T vs ϕ graph

How wide is peak? answer: $\Delta\phi_{FWHM} \approx \frac{4}{\sqrt{F}}$

Proof: $T = \frac{T_{max}}{1 + F\sin^2\frac{\phi}{2}}$

drops to $\frac{1}{2}$ when $F\sin^2\frac{\phi}{2} = 1$

$\sin^2\frac{\phi}{2} = \frac{1}{F}$

$\sin\frac{\phi}{2} = \sqrt{\frac{1}{F}}$

if ϕ = small, $\frac{\phi}{2} = \sqrt{\frac{1}{F}}$ since $\sin x \approx x$

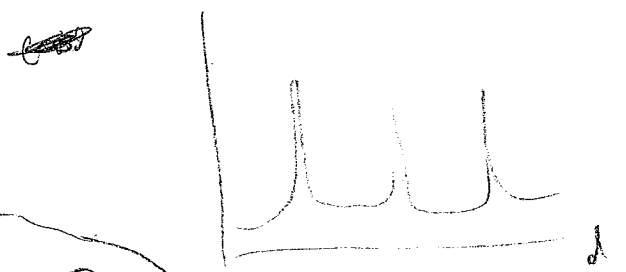
$\phi = \frac{2}{\sqrt{F}}$

FWHM = twice this

$\boxed{\Delta\phi = \frac{4}{\sqrt{F}}}$

Recall

ϕ changes via d, θ_i, or λ_{vac}



power point

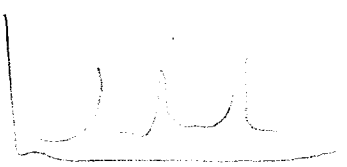
Fig 4.9

Prob 4 question

high or low R?

R = .9

→ F = 360!



→ PPT

Fig 4.11

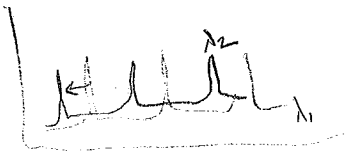


Fig 4.13 → PPT

day 12 of 12

Misc odds + ends (9-12)

Wavelength discrimination

$$\Phi + \Delta\Phi = \frac{4\pi n_1 d\cos\theta_1}{\lambda + \Delta\lambda} = \frac{4\pi n_1 d\cos\theta_1}{\lambda}\underbrace{\left(1 + \frac{\Delta\lambda}{\lambda}\right)^{-1}}_{1 - \frac{\Delta\lambda}{\lambda}}$$

$$\Delta\Phi = 4\pi n_1 d\cos\theta_1 \frac{\Delta\lambda}{\lambda^2} \quad \text{(drop negative sign)}$$

(2) "Free spectral range" $\Delta\lambda$ that will cause $\Delta\Phi = 2\pi$ = "largest permissible set while avoiding confusion"

$$2\pi = 4\pi n_1 d\cos\theta_1 \frac{\Delta\lambda_{FSR}}{\lambda^2}$$

$$\boxed{\Delta\lambda_{FSR} = \frac{\lambda^2}{2 n_1 d\cos\theta_1}}$$

numbers: $\lambda = 500\text{nm}$ (green), $d = 1\text{cm}$, $\theta = 0°$, $n_1 = 1$

then $\Delta\lambda_{FSR} = .013\text{nm}$

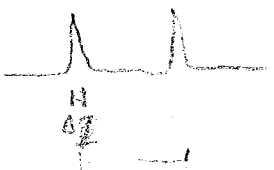
ie can't tell diff between 500nm & 500.013

if $\lambda' > \lambda + \Delta\lambda_{FSR}$ you will undershoot the change

"reflecting finesse" aka "finesse"

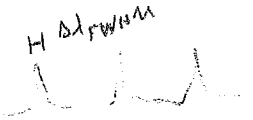
$$f = \frac{2\pi}{\Delta\Phi_{FWHM}} \approx \frac{2\pi}{4\sqrt{F}} = \boxed{\frac{\sqrt{F}}{2}}$$

(4) next page



$f \approx$ % of "time" the graph is non-zero

or equivalently $f = \Delta\lambda_{FWHM} / \Delta\lambda_{FSR}$



(1) $\Delta\lambda_{FWHM}$: $\Delta\Phi_{FWHM} = 4\pi n_1 d\cos\theta_1 \frac{\Delta\lambda_{FWHM}}{\lambda^2}$

$$\frac{4}{\sqrt{F}} = 4\pi n_1 d\cos\theta_1 \frac{\Delta\lambda_{FWHM}}{\lambda^2}$$

$$\boxed{\Delta\lambda_{FWHM} = \frac{\lambda^2}{\pi n_1 d\cos\theta_1 \sqrt{F}}}$$

minimum resolvable wavelength change ie 500 vs 500.0008 to be sure

numbers: $\lambda = 500\text{nm}$, $d = 1\text{cm}$, $F = 400$, $\theta = 0$, $n_1 = 1$

$\Delta\lambda_{FWHM} = .0008\text{nm}$

(3) resolving power $RP = \frac{\lambda_0}{\Delta\lambda} = \frac{500\ nm}{.0008\ nm} = \underline{\underline{600{,}000}}$

my grating spectrometer $RP \approx \frac{500\ nm}{.05\ nm} = \underline{\underline{10000}}$

but spectrometer can see much wider range of wavelengths at once (not limited to $\Delta\lambda_{FSR}$)

next time: new method using matrices

→ (almost) End of two boundary situations —
(three material)