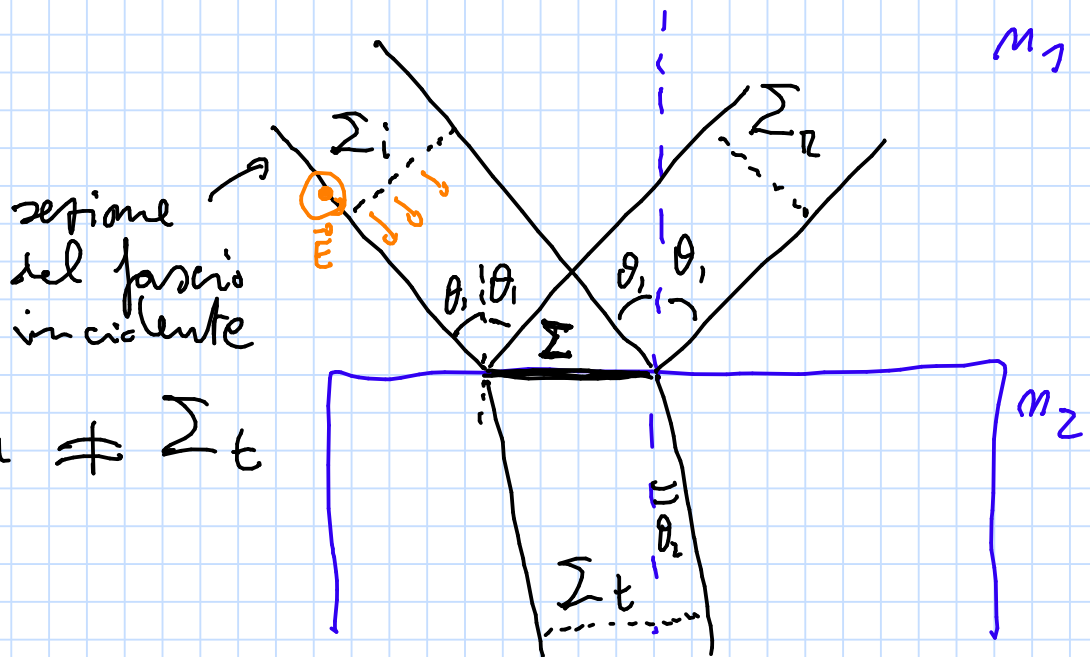
$\pi \rightarrow r_\pi \quad e \quad t_\pi$

$\sigma \rightarrow r_\sigma \quad e \quad t_\sigma$

per rapporti
del campo
 $\vec{E}$ con quello
incidente

dim.: servono due eq linearmente ind.
per $\vec{E}$ (da cond. contorno, potenza, etc)

2) σ



$$\Sigma_i = \Sigma_r \neq \Sigma_t$$

$$\begin{cases} P_i = \Sigma_i I_i \\ = \Sigma \cos \theta_i \epsilon_1 v_1 E_i^2 \\ P_r = (\quad) E_r^2 \\ P_t = \Sigma \cos \theta_t \epsilon_2 v_2 E_t^2 \end{cases} \Rightarrow \begin{cases} P_i = P_r + P_t \\ \vec{E}_i + \vec{E}_r = \vec{E}_t \end{cases}$$

I_i risp Σ_i , cioè che segue $\vec{k}_i$

$$r_\sigma = \frac{E_{r,\sigma}}{E_{i,\sigma}}$$

$$t_\sigma = \frac{E_{t,\sigma}}{E_{i,\sigma}}$$

$$\dots \Rightarrow \begin{cases} r = t - 1 \\ 4 = r^2 + \underbrace{\frac{\cos \theta_2}{\cos \theta_1}}_{\alpha} \underbrace{\frac{n_2}{n_1}}_{\beta} t^2 \end{cases}$$

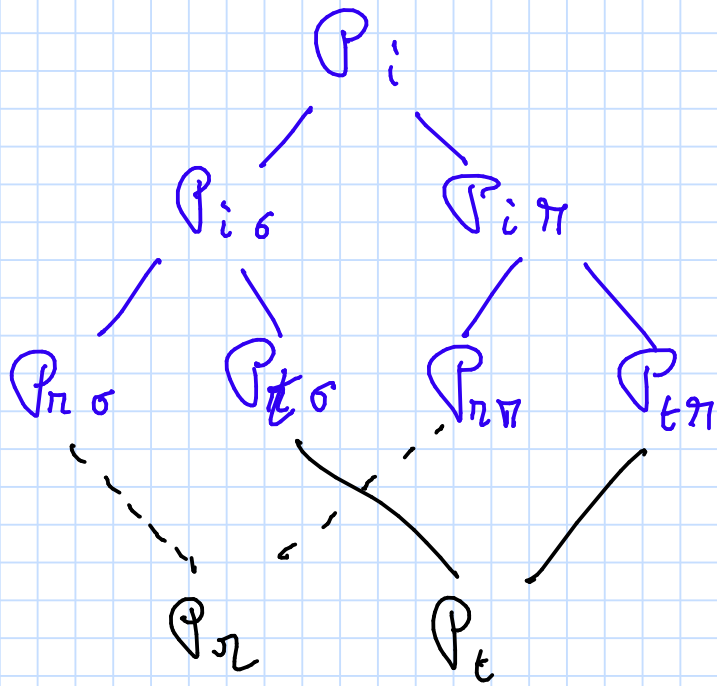
$$\Rightarrow r_\sigma = \frac{1 - \alpha \beta}{1 + \alpha \beta}$$

$$t_\sigma = \frac{2}{1 + \alpha \beta}$$

Potenza $b. / r.$

la frazione di $\mathbb{P}$ t./n. è diversa per σ e π .

$$\cdot \quad \mathbb{E}_i \Rightarrow \mathbb{E}_i^\pi + \mathbb{E}_i^\sigma$$



$$P_L = P_{L\sigma} + P_{L\pi}$$

$$P_t = \sigma_t^{-1} P_t \pi$$

$$\text{def } R_{\sigma} = \frac{P_{\pi\sigma}}{P_{i\sigma}} = \dots = (\pi_{\sigma})^2$$

$$T_{\sigma} = \frac{P_{t\sigma}}{P_{i\sigma}} = \frac{\sum_t I_t}{\sum_i I_i} = \dots = \frac{\alpha}{\sigma} \beta L_{\sigma}^2$$

stmo per π

non c'è dispersione
(1)

$$A = \tau_{\pi} + R_{\pi}$$

si conserva potente

$$1 = T_6 + R_6$$

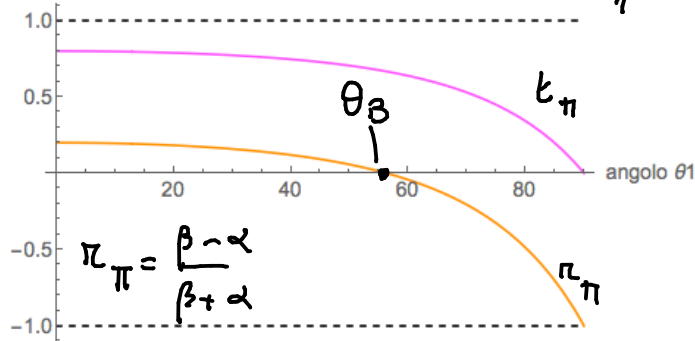
Now in compressed intensities



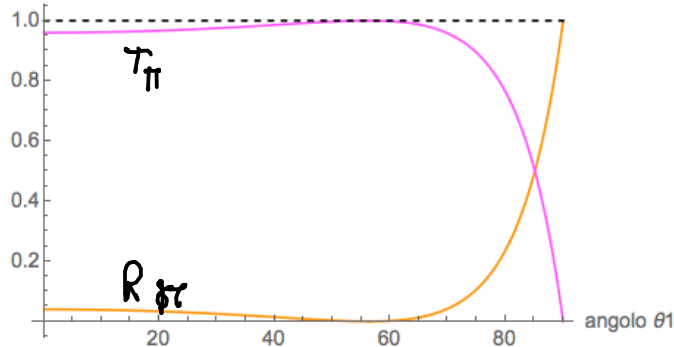
PIANO π --- Riflesso ■ Trasmesso ■ {n1 $\rightarrow$ 1, n2 $\rightarrow$ 1.5}

coefficienti r_π, t_π

$M_1 < M_2$



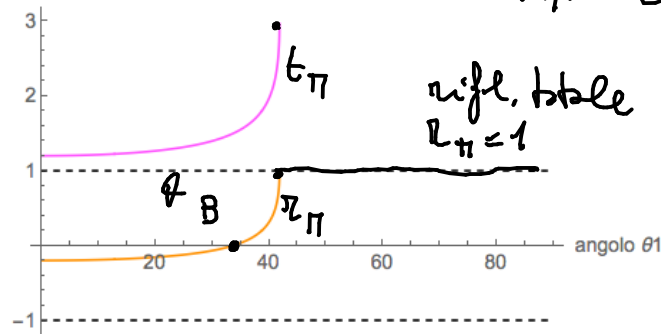
coefficienti R_π, T_π



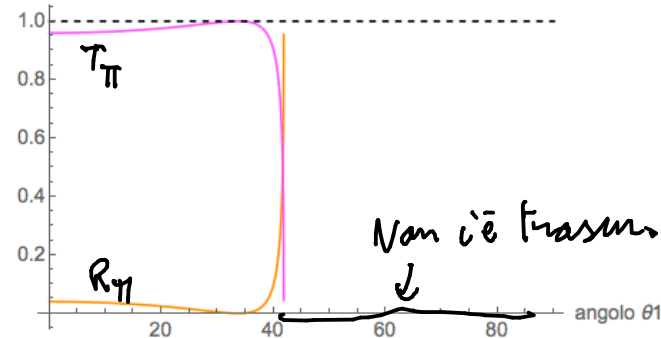
PIANO π --- Riflesso ■ Trasmesso ■ {n1 $\rightarrow$ 1.5, n2 $\rightarrow$ 1}

coefficienti r_π, t_π

$M_1 > M_2$



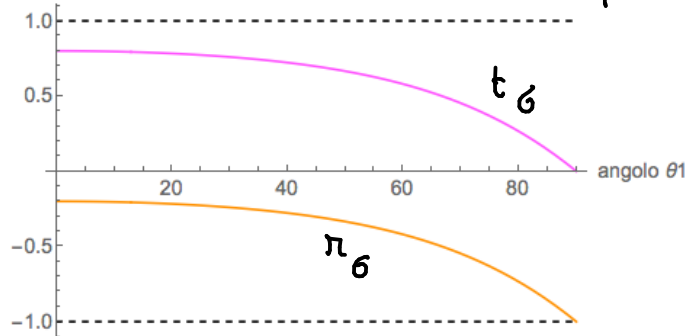
coefficienti R_π, T_π



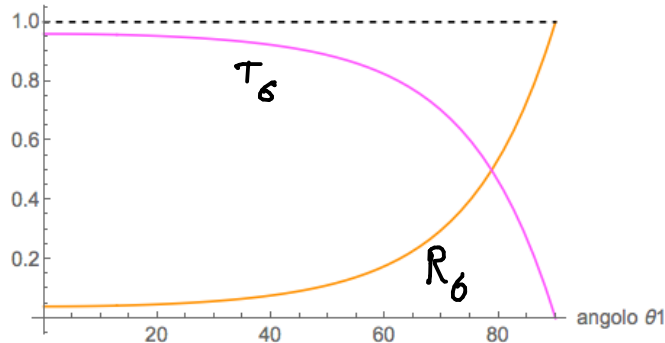
PIANO σ --- Riflesso ■ Trasmesso ■ {n1 $\rightarrow$ 1, n2 $\rightarrow$ 1.5}

coefficienti r_σ, t_σ

$M_1 < M_2$



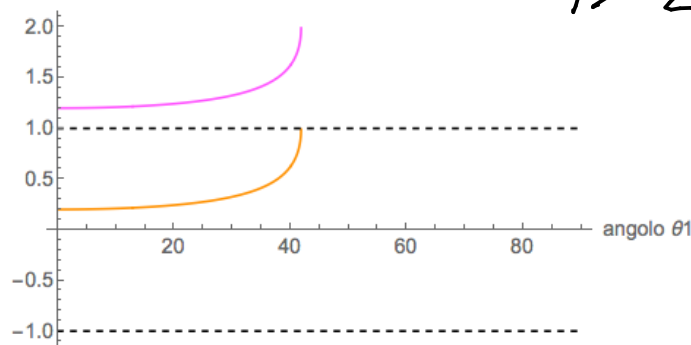
coefficienti R_σ, T_σ



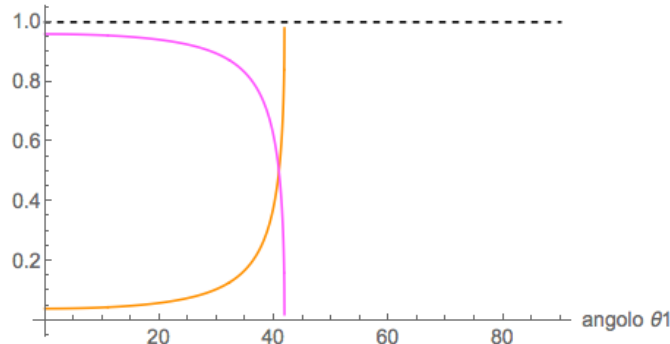
PIANO σ --- Riflesso ■ Trasmesso ■ {n1 $\rightarrow$ 1.5, n2 $\rightarrow$ 1}

coefficienti r_σ, t_σ

$M_1 > M_2$



coefficienti R_σ, T_σ



Angolo di Brewster

$$R_{\pi} = 0$$

$$R_{\pi} = 0$$

$$\alpha = \beta = \alpha$$

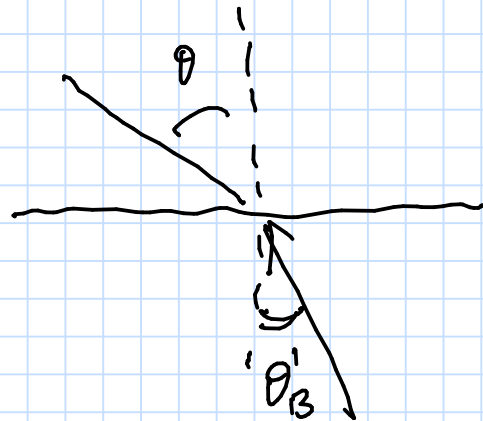
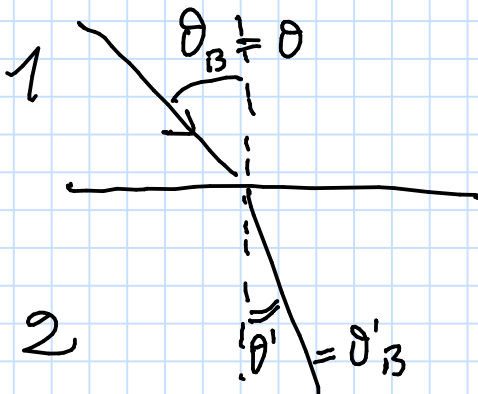
$$\left\{ \begin{array}{l} \alpha = \frac{\cos \theta_2}{\cos \theta_1} \\ \beta = \frac{n_2}{n_1} \end{array} \right.$$

$$\text{da Snell} \Rightarrow \sin \theta_1 \cos \theta_1 = \sin \theta_2 \cos \theta_2$$

$$\text{in realt a se } \theta_1 = \theta_B \quad \text{e} \quad \theta_2 = \frac{\pi}{2} - \theta_B$$

$$\text{con } \tan \theta_B = \beta$$

$$\theta_B = \arctan \frac{n_2}{n_1}$$



$$\theta_{B, 2 \rightarrow 1} = \frac{\pi}{2} - \theta_{B, 1 \rightarrow 2}$$

"Problema A"

vetro
 $n_2(\lambda) = a + \frac{b}{\lambda^2}$
 /
 esggl
 di
 canchy

$$a \approx 1.73$$

$$b = 0.02 \mu\text{m}^2$$

$\theta = \theta_B$ Brewster

(a) n_2 ?

che ci sarebbe nel vuoto

$$c = \lambda \nu \Rightarrow \lambda = c / \nu = 7.5 \cdot 10^{-7} \text{ m}$$

$$n_2 = a + b \frac{\nu^2}{c^2} = 1.77$$

(b) calcolare $\sin \theta'$ con solo n_1 e n_2

$$\theta' = \frac{\pi}{2} - \theta$$

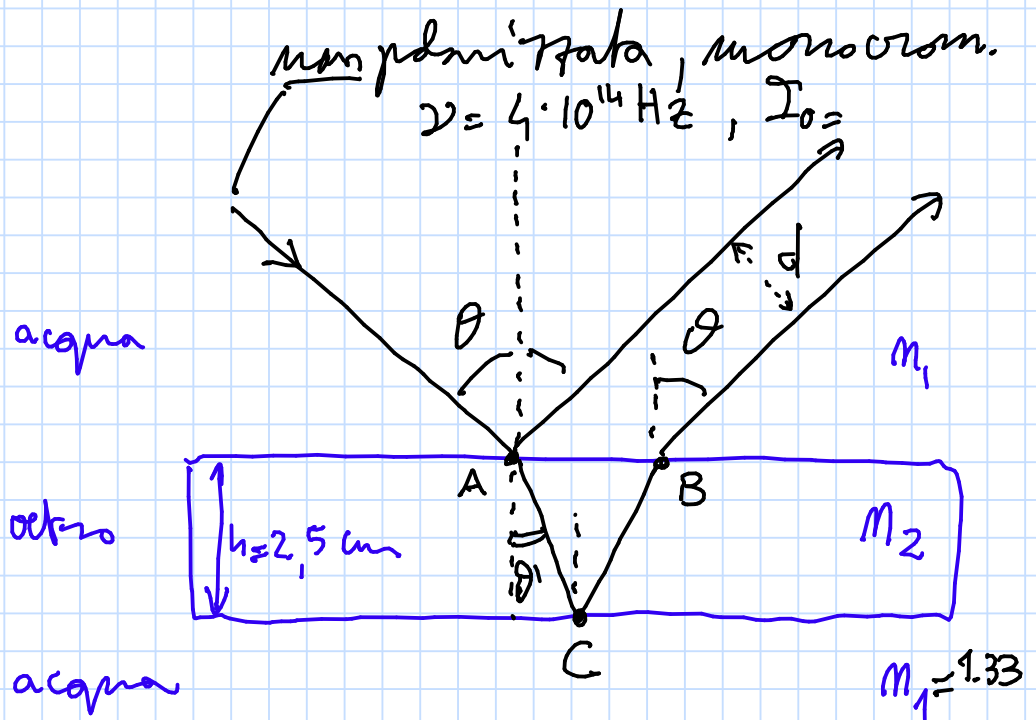
$$\theta = \frac{\pi}{2} - \theta'$$

Brewster

Snell $n_1 \sin \theta = n_2 \sin \theta'$

$$\cos(x) = \sqrt{1 - \sin^2 x} \dots$$

$$\sin \theta' = \frac{n_1}{\sqrt{n_1^2 + n_2^2}} = 0.602$$



(c) $\theta' = ?$

$$\theta' = \arcsin(\sin \theta) = 0.646$$

opposto

Brewster

$$\theta_B = \theta = \arctan \frac{n_2}{n_1} = 0.926$$

$$\theta' = \frac{\pi}{2} - \theta = 0.64. \quad \checkmark$$

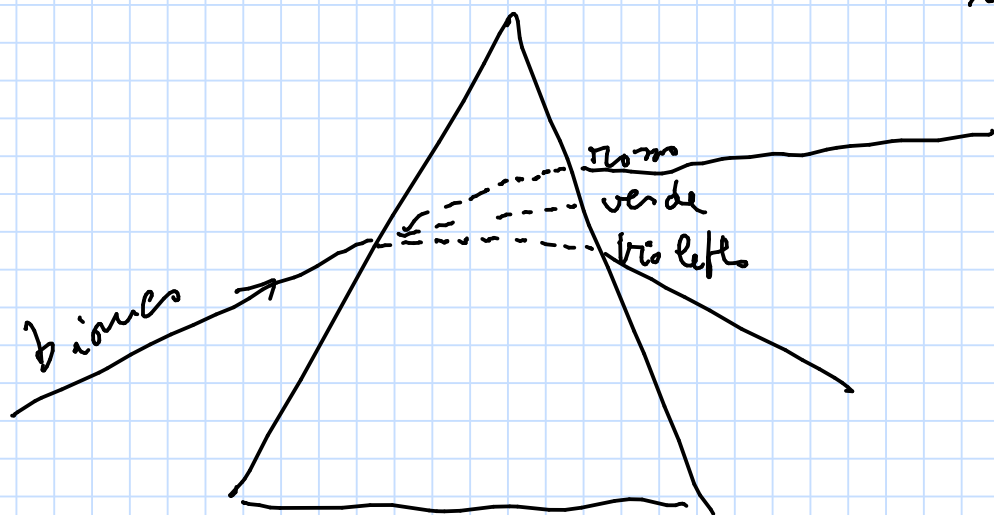
(d) vedere su

(e) AB se si usa $\tilde{\nu} \neq \nu$

$$\tilde{\nu} = 7.6 \cdot 10^{14} \text{ Hz}$$

$$\tilde{\nu} \Rightarrow \tilde{n}_2 = a + \frac{\tilde{\nu}^2}{c^2} b = 1.86 > n_2$$

freq. alte, n più alto $\Rightarrow$ deflexione maggiormente

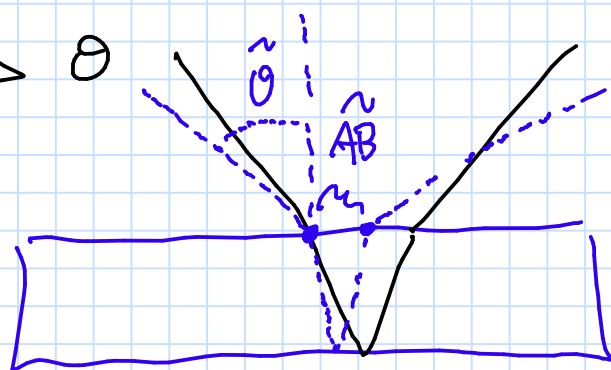


variato $n_2 \rightarrow \tilde{n}_2 \Rightarrow \theta$ è cambiato, $\tilde{\theta}$

$$\tan \tilde{\theta} = \frac{\tilde{n}_2}{n_1} \Rightarrow \tilde{\theta} = 0.95 > \theta$$

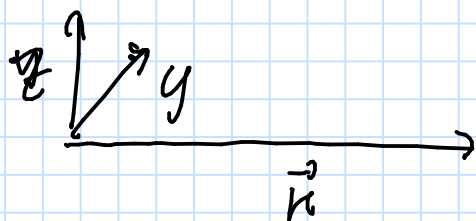
$$\tilde{AB} < AB$$

$$\tilde{AB} = 2h \frac{n_1}{\tilde{n}_2} = 3.58 \text{ cm}$$



(f) abbiamo luce non polarizzata
 50% dell'int. nella comp σ
 50% " " " π

┌ luce solare non è monocromatica
 ed è non polarizzata

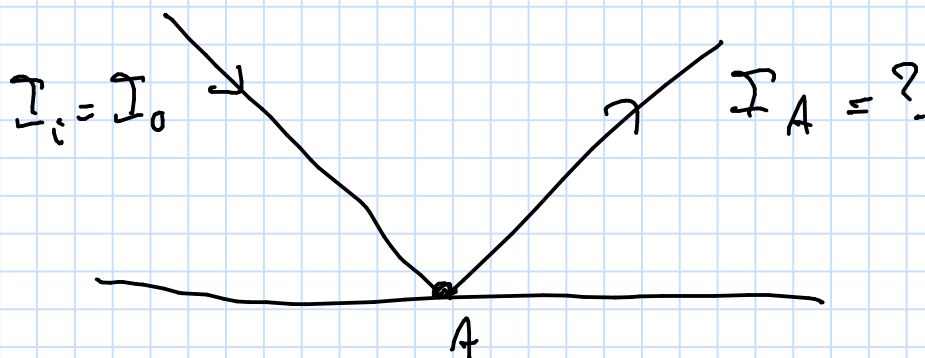


$$I = \frac{\langle E^2 \rangle}{Z_0} = I_y + I_z$$

$$= \frac{I}{2} + \frac{I}{2}$$

per onde monocromatiche (armoniche)

$$\langle E^2 \rangle = \frac{E_{\max}^2}{2}$$



$$I_0 = 0.45 \cdot 10^{-3} \text{ W/m}^2 \quad \text{non è polarizz.}$$

$$I_{0\sigma} = I_{0\pi} = \frac{1}{2} I_0$$

Brewster: comp. π tutta trasmessa

$$\pi_5 = \frac{1 - \alpha \beta}{1 + \alpha \beta}$$

$$\alpha = \frac{\cos \theta'}{\cos \theta} = 1.33$$

$$\beta = \frac{n_2}{n_1} = \dots 1.33$$

ovviamente

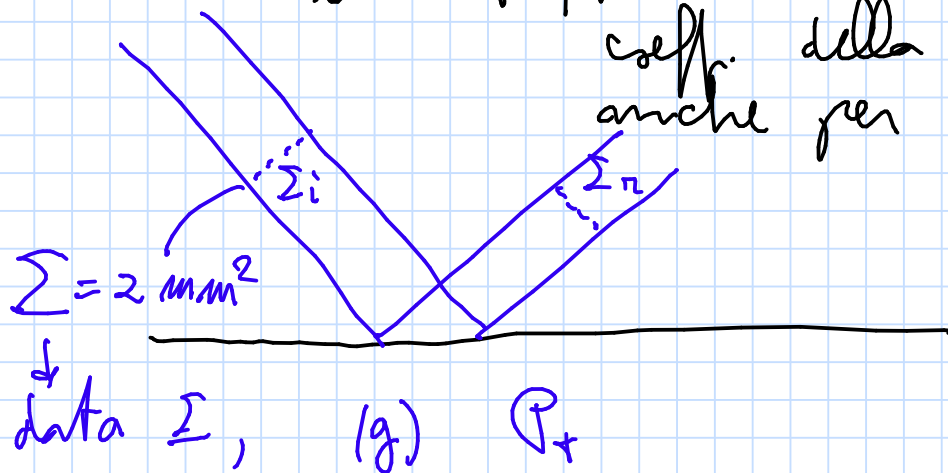
$$\pi_6 = \dots$$

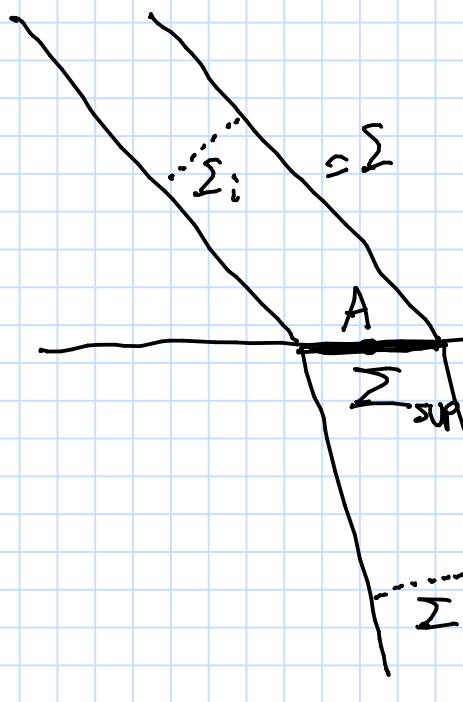
$$\pi_{II} = \frac{\beta - \alpha}{\beta + \alpha}$$

$$R_6 = (\pi_6)^2 = 0.077$$

$$I_A = R_6 \frac{I_0}{2} = 1.7 \cdot 10^{-5} \frac{W}{m^2}$$

$\Sigma_{\pi} = \Sigma_i$, possiamo usare i
coeff. della protettiva
anche per int.





$$P_i = I_0 \Sigma_i$$

$$= P_{i\pi} + P_{i\sigma}$$

$$P_{i\pi} = P_{i\sigma} = \frac{1}{2} P_i$$

$$\Sigma_{srf} = \frac{\Sigma_i}{\cos \theta} = \frac{\Sigma_t}{\cos \theta'}$$

$$\Sigma_t = \Sigma_i \frac{\cos \theta'}{\cos \theta} = \alpha \Sigma_i$$

$$P_t = \underbrace{P_{i\pi}}_{\text{transmissione Brewster}} + T_\sigma P_{i\sigma} = \frac{1}{2} P_i (1 + (1 - R_\sigma))$$

$$= \frac{P_i}{2} (2 - R_\sigma) = 0.65 \cdot 10^{-10} \text{ W}$$

(g') $I_t = ?$ (da A a C)

$$I_t = \frac{W_t}{\Sigma_t} = \frac{I_0}{\alpha} \left(1 - \frac{R_\sigma}{2}\right) = 3.25 \cdot 10^{-4} \frac{\text{W}}{\text{m}^2}$$

↑
fattore $\frac{1}{\alpha}$ della
"diluzione" in
 I_t maggiore di Σ_i

ese

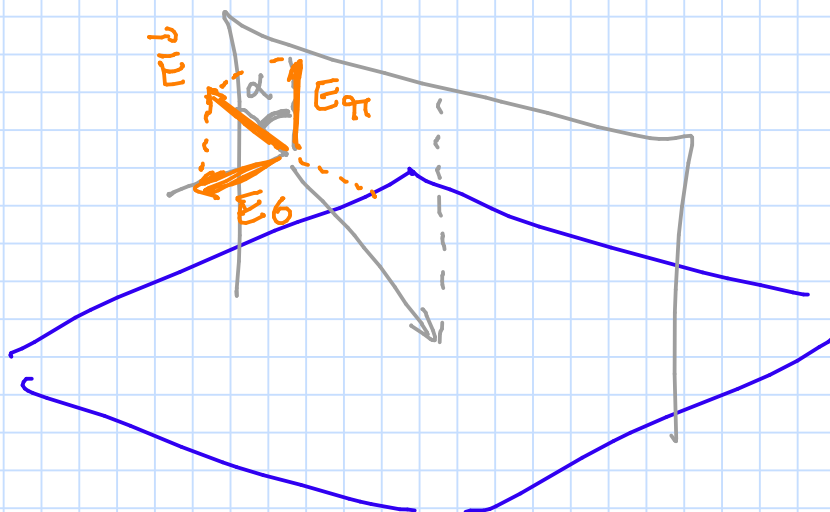
onda armonica, $\nu = 80 \text{ MHz}$, $I = 300 \text{ W/m}^2$
polarizz. obliqua, $\alpha = 30^\circ$ risp. al piano π
passa dal vuoto a diel. trasparente

$$\theta_1 = 20^\circ, \quad \theta_2 = 13^\circ$$

1) λ_2 nel dielettr. ?

2) $B_{\max}$ nel diel. ? B_t

3) I dell'onda nel diel. ? I_t



$$E_{\pi} = (\cos \alpha) E$$

$$E_{\sigma} = (\sin \alpha) E$$

1) $v = v_2 = \frac{c}{n_2}$ nel diel.

$$= \lambda_2 \nu \Rightarrow \boxed{\lambda_2 = \frac{v_2}{\nu} = \frac{c}{n_2 \nu}} \Leftrightarrow \frac{2\pi c}{n_2 \lambda_2}$$

Snell $n_1 \sin \theta_1 = n_2 \sin \theta_2$

vuoto $n_1 = 1$

$$n_2 = \frac{\sin \theta_1}{\sin \theta_2} = \frac{0.342}{0.225} = 1.52$$

$$\lambda_2 = 2.55 \text{ m}$$

$$\left(\beta = \frac{n_2}{n_1} = n_2 \right)$$