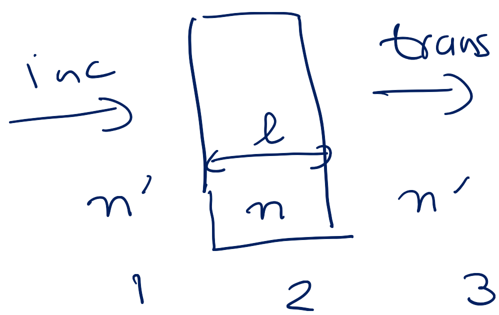
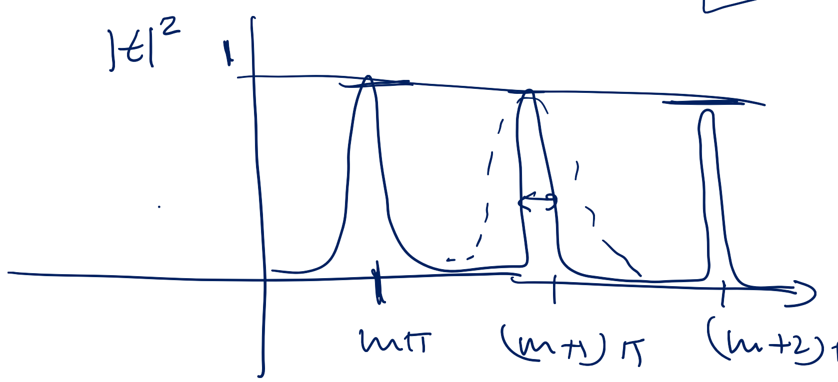
FPI



$$|t|^2 = \frac{(1-R)^2}{(1-R)^2 + 4R\sin^2\phi}$$

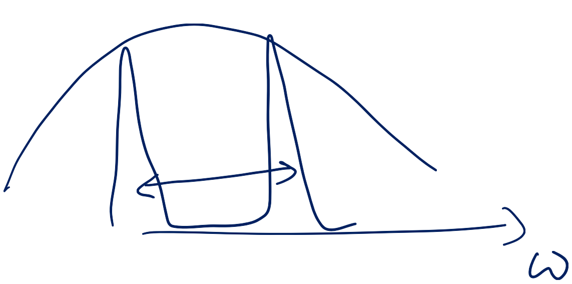


$$\phi = k_0 n l \cos\theta$$

$$k_0 = \frac{2\pi}{\lambda_{0m}} = \frac{2\pi f_m}{c} \qquad \phi = m\pi$$

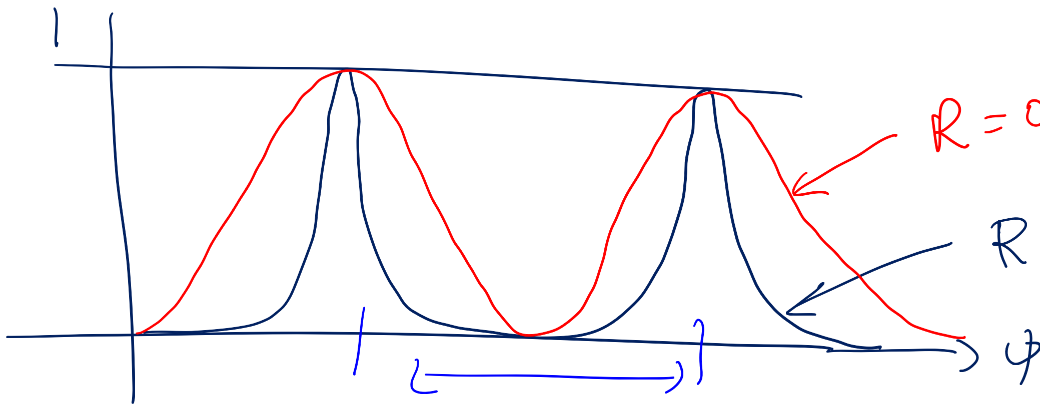
$$\frac{2\pi f_m}{c} n l \cos\theta = m\pi$$

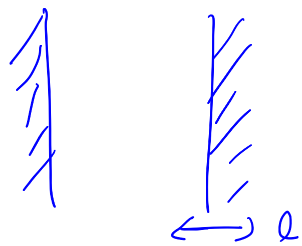
$$\boxed{f_m = \frac{mc}{2 n l \cos\theta}}$$



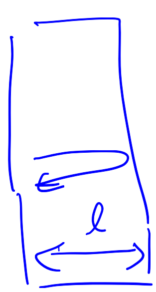
Free spectral range (FSR)

$$FSR = \Delta f = f_{m+1} - f_m = \frac{c}{2nl\cos\theta}$$





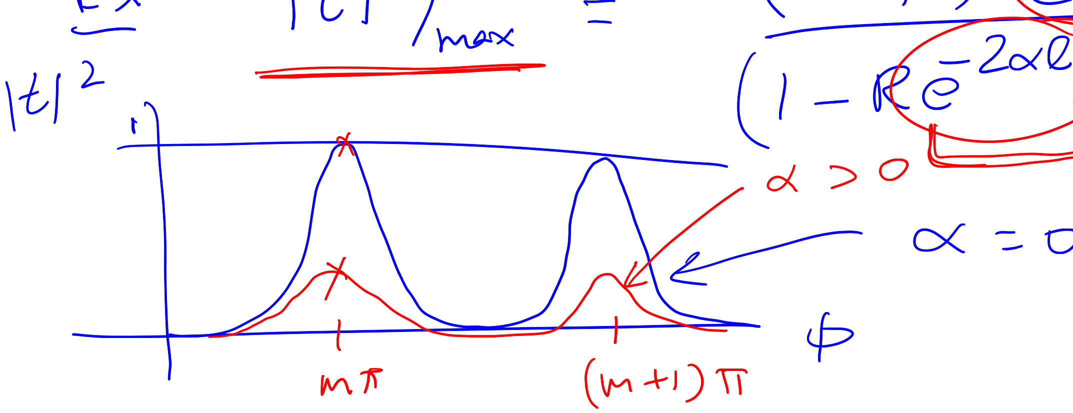
FPI with $\underbrace{\text{losses}}$



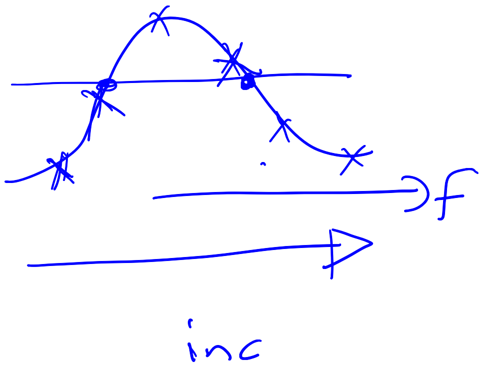
$$t = \left[\frac{T e^{i\phi} \cdot e^{-\alpha l}}{1 - R e^{2i\phi} \cdot e^{-2\alpha l}} \right]$$

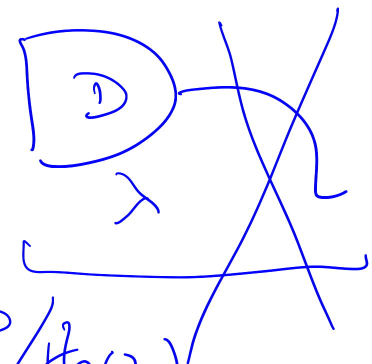
$$e^{i(n+ik) l k_0} = e^{ink_0 l} \, e^{-k_0 k l}$$

Ex $\underline{\left(|t|^2\right)_{max}} = \left[\frac{(1-R)^2 e^{-2\alpha l}}{\left(1 - R\underbrace{e^{-2\alpha l}}\right)^2} \right]$

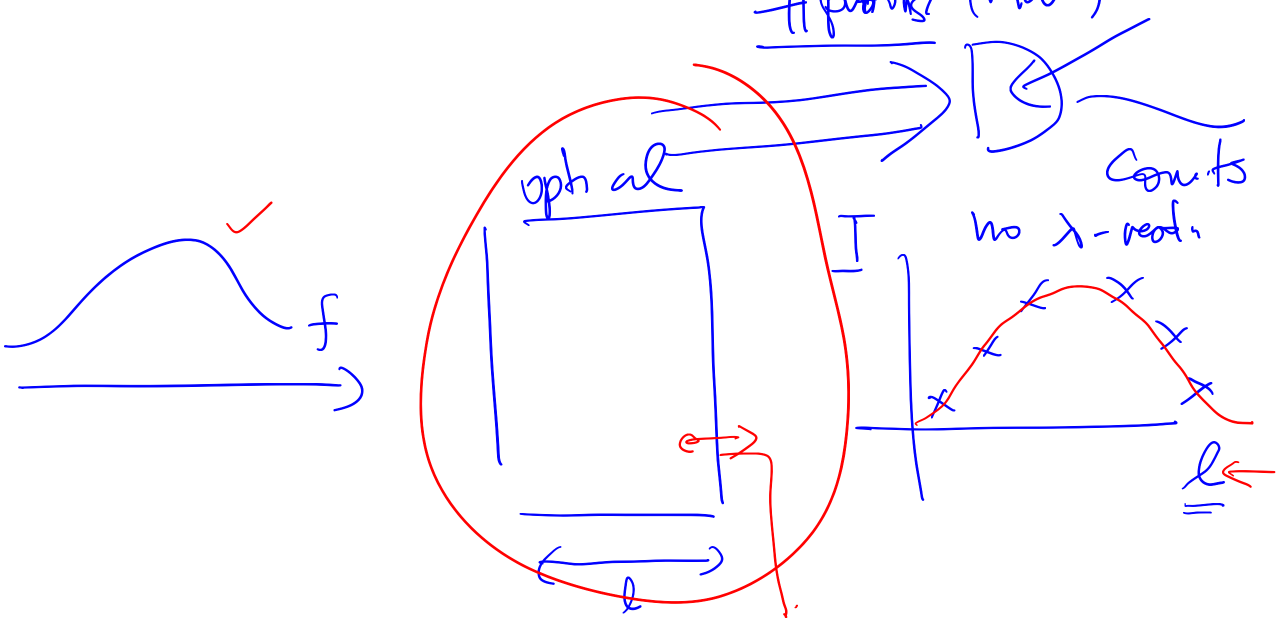


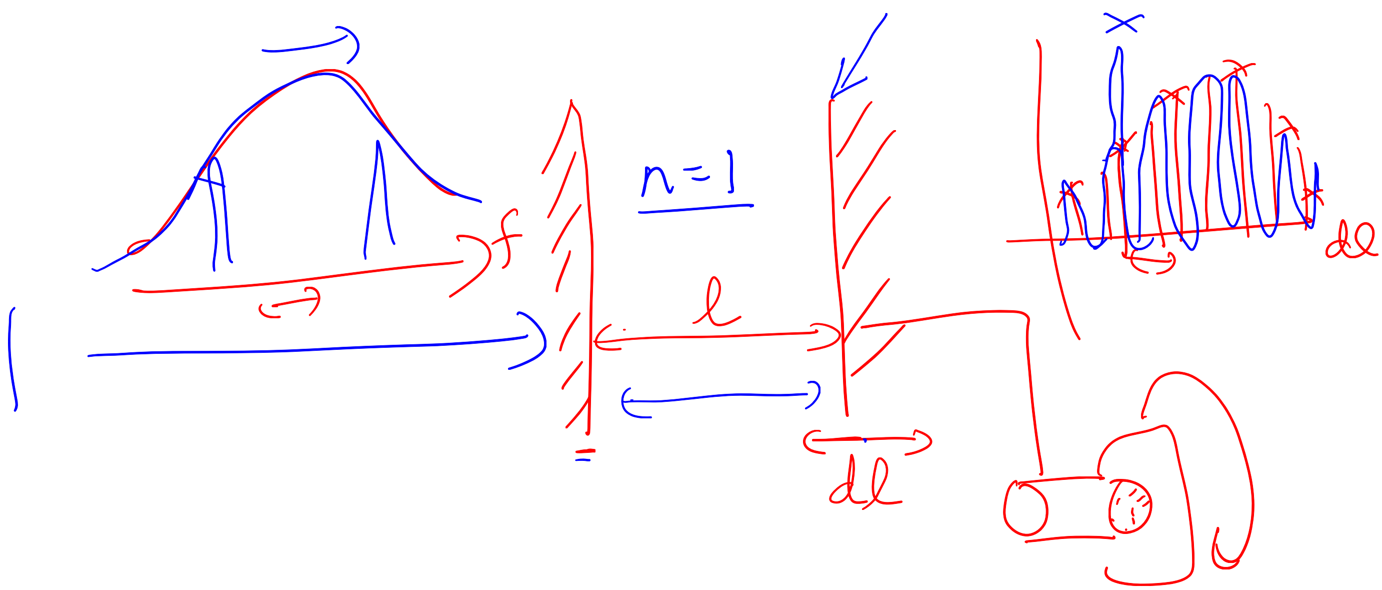
APPLICATION: MEASURING OPTICAL SPECTRUM





photons/ ħω)





Figures of merit

(1) resolving power
(2) (useful) spectral range

inc: $\theta = 0°$;

max transmission $\phi = m\pi$

$$k_0 \ell = m\pi$$

$$\boxed{\ell = \frac{m\lambda_0}{2}}$$

$n = 1$

$$f_m = \frac{mc}{2\ell} \rightarrow FSR = \frac{c}{2\ell}$$

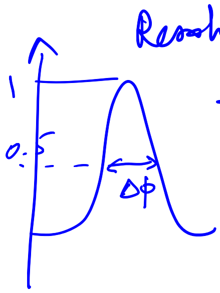
$$\ell = \underbrace{15\text{ cm}}, \quad FSR = 1\text{ GHz}$$

$$df = \frac{mc}{2\ell^2}\, d\ell = FSR \cdot \frac{m}{\ell}\, d\ell$$

$$\boxed{\underbrace{df} = \underbrace{FSR} \cdot \left(\frac{d\ell}{\lambda_0/2}\right)}$$

$$\underbrace{d\ell < \lambda_0/2}$$

Resolution of the spectrum analyzer



— Calculate FWHM

$$|t|^2 = \frac{(1-R)^2}{(1-R)^2 + 4R\sin^2\phi}$$

$$|t|^2 = 0.5 \Rightarrow \underbrace{\sin^2\phi} = \frac{(1-R)^2}{4R}$$

$$R \approx 1 \qquad \phi = m\pi \pm \frac{1-R}{2\sqrt{R}}$$

$$\phi = \frac{2\pi f}{c}\ell$$

$$\Delta\phi_{1/2} = \frac{1-R}{\sqrt{R}} = \frac{2\pi\ell}{c}\Delta f_{1/2}$$

$$\Delta f_{1/2} = \frac{c}{2\pi\ell}\frac{1-R}{\sqrt{R}} = \frac{c}{2\ell}\left(\frac{1-R}{\pi\sqrt{R}}\right)$$

$1/F$ Finesse

$$\boxed{\Delta f_{1/2} = \frac{FSR}{F}}$$

Diffraction

Huygen - Fresnel principle

$$U(P) = \frac{Ae^{ikr_0}}{r_0}\iint_S \frac{e^{iks}}{s} K(\chi)\, dS$$

inclination factor