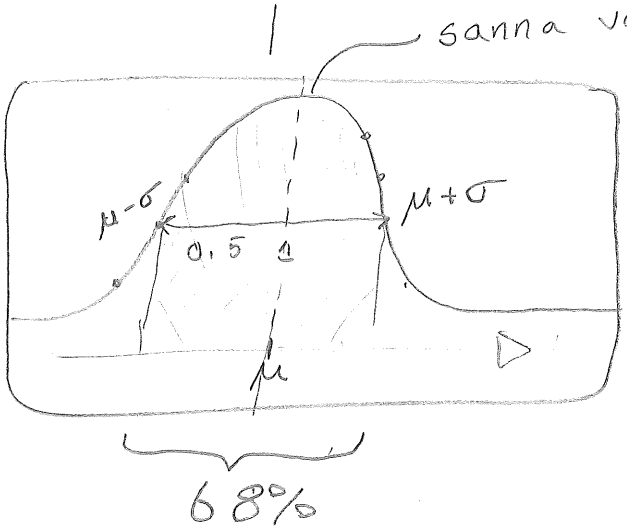
Föreläsning 8

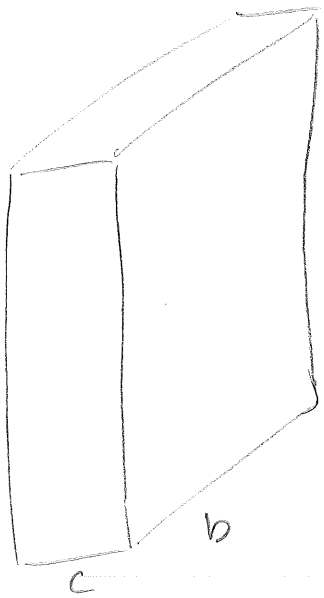
Mätfel

Vi mäter A, res blir

$$\boxed{A \pm \sigma_a \text{ el. } A \pm \Delta a \text{ el. } A \pm \delta_a}$$

Slumpmässiga ⇒ Normalfördelning





$V = abc$

$m_1 = 250g$ full kopp

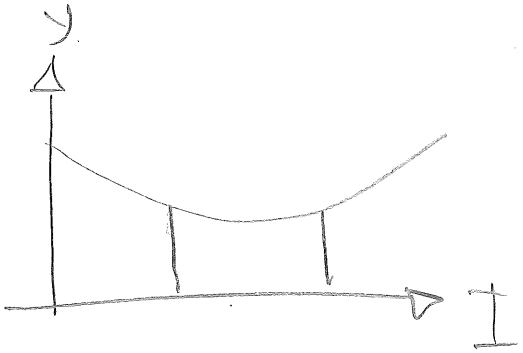
$m_2 = 50g$ tom kopp

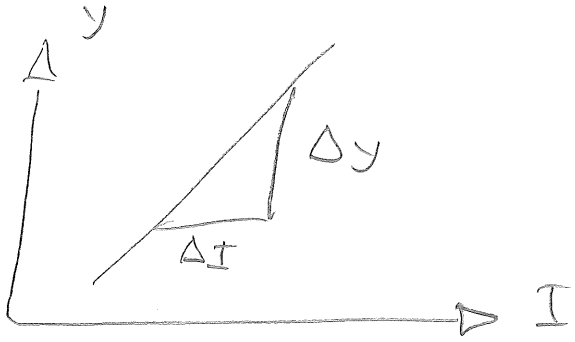
$\Delta m = 5g$ mätfel

$m_3 = 250 - 50 = 200 \pm \boxed{?}$

$$\boxed{\Delta m_3^2 = \Delta m_1^2 + \Delta m_2^2} \Rightarrow \Delta m_3 = \sqrt{5^2+5^2} = \boxed{7{,}1g}$$

Felfortplantning: $\sigma_c = \sqrt{\sigma_A^2 + \sigma_b^2}$





$$\frac{dy}{dI} = \text{lutning.}$$

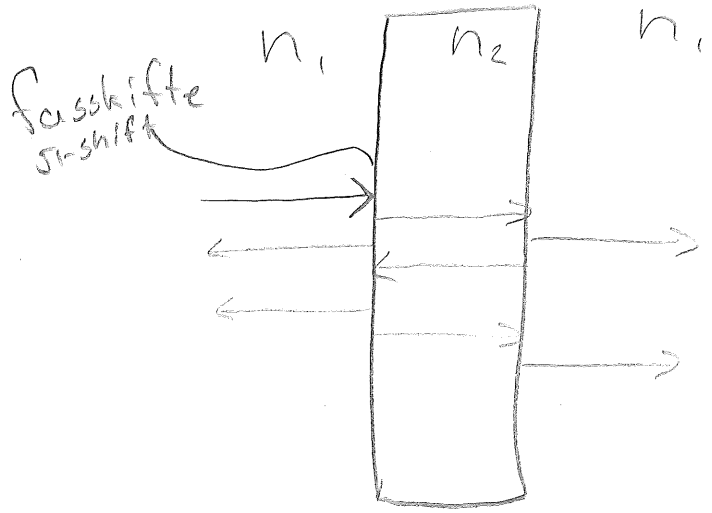
$$\Delta y = \text{lutn} \cdot I = \frac{dy}{dI} \cdot \Delta I$$

$$\Delta y^2 = \left|\frac{dy}{dI}\right|^2 \cdot \Delta I^2$$

$$\boxed{\Delta \psi^2 = \left|\frac{d\psi}{dp}\right| \cdot \Delta p^2 + \left|\frac{d\psi}{dq}\right|^2 \cdot \Delta q^2}$$

Interferens i tunna skikt

Varför blir fjärilar och påfåglar inte solblekta?

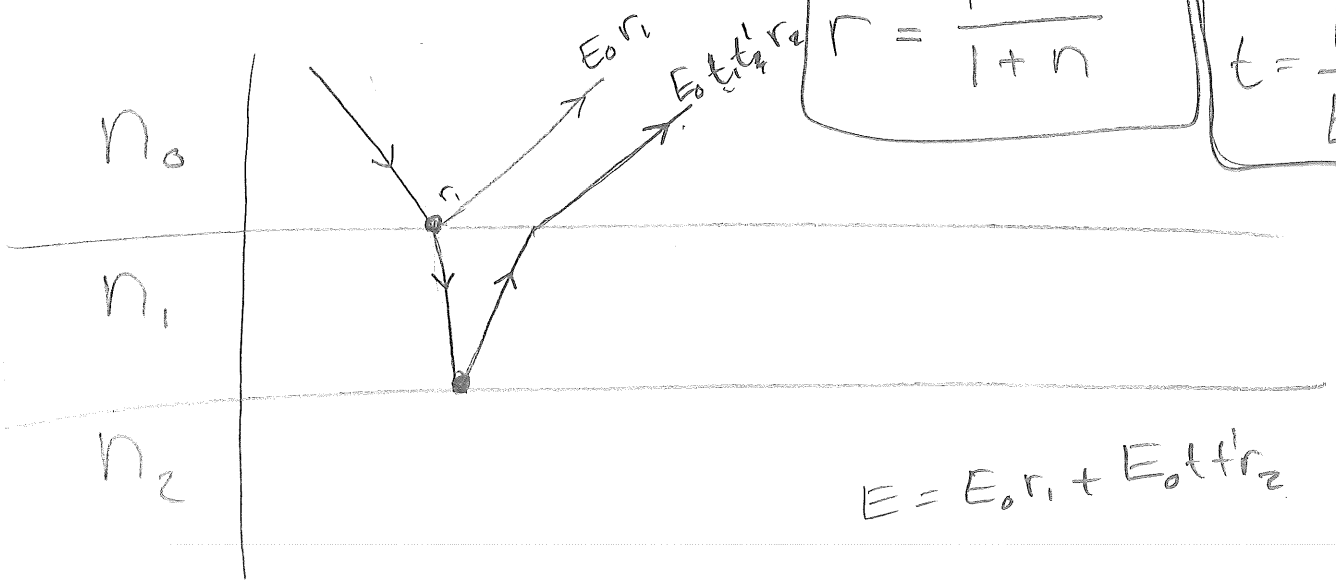


luft $\rightarrow n$

$$r = \frac{1-n}{1+n}$$

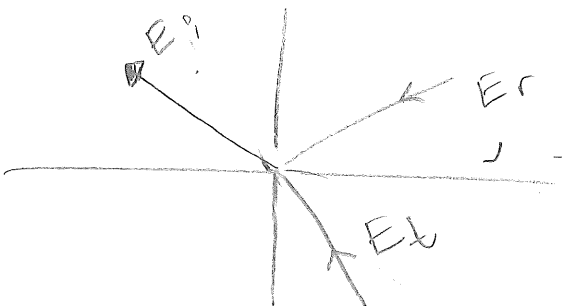
$$r = \frac{E_r}{E_i}$$

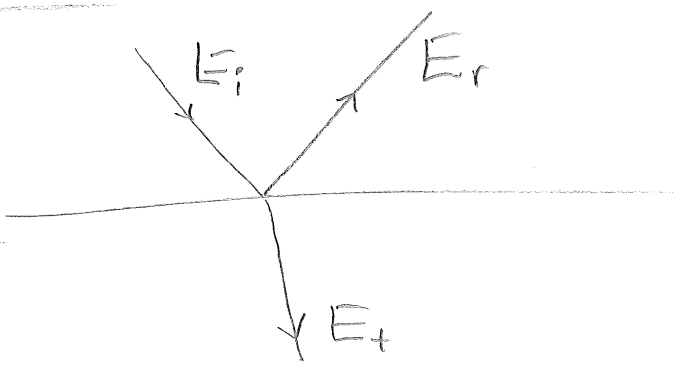
$$t = \frac{E_t}{E_i}$$



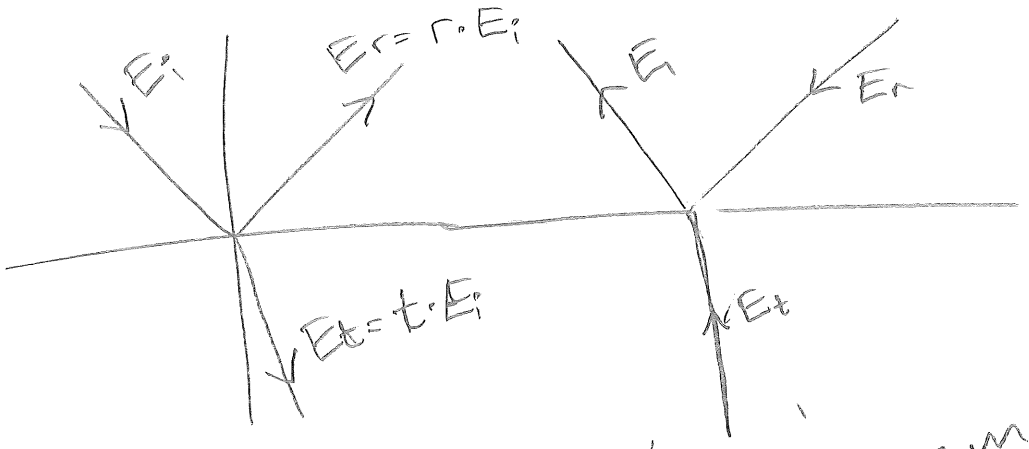
$$E = E_0 r_1 + E_0 t t' r_2$$

Stokes relationer

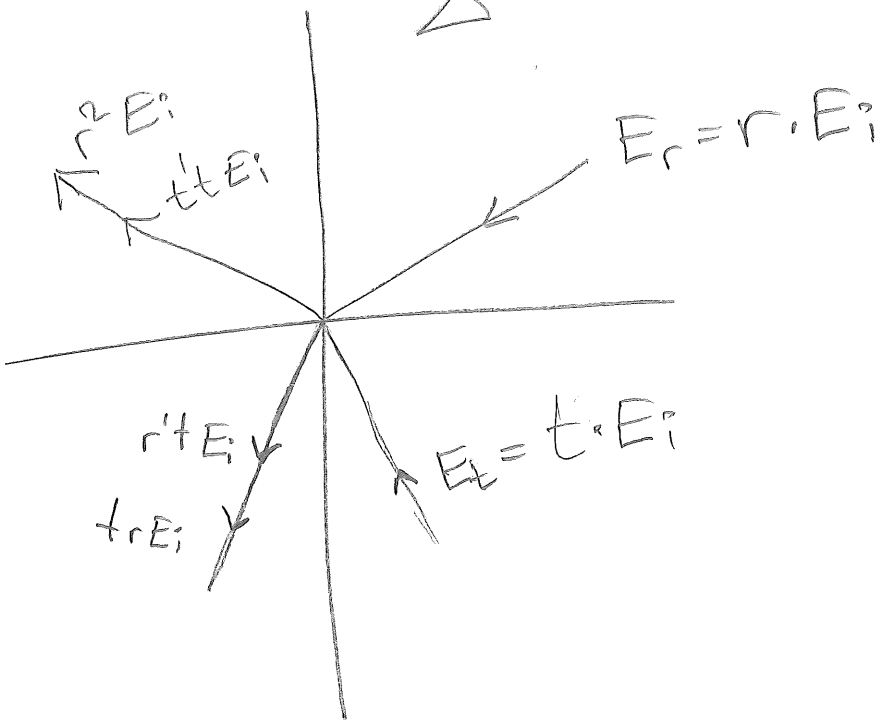




Stokes relationer

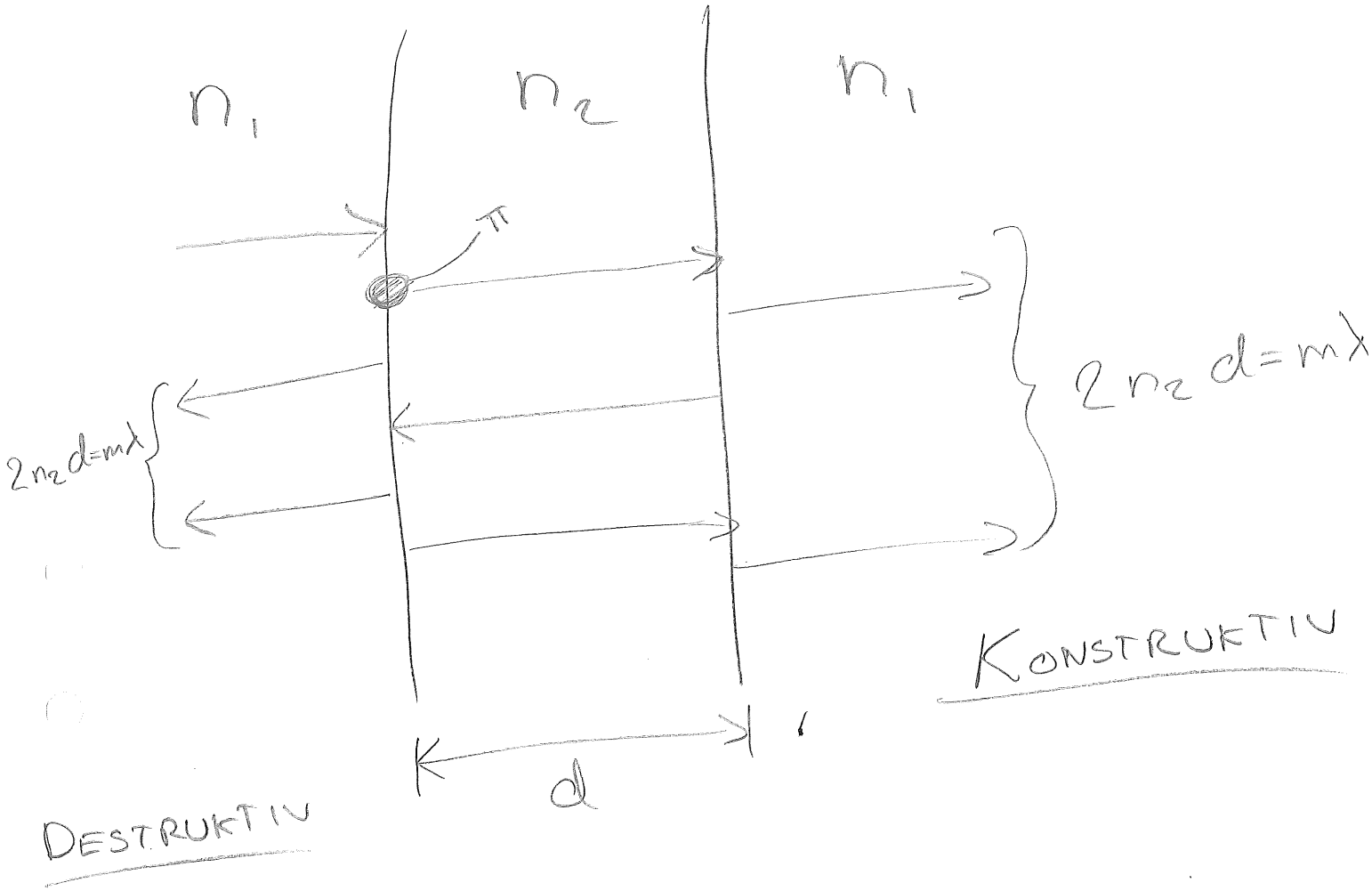


samma som



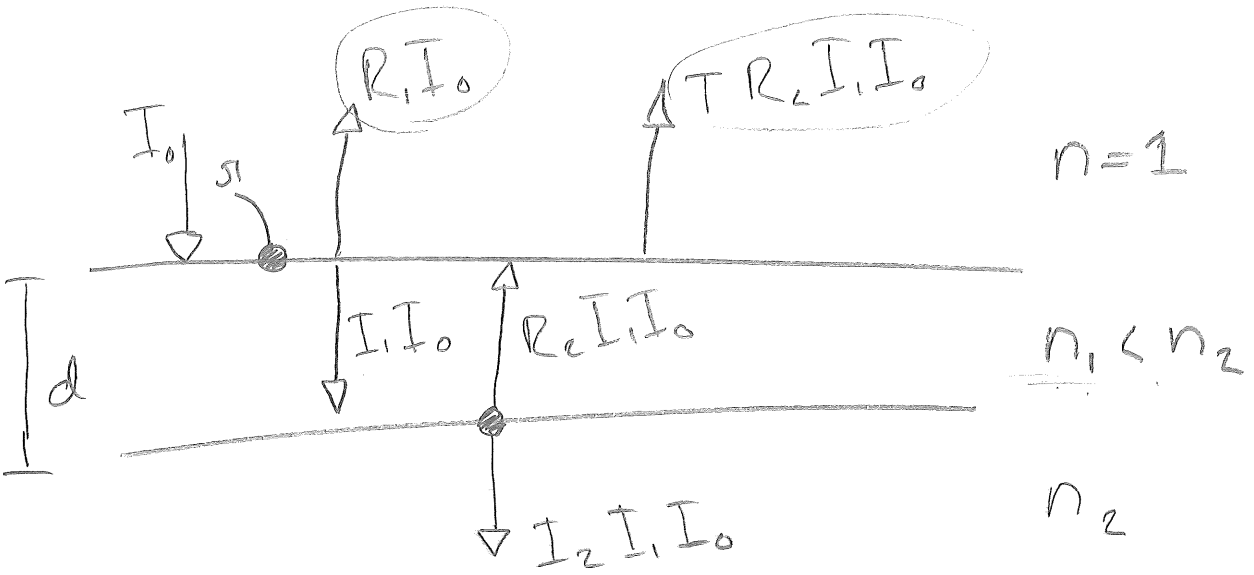
$$\left.\begin{aligned} E_i &= (r^2 + t t') E_i \\ 0 &= (r' t + t r) E_i \end{aligned}\right\} = \boxed{t t' = 1 - r^2} \quad \boxed{r = -r'}$$

FASSKIFTE!



Fasskifte sker då vi går från tunnare till tätare!

Antireflexbehandlade glasögon



De två inringade ska släcka ut varandra.

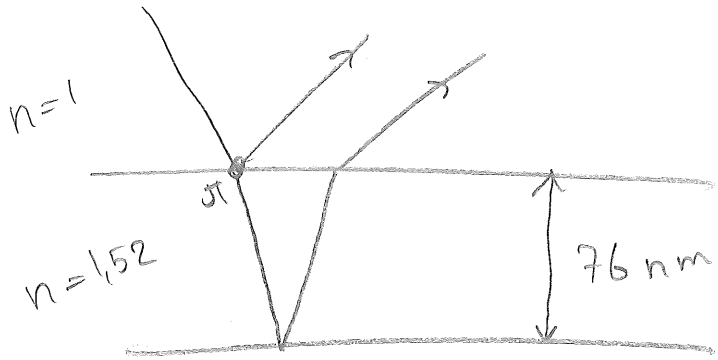
$$2 n_1 d = m\lambda + \frac{\lambda}{2}$$

minsta tjocklek: $d = \frac{\lambda}{4 n_1}$

$$\Rightarrow \boxed{n_1 = \sqrt{n_2}}$$

så vi lägger på en tunn yta som har roten ur glasets brytningsindex.

UPPGIFT [fjäril]



$$2nd = \frac{\lambda}{2} + m\lambda$$

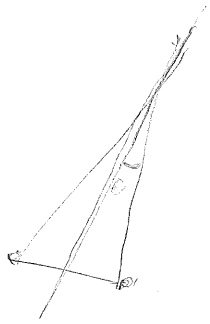
$m=0 \Rightarrow \lambda = 462\,nm$

$m=1 \Rightarrow \lambda = 154\,nm$

n=1

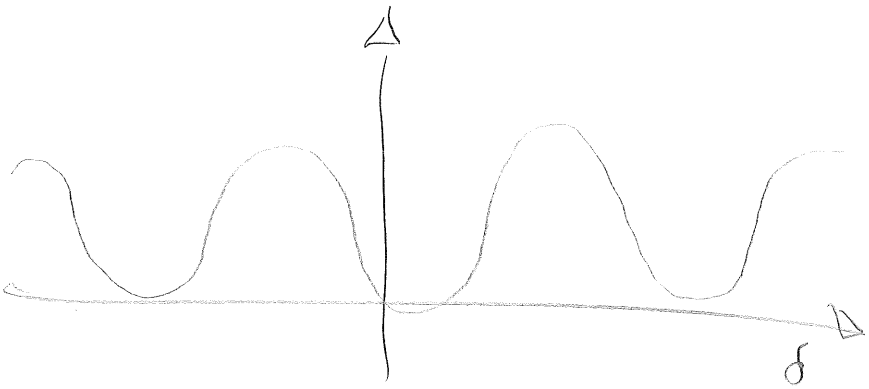
Föreläsning 9

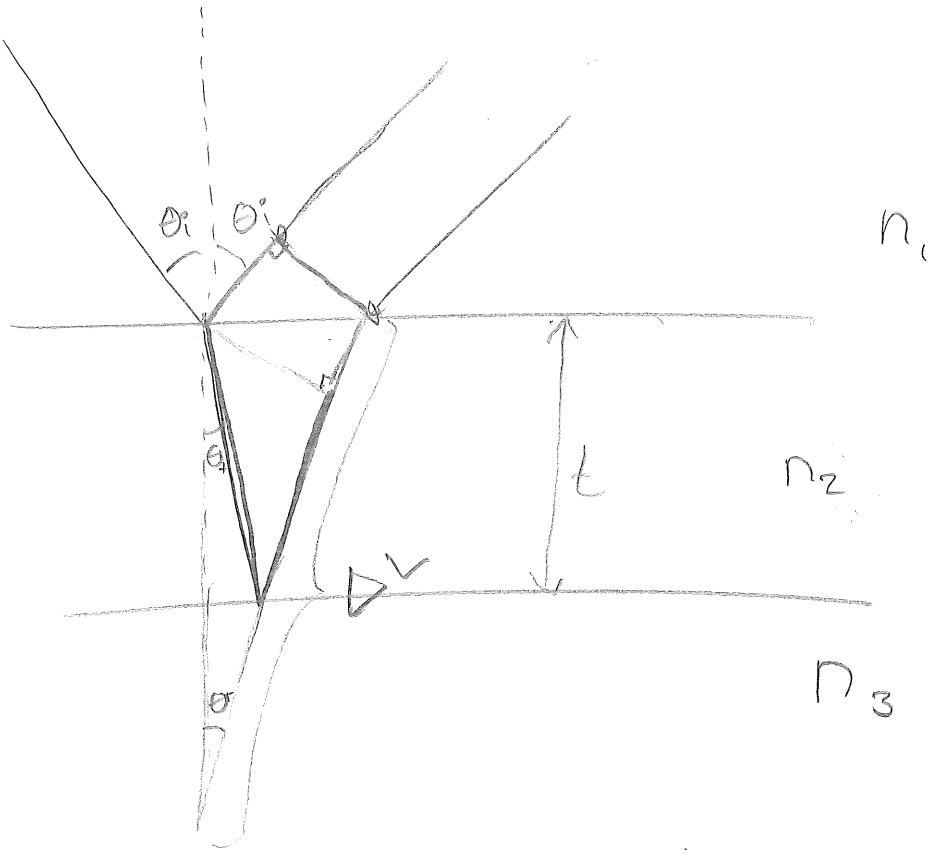
$$I = I_1 + I_2 + \underbrace{2\sqrt{I_1 I_2}\cos\delta}_{\text{interferensterm}}$$



Om $I_1 = I_2 = I_0$

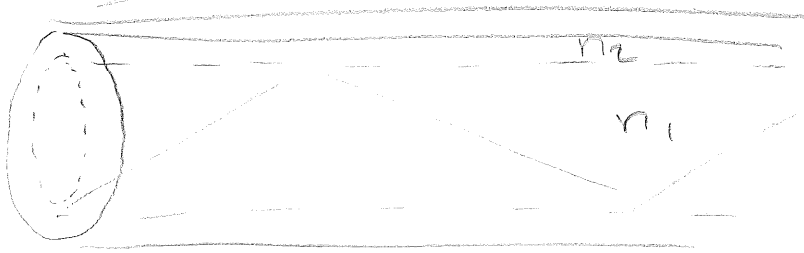
$$\Rightarrow \boxed{\begin{aligned} I_{max} &= 4I_0 \\ I_{min} &= 0 \end{aligned}}$$



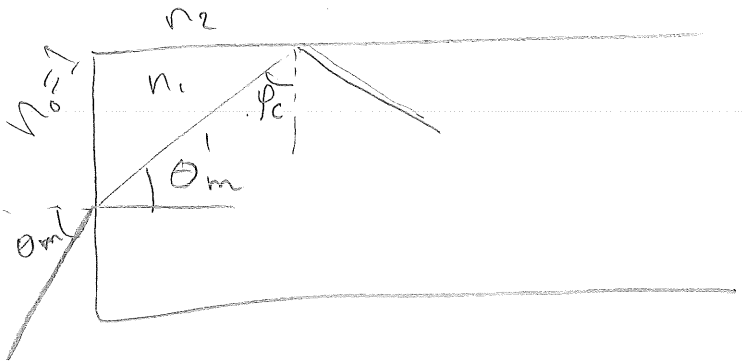


$$\cos\theta_t = \frac{\Delta L}{2t \cdot n} \Rightarrow \boxed{\Delta L = 2t \cdot n \cdot \cos\theta_t}$$

Fiberoptik - vad är grejen?



$$\boxed{n_1 > n_2}$$



Totalreflektion

$$n_1 \sin\varphi_c = n_2 \sin 90^\circ = n_2$$

$$\Rightarrow \boxed{\varphi_c = \arcsin\left(\frac{n_2}{n_1}\right)}$$

$$n_0 \sin\theta_m = n_1 \sin\theta_m'$$

$$\theta_m' = 90 - \varphi_c$$

$$N.A \equiv n_0 \cdot \sin\theta_m =$$

$$= n_1 \sin\theta_m' =$$

$$= n_1 \cdot \sin(90 - \varphi_c)$$

$$= n_1 \cos\varphi_c$$

$$\sin^2\varphi_c + \cos^2\varphi_c = 1$$

$$\cos\varphi_c = \sqrt{1 - \sin^2\varphi_c}$$

$$\sin^2\varphi_c = \frac{n_2^2}{n_1^2} \Rightarrow$$

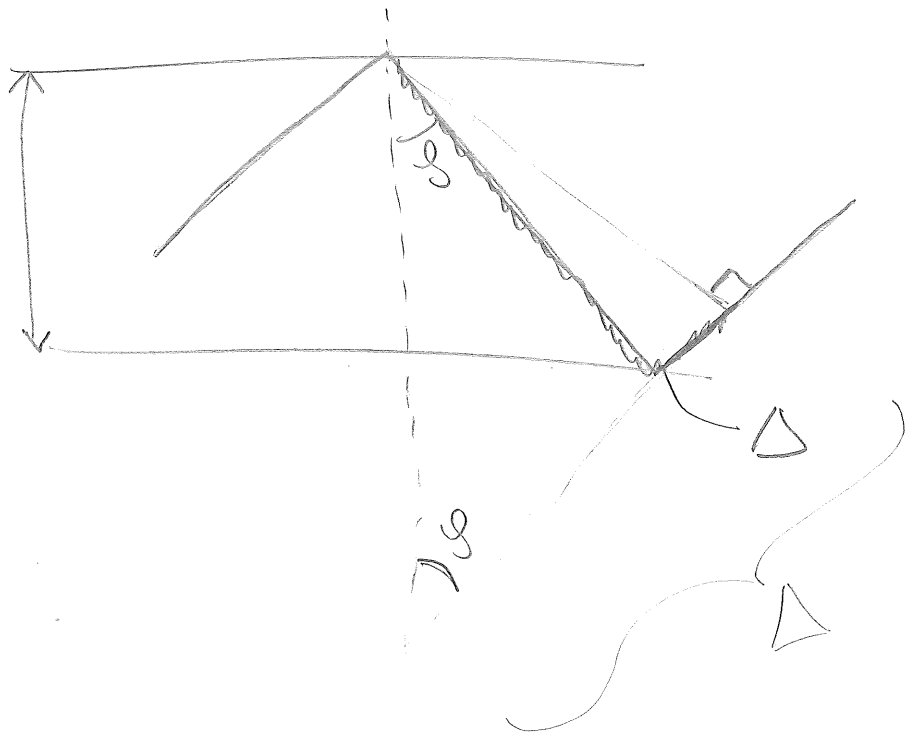
$$\Rightarrow N.A = n_1 \sqrt{1 - \frac{n_2^2}{n_1^2}} = \sqrt{n_1^2 - n_2^2}$$

#

$$\boxed{n_0 \sin\theta_m = \sqrt{n_1^2 - n_2^2}}$$

Tillåtna moder

plan guide



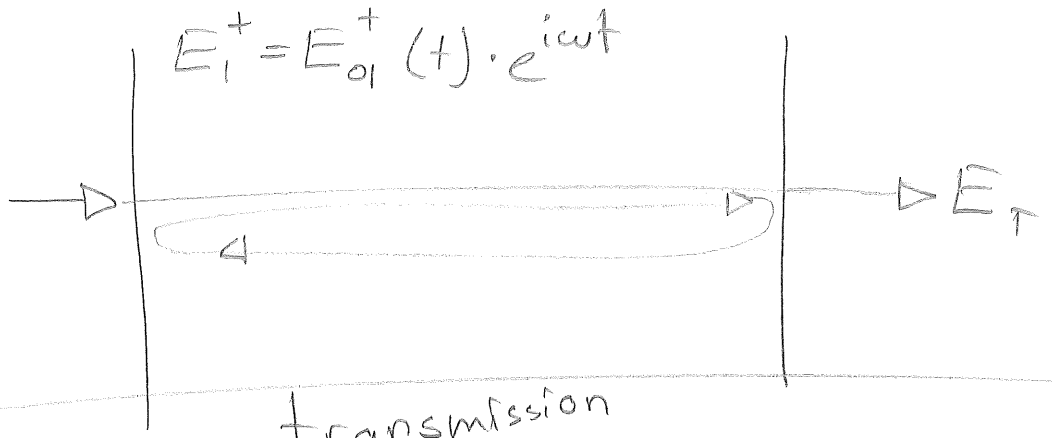
$$\left.\begin{aligned} \frac{2\pi}{\lambda}\Delta + 2\theta_r &= 2m\pi \\ \Delta &= 2n_1 d\cos\varphi \end{aligned}\right\} \quad m = \frac{2n_1 d\cos\varphi}{\lambda} + \cancel{\frac{\theta_r}{\pi}}$$

max då $\varphi = \varphi_c$ $\quad n_1\cos\varphi = NA = \sqrt{n_1^2 - n_2^2}$

plan $\Rightarrow$ $\boxed{m_{tot} = \frac{2d}{\lambda}\sqrt{n_1^2 - n_2^2} + 1}$ Den kan gå rakt igenom utan att studsa.

fiber $\Rightarrow$ $\boxed{m_{tot} = \frac{1}{2}\left(\frac{\pi d}{\lambda} NA\right)^2}$

$$E_I = E_{0I} \cdot e^{i\omega t}$$



transmission

$$\boxed{E_{01}^+(t+\tau) = (tr) E_{0I}\, e^{i\omega(t+\tau)} + r^2 E_{01}^+ e^{i(\omega\tau - 2kd)}}$$

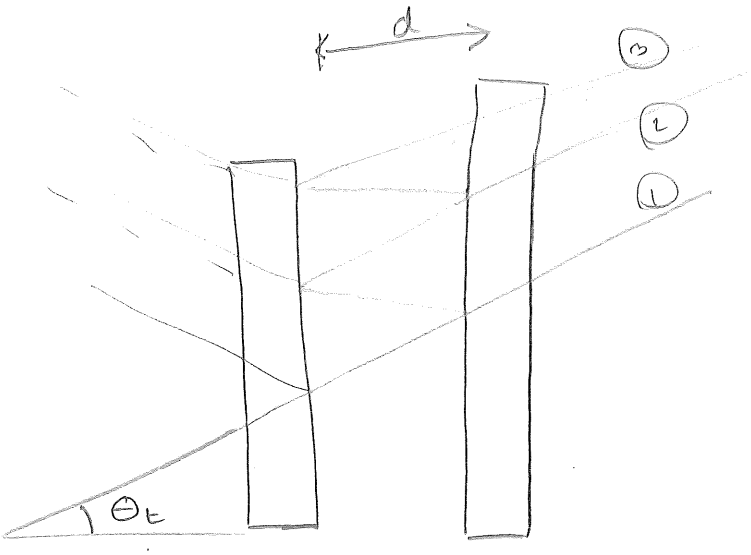
Steady state

$$E_{01}^+(t+\tau) = E_{01}^+(t) \equiv E_{01}^+$$

$$\Rightarrow \boxed{E_{01}^+ \frac{t}{1 - r^2 e^{-i\delta}} E_{0I} \quad , \delta = 2kd}$$

FABRY-PEROT,

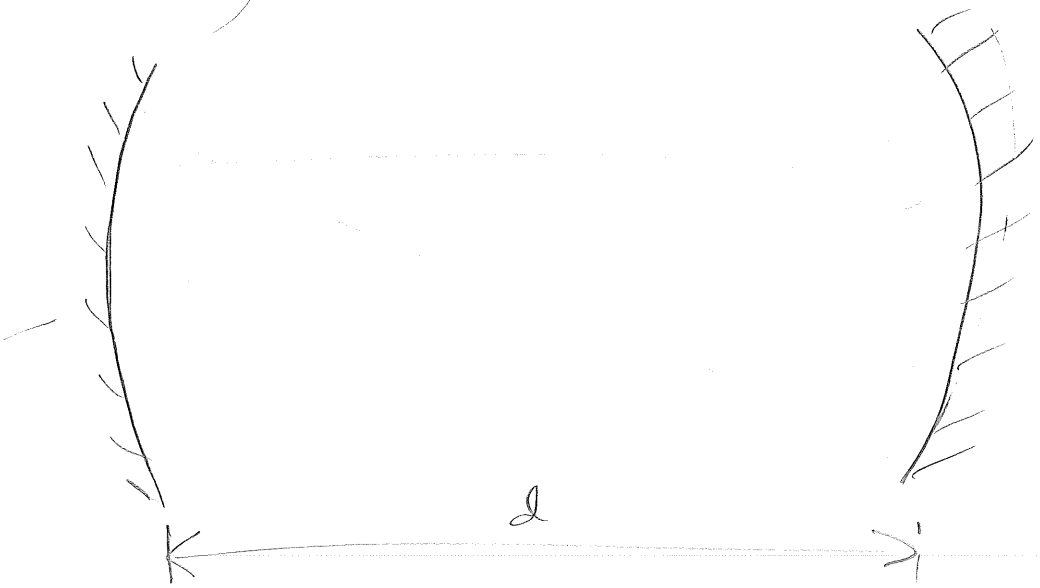
som interferens i tunna skikt



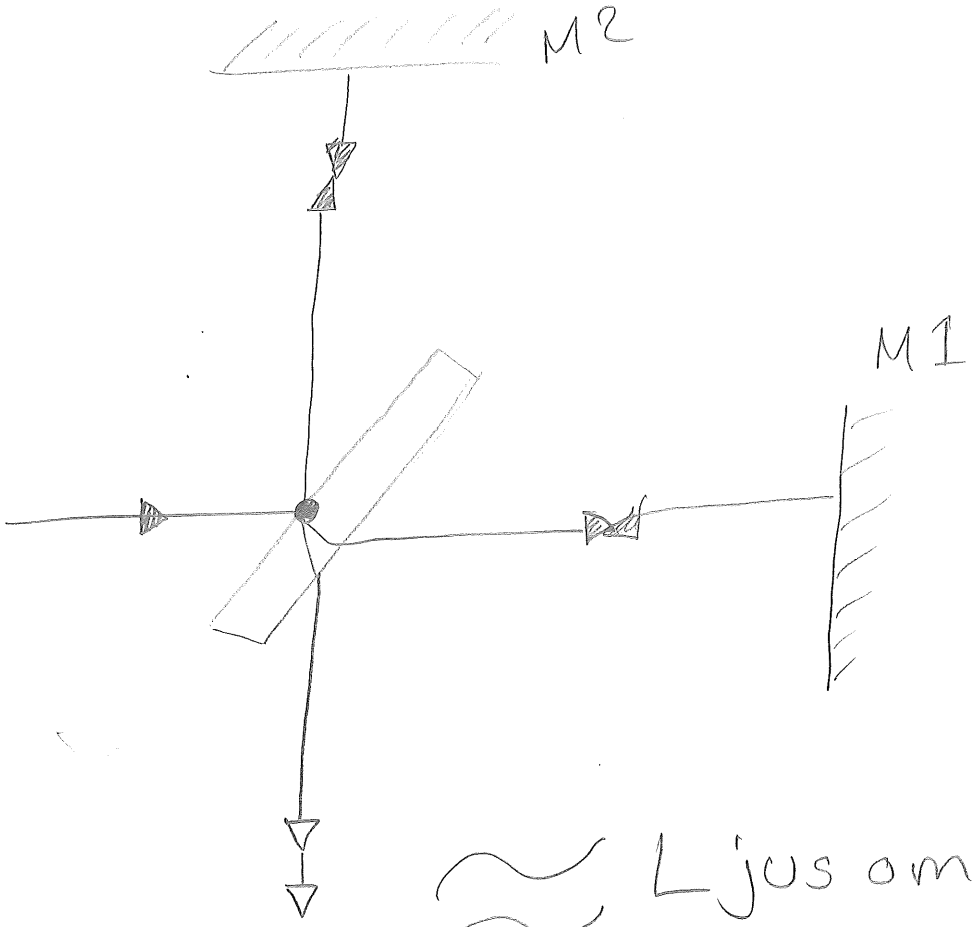
Alla vågorna som kmr ut kommer addas.

Stråle 2 har 2 reflekt. än str. 1

$$2d\cos\theta_t = m\lambda \Rightarrow \text{Ljust}$$



tid $\tau = \frac{2d}{v} = \frac{2nd}{c}$



≈ Ljus om konstr.

≈ Mörkt om destr.