Physics.

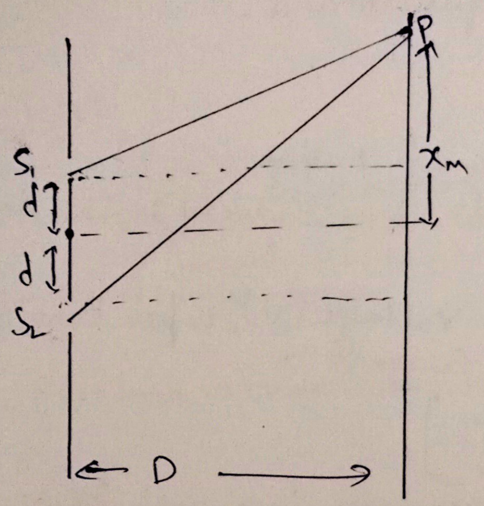
Physical path = L optical path = μL

path diffrence = $\frac{2\pi L}{\lambda}$ path diffrence = $\frac{2\pi \mu L}{\lambda}$

Condition for Interfrence: (sustained)

* light source- Monochromatic
* Coherent Source
* bright fringe / constructive interfrence $(\Delta x = n\lambda)$
* dark fringe / destructive interfrence $\left[\Delta x = (2n+1)\frac{\lambda}{2}\right]$

YDSE



$\Delta x = S_2P - S_1P$

$S_1P^2 = (x_m - d)^2 + D^2$ $S_1P = D\left[1 + \frac{(x_m-d)^2}{D^2}\right]^{1/2}$

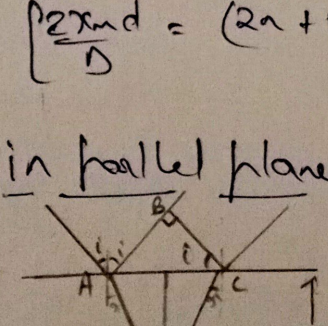
$S_1P = D\left[1 + \frac{1}{2}\frac{(x_m - d)^2}{D}\right]$ $S_2P = D\left[1 + \frac{1}{2}\frac{(x_m+d)^2}{D^2}\right]$

$S_2P - S_1P = \frac{2x_m d}{D}$

for bright $\left[\frac{2x_m d}{D} = n\lambda\right]$

for dark $\left[\frac{2x_m d}{D} = (2n+1)\lambda\right]$

Interfrence in parallel plane thin films :



$$\Delta x = \mu(AD+DC) - AB \qquad \because \frac{t}{DC} = \cos r$$

$$= 2\mu DC - AB$$

$$= \frac{2\mu t}{\cos r} - AC\sin i = \frac{2\mu t}{\cos r} - \mu AC \sin r$$

$$= \frac{2\mu t}{\cos r}\left[1-\sin^2 r\right] \qquad \because \frac{AC/2}{t} = \tan r .$$

$$\boxed{\Delta x \Rightarrow 2\mu t \cos r}$$

Strokes' law!

When light reflects from a surface separating two mediums, It undergoes a phase change of π if it reflects from denser to rarer mediums, but no phase change if reflecting from rarer to denser

At point A there is addition phase diffrence i.e π

$$K\Delta x = \pi \qquad \left[\Delta x = \lambda/2\right]$$

Actual path diffrence $= 2\mu t\cos r - \lambda/2$

* for constructive

$$n\lambda = 2\mu t\cos r - \lambda/2$$

$$\boxed{2\mu t\cos r = (2n+1)\lambda/2}$$

* for destructive

$$\left[2\mu t\cos r = (n+1)\lambda/2\right]$$

*if $t \to 0$ dark fringe

Case 2 reflection at transmitted beam.

$$\Delta x = 2\mu t\cos r$$

$n\lambda = 2\mu t\cos r$ bright

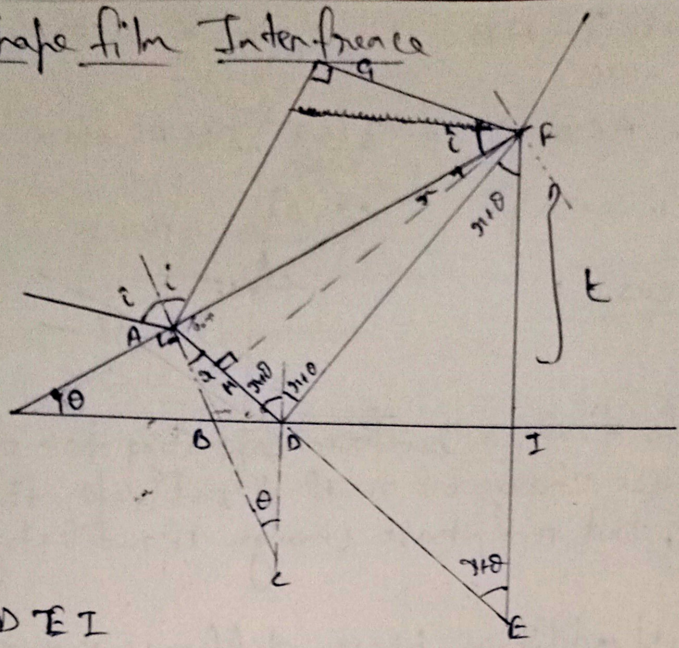
$(2n+1)\frac{\lambda}{2} = 2\mu t\cos r$ dark.

$$\Longrightarrow \quad 2\mu t\cos r - \frac{\lambda}{2} < l_{coh}$$

$$2\mu t\cos r - \frac{\lambda}{2} < \frac{\lambda^2}{\Delta\lambda}$$

$$\boxed{2\mu t\cos r < \frac{\lambda^2}{\Delta\lambda}}$$

Wedge shape film Interference



$DFI \cong DEI$

$\Delta x = \mu(AD + DF) - AG$ $\quad \because DF = DE$ by CPCT

$\Rightarrow \mu(AD + DE) - AG$

$\Rightarrow \mu(AE) - AF\sin i$ $\quad \because AG = AF\sin i$

$\Rightarrow \mu AE - \frac{AH\sin i}{\sin r}$

$\Rightarrow \mu(AE - AH) \Rightarrow \mu EH$ $\quad \frac{EH}{2t} = \cos(r+\theta)$

$= \cancel{\mu 2t \sin}(r+\theta)$

$$\boxed{\Delta x = 2\mu t\cos(r+\theta)}$$ Apparent

Actual

$[\Delta x = 2\mu t\cos(r+\theta) - \lambda/2]$ if $t \to 0$ dark fringe.

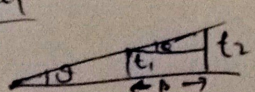
for Constructive:

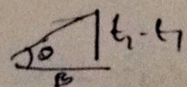
$$[2\mu t\cos(r+\theta) = (2n+1)\lambda/2]$$

for destructive:

$$[2\mu t\cos(r+\theta) = (n+1)\lambda]$$

Fringe width





$2\mu t_1\cos(r+\theta) = (m+1)\lambda$ $\qquad 2\mu t_2\cos(r+\theta) = (m+2)\lambda$

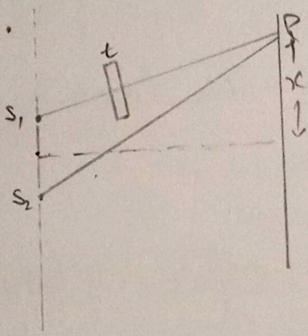
$$2\mu\cos(r+\theta)\,(t_2-t_1)=\lambda$$

$$2\mu\cos(r+\theta)\,\beta\tan\theta=\lambda \qquad \tan\theta\approx\theta \qquad \cos(r+\theta)\to 1$$

$$\beta=\frac{\lambda}{2\mu\cos(r+\theta)\tan\theta}$$

$$\boxed{\beta=\frac{\lambda}{2\mu\theta}}$$

Determination of thickness of thin transparent Sheet :



$\Delta x = S_2P - S_1P$

time taken by S_1P = S_2P

$$\frac{S_1P-t}{c}+\frac{t}{v}=\frac{S_2P}{c}$$

$$\frac{t}{v}-\frac{t}{c}=\frac{S_2P-S_1P}{c} \qquad t(\mu-1)=S_2P-S_1P$$

$$\boxed{t(\mu-1)=S_2P-S_1P}$$

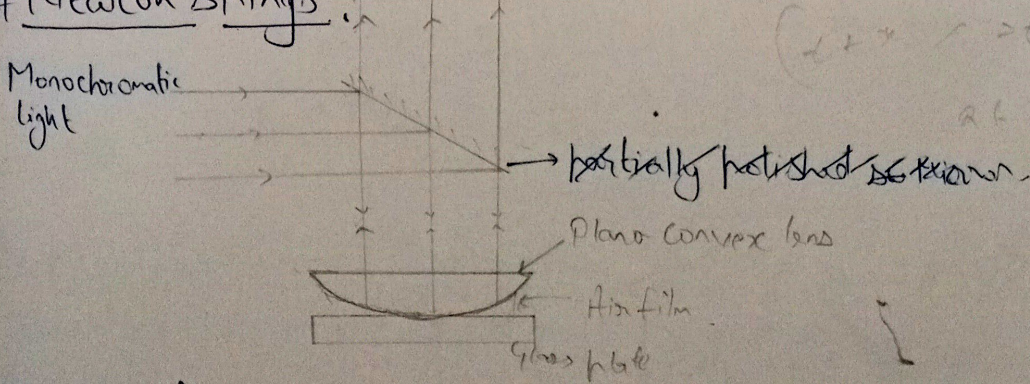
If the point P occupied by n^{th} order bright fringe.

$$t(\mu-1)=n\lambda$$

The distance x_n through which the fringe is shifted to point P from the central max $\left[x_n=\frac{n\lambda D}{2d}\right]$

$$\frac{x_n 2d}{D}=n\lambda=t(\mu-1) \qquad \boxed{t=\frac{x_n 2d}{D(\mu-1)}}$$

Newton's Rings :



The Interference pattern is observed in form of circular fringes

due to the interference b/w reflected waves from the top and the bottom surfaces of the air film.
These fringes are circular since the air film has a circular symmetry and the thickness of the film corresponding to each fringe is same throughout the circle.

The path difference b/w the two reflected rays, can be obtained as done in the case of wedge shaped film.

$$\left[\Delta x = 2\mu t\cos(r+\theta) \mp \lambda/2\right]$$

for normal incidence $i = 0$, $r = 0$ $\mu = 1$ θ very small

$$\left(\Delta = 2t + \lambda/2\right]$$

At the point of contact, $t = 0$ $\Delta = \lambda/2$ (dark)

Condition for maxima:

$$\Delta = n\lambda$$

$$\left[2\mu t\cos(r+\theta) = (2n+1)\lambda/2\right] \qquad \boxed{2t = (2n+1)\frac{\lambda}{2}}$$

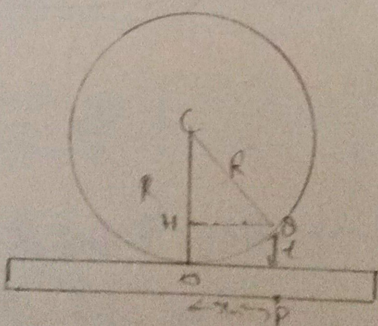
Condition for Minima

$$\Delta = \frac{n\lambda}{2} \qquad 2\mu t\cos(r+\theta) + \lambda/2 = \cancel{2n\lambda}(2n+1)\frac{\lambda}{2}$$

$$2\mu t\cos(r+\theta) = \cancel{\frac{n\lambda}{2}}/2\,(2n+1)\frac{\lambda}{2} + \lambda/2$$

$$\boxed{2\mu t\cos(r+\theta) = (n+1)\lambda} \Rightarrow \boxed{2t = (n+1)\lambda}$$

Diameter ~~of~~ for Dark and bright Rings



$OC = CQ = R$, $HQ = r_n$ $\quad HC = R - t$

ΔCHQ

$$CQ^2 = CH^2 + HQ^2$$
$$R^2 = (R-t)^2 + r_n^2 \qquad \left[r_n^2 = 2Rt - t^2\right]$$

$r_n^2 = 2Rt$ $\qquad$ $r_n^2 = R \times 2t$

for bright fringes:

$$2t = (2n-1)\lambda/2 \qquad \because \frac{r_n^2}{R} = 2t$$

$$r_n^2 = R(2n-1)\lambda/2$$

$$\Rightarrow (D_n/2)^2 = R(2n-1)\lambda/2 \qquad \boxed{D_n^2 = 2\lambda R(2n-1)}$$

The above equation gives the diameter D_n of n^{th} order bright fringe as

$$D_n = \sqrt{2\lambda R(2n-1)}$$

$$\left[D_n \propto \sqrt{2n-1} \right]$$

for dark Rings

$$r_n^2 = n\lambda R$$

$$D_n^2 = 4n\lambda R \qquad \boxed{D_n \propto \sqrt{n}}$$

Determination of wavelength of light:

$$D_n^2 = 4n\lambda R \quad \text{---} (x)$$

From the above relation, the diameter of $(n+p)^{th}$ the order dark fringe can be written as

$$D_{(n+p)}^2 = 4(n+p)\lambda R \quad \text{---} (xi)$$

Subtracting Eq (x) from eq (xi) we get.

$$D_{(n+p)}^2 - D_n^2 = 4p\lambda R$$

$$\boxed{\lambda = \frac{D_{(n+p)}^2 - D_n^2}{4pR}}$$

Determination of Radius of curvature of plano convex lens:

$$\left[R = \frac{D_{(n+p)}^2 - D_n^2}{4p\lambda} \right]$$

Determination of Refractive Index

The diameter of n^{th} order dark fringe in air film given by

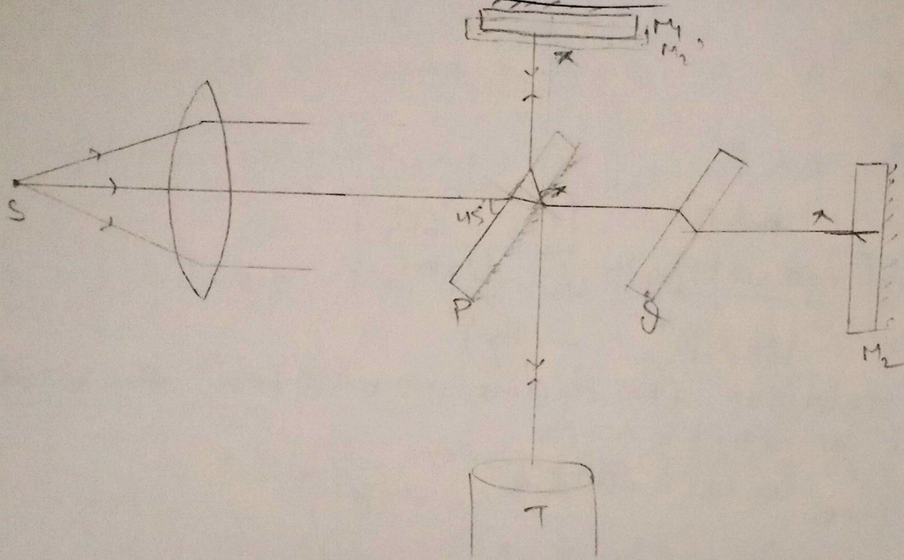
$$\left[D_n^2 = 4n\lambda R \right]$$

Similarly, the diameter of n^{th} order dark fringe in liquid film would be

$$\left[D_n^2{}_{liq} = \frac{4n\lambda R}{\mu} \right]$$

$$\boxed{\mu = \frac{[D_n^2]_{air}}{[D_n^2]_{liq}}}$$

Michelson's Interferometer



$$\Delta = 2t\cos\theta - \lambda/2$$

for bright fringes the following:

$$n\lambda = 2t\cos\theta - \lambda/2 \qquad \left[2t\cos\theta = (2n+1)\frac{\lambda}{2} \right]$$

for dark fringe:

$$2t\cos\theta - \frac{\lambda}{2} = (2n+1)\frac{\lambda}{2}$$

$$\left[2t\cos\theta = (n+1)\lambda \right]$$

Applications:

1) Determination of wavelength of light

first of all Michelson's interferometer is set for circular fringes with central bright spot, which is possible when both the mirror are parallel ($\theta = 0$).

• If t be the thickness of air film enclosed b/w two mirrors (M_1 and M_2') and n be the order of spot obtained, then for normal incidence $\cos r = 1$ we have,

$$2t - \frac{\lambda}{2} = n\lambda$$

$$\boxed{2t = (2n+1)\frac{\lambda}{2}}$$

If M_1 is moved $\lambda/2$ away from M_2' then an additional path diffrence of λ will be introduced and hence $(n+1)^{th}$ bright spot appears at the center of the field

$$x = x_2 - x_1 = \frac{N\lambda}{2}$$ x distance moved by M_1

$$\boxed{\lambda = \frac{2x}{N}}$$

Determination of diffrence in wavelength

* let the Source be non chromatic
* It contains two wavelength λ_1 and λ_2 close to each other
* As thickness of film is very small, and $\lambda_1 \approx \lambda_2$ practically fringes coincide
* So to seprate M_1 moves slowly until the dark fringe of λ_1 falls on bright fringe of λ_2, the result is maximum indistinctness
* Now again move mirror by x so that next indistinct position is reached.
* In this position if n fringes of λ_1 appears at center, then $(n+1)$ fringes of λ_2 should appear at the center of the field of view.

$$x = \frac{n\lambda_1}{2} \qquad x = \frac{(n+1)\lambda_2}{2}$$

$$n = \frac{2x}{\lambda_1} \qquad \frac{2x}{\lambda_2} - 1 = n$$

$$2x\left[\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right] = 1 \qquad \frac{2x(\lambda_1 - \lambda_2)}{\lambda_1\lambda_2} = 1$$

$$\lambda_1 - \lambda_2 = \frac{\lambda_1\lambda_2}{2x} = \frac{\lambda_{avg}^2}{2x} \qquad \boxed{\lambda_1\lambda_2 = \lambda_{avg}^2}$$

Determination of thickness and Refractive index of thin transparent film.

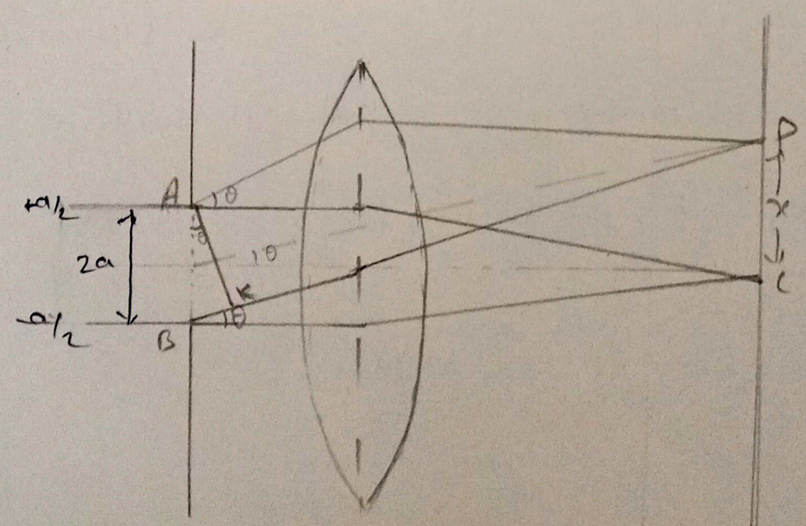
$$2x = 2(\mu - 1)t$$

$$\left[t = \frac{x}{\mu - 1}\right] \qquad \left[\mu = \frac{x}{t} + 1\right]$$

Diffraction

Fraunhofer Diffraction	Fresnel diffraction
① Plane wavefront	① Cylindrical / spherical
② Source at ∞	② Source at finite
③ wavelets are in same phase	③ Not in same phase
	* obliquity factor $1 + \cos\alpha$
Eg: grating	Eg: straight edge, thin wire. $\alpha = \pi$, $= 0$, absence of backward.

Fraunhofer diffraction



$\delta = BK = AB\sin\theta$ for AP and BP while for AC BC $\delta = 0$

Hence $[b\sin\theta \geq \delta \geq 0]$

The phase difference to path difference $b\sin\theta = \frac{2\pi}{\lambda} b\sin\theta$

The phase diffrence b/w ~~any two~~ consecutive parts = $\frac{2\pi}{\lambda}\frac{b\sin\theta}{n}$

where n = total equal parts in aperture.

General Eq^n of wave :

$$\left[y = Ae^{i\omega t} \right] \qquad \because \delta = \frac{2\pi}{\lambda}\sin\theta$$

$$y = Ae^{(i\omega t + lx)} \qquad \because l = \frac{2\pi}{\lambda}\sin\theta$$

$$\int dy = \int_{-a/2}^{a/2} Ae^{(i\omega t + lx)i}\, dx$$

$$y = Ae^{i\omega t}\int_{-a/2}^{a/2} e^{ilx}\, dx$$

$$y = Ae^{i\omega t}\frac{e^{i(la/2)} - e^{-(la/2)i}}{\frac{2}{a}(la/2)} \qquad \because \frac{e^{ix} - e^{-ix}}{2i} = \sin x$$

$$\Rightarrow Ae^{i\omega t}a \cdot \frac{\sin(la/2)}{(la/2)}$$

$$\left[y = \frac{Aae^{i\omega t}\sin(la/2)}{(la/2)} \right] \qquad \because \alpha = \frac{la}{2} = 2\pi\sin\theta\frac{a}{2\lambda}$$

$$\left[\alpha = \frac{a\pi\sin\theta}{\lambda} \right]$$

$$I \propto \frac{KA^2a^2\sin^2\alpha}{\alpha^2}$$

$$\boxed{I = I_0\frac{\sin^2\alpha}{\alpha^2}}$$

__Max Intensity__ :

$$\lim_{\alpha\to 0}\frac{\sin\alpha}{\alpha} = 1 \qquad I = I_0$$

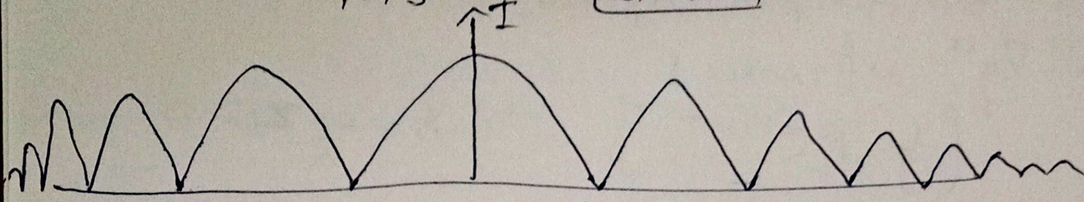
__derivative cond^n__

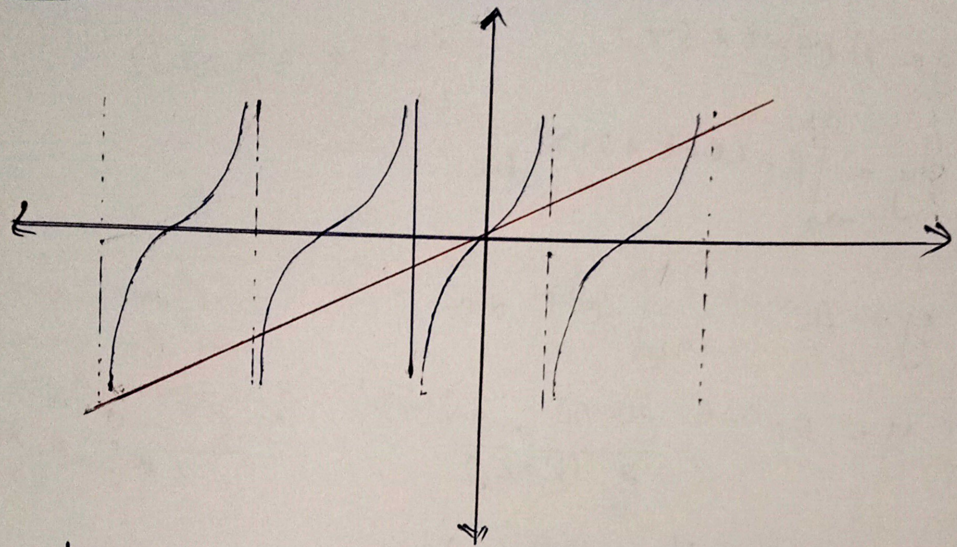
$$\frac{dI}{d\alpha} = I_0\left[\frac{\sin 2\alpha}{\alpha^2} - \frac{2\sin^2\alpha}{\alpha^3} \right] \qquad 2\alpha\cos\alpha = \sin\alpha$$

$$\boxed{\tan\alpha = \alpha} \qquad \boxed{\sin\alpha = 0}$$

Condⁿ for secondary Maxima : minima

$\alpha = m\pi \quad m = 1, 2, 3 \quad \boxed{\sin\alpha = 0}$





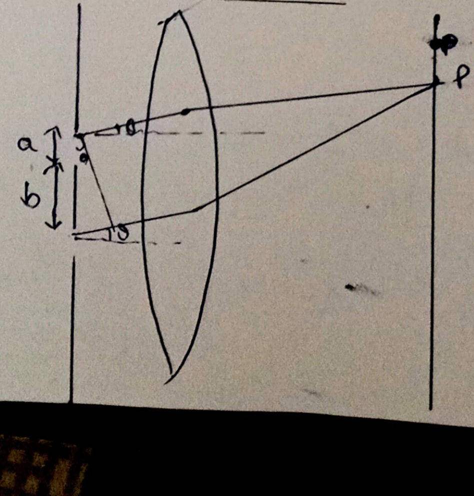
Secondary Maxima

$$\alpha \approx \mp \frac{3\pi}{2}, \mp \frac{5\pi}{2}, \mp \frac{7\pi}{2}$$

$$I_{\sin(3)} = \frac{I_0 \sin^2(3\pi/2)}{(3\pi/2)^2} = \frac{4}{9\pi^2} I_0$$

$$I_{\sin(5)} = \frac{I_0 \sin^2(5\pi/2)}{(5\pi/2)^2} = \cancel{\frac{4}{25\pi} I_0} \; \frac{4}{25\pi^2} I_0$$

Double Slit diffraction:



① $A_1 = A_0 \frac{\sin\alpha}{\alpha}$ $\qquad \because A_0 = Aa$

② $A_2 = \frac{A_0 \sin\alpha}{\alpha}$

$\Delta = (a+b)\sin\theta \qquad \delta = \frac{2\pi}{\lambda}(a+b)\sin\theta = \Delta\phi$

$$\left[\delta = \frac{2\pi}{\lambda} d \sin\theta\right]$$

$\vec{A} = \vec{A_1} + \vec{A_2}$

$= A^2 + A^2 + 2A^2 \cos\Delta\phi$

$\Rightarrow 2A^2(1 + \cos\delta)$

$= 4A^2 \cos^2 \delta/2 \qquad \because A = A_0 \frac{\sin\alpha}{\alpha} \qquad \because \beta = \delta/2$

$|A|^2 = 4A_0^2 \frac{\sin^2\alpha}{\alpha^2} \cos^2\beta$

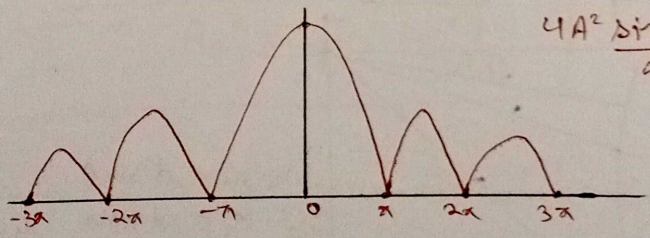
$$I = I_0\, 4 A_0^2 \frac{\sin^2\alpha}{\alpha^2} \cos^2\beta$$

$$\left[I = 4 I_0 A_0^2 \frac{\sin^2\alpha}{\alpha^2} \cos^2\beta \right]$$

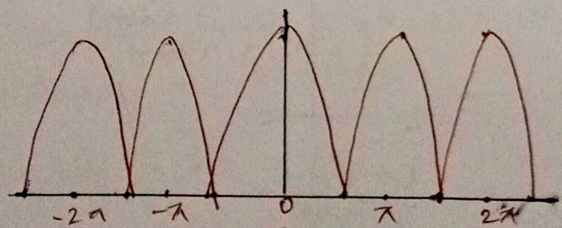
Resultant Intensity is due to :

① $4A^2 \frac{\sin^2\alpha}{\alpha^2}$ ② $\cos^2\beta$

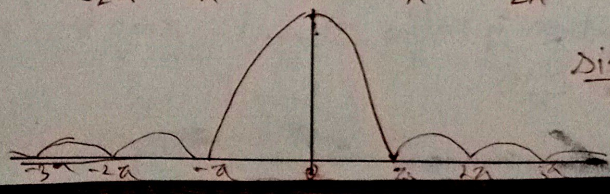
c) $4A^2 \frac{\sin^2\alpha}{\alpha^2} \cos^2\beta$



b) $\cos^2\beta$



a) $\frac{\sin^2\alpha}{\alpha^2}$



Missing order in diffraction pattern

Here the directions of diffraction minima and Interfrence maxima are respectively given by:

$$b\sin\theta = \mp m\lambda \quad m = 1, 2, 3, \dots \quad \text{and}$$

$$(b+d)\sin\theta = \mp n\lambda \quad n = 0, 1, 2, 3, \dots$$

Condition for missing order!

① diffraction minima and Interfrence maxima.

Since the diffraction minima dominates the Interfrence maxima the Resultant Intensity obtained is zero.

$$\frac{b+d}{b} = \frac{n}{m}$$

Case 1: $b = d$

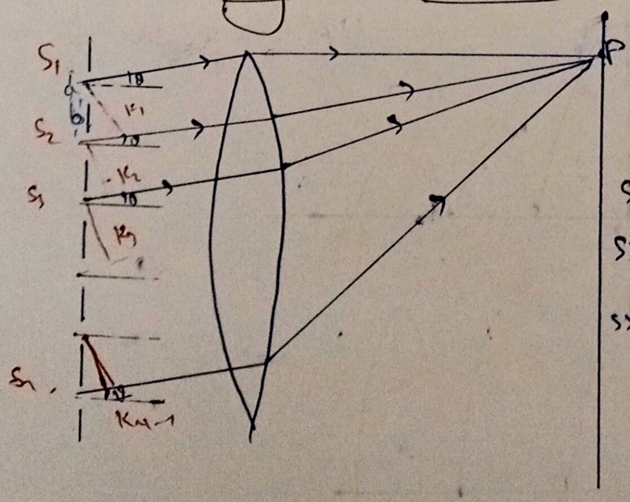
$n = 2m$

Since $m = 1, 2, 3, \dots$ the above cond^n reads $n = 2, 4, 6 \dots$ even order Interfrence max will absent.

Case 2: $d = 2b$

$n = 3m$ $\quad 3, 6, 9 \dots$

Diffraction by N slits:



$S_1S_2K_1 = d\sin\theta$

$SS_3\ K_2 = d\sin\theta$ $\quad K_1 S_1 K_2$

$2d\sin\theta$

$SS_4 = 3d\sin\theta$

$d = a+b$ grating constant or grating element 1500 lns/inch.

$A_0 = A_0 \frac{\sin\alpha}{\alpha}$

$y = A_0 e^{i\omega t}$ $\qquad A_\theta = \frac{A_0 \sin\alpha}{\alpha}$

$$\vec{y}_{net} = \vec{y}_1 + \vec{y}_2 + \vec{y}_3 \ldots y_n$$

$$= A_\theta e^{i\omega t} + A_\theta e^{i(\omega t+\delta)} + A_\theta e^{i(\omega t+2\delta)} \ldots A_\theta e^{i(\omega t + (n-1)\delta)}$$

$$\vec{y}_{net} = A_\theta e^{i\omega t}\left[1 + e^{i\delta} \ldots e^{i(n-1)\delta}\right)$$

$$\Rightarrow A_\theta e^{i\omega t} \frac{(1-(e^{i\delta})^n)}{[1-e^{i\delta}]}$$

$$\left[y_{net} = A_\theta e^{i\omega t} \frac{(1-e^{in\delta})}{(1-e^{i\delta})} \right]$$

Intensity:

$$I = y \cdot y^*$$

$$= A_\theta e^{i\omega t} \frac{(1-e^{in\delta})}{(1-e^{i\delta})} \cdot A_\theta e^{-i\omega t} \frac{(1-e^{-in\delta})}{(1-e^{-i\delta})}$$

$$= A_\theta \frac{(1-\cos n\delta)}{(1-\cos\delta)}$$

$$= A_\theta \frac{\sin^2(n\delta)/2}{\sin^2(\delta/2)} \qquad \because \delta/2 = \beta$$

$$\boxed{I \Rightarrow A_0^2 \frac{\sin^2\alpha}{\alpha^2} \cdot \frac{\sin^2\beta N}{\sin^2\beta}}$$

The factor $\frac{A_0^2 \sin^2\alpha}{\alpha^2}$ gives the Intensity distribution in diffraction due to single slit while $\frac{\sin^2 N\beta}{\sin^2\beta}$ gives Interference due to N slits.

Analysing factor $\frac{\sin^2\beta N}{\sin^2\beta}$

When $\sin\beta \Rightarrow 0$ $\quad \beta = \pm n\pi \quad \beta = 0, 1, 2, 3, \ldots$

$$\lim_{\beta \to \pm n\pi} \left(\frac{\sin N\beta}{\sin\beta}\right)$$

Applying L-hospital,

$$\lim_{\beta \to \mp n\pi} \frac{N \cos N\beta}{\cos\beta} = \mp N$$

By substituting this value

$$\left[I = A_0^2 \left(\frac{\sin^2\alpha}{\alpha^2}\right) N^2 \right]$$

Therefore the resultant Intensity of any of the principal maxima in the diffraction pattern can be obtained by multiplying by N^2 to the factor $\frac{A_0^2 \sin^2\alpha}{\alpha^2}$.

$$\beta = \mp n\pi$$

$$\frac{\pi (b+d) \sin\theta}{\lambda} = \mp n\pi \qquad \boxed{(b+d)\sin\theta = \mp n\lambda}$$

where $n = 0, 1, 2, \ldots$

Minima

Where $\sin N\beta = 0$ but $\sin\beta \neq 0$

$$N\beta = \mp m\pi$$

$$N \frac{\pi}{\lambda} (b+d)\sin\theta = \mp m\pi$$

$$\boxed{N(b+d)\sin\theta = \mp m\lambda}$$

Where m can have all integral values except $0, N, 2N, 3N, \ldots nN$ because of then $\sin\beta = 0$

Secondary Maxima :

$$\frac{dI}{d\beta} = \frac{A_0^2 \sin^2\alpha}{\alpha^2} \frac{d\left(\frac{\sin^2 N\beta}{\sin^2\beta}\right)}{d\beta}$$

$$\Rightarrow K \left[\frac{2N \sin N\beta \cos N\beta}{\sin^2\beta} - \frac{\sin^2 N\beta \, 2\sin\beta\cos\beta}{\sin^3\beta} \right]$$

$$\Rightarrow \frac{K \sin N\beta}{\sin^2\beta} \left[N\cos N\beta \, \sin\beta - \cos\beta \sin N\beta \right] = 0$$

$$\frac{\sin N\beta}{\sin^2\beta} = 0 \qquad \text{or} \qquad N\cos N\beta = \cos\beta .$$

$$N^2 \cancel{\frac{\sin^2 N\beta}{\beta^2}}$$

$$\tan N\beta = N\tan\beta$$

$$\cancel{\frac{\sin^2 N\beta}{\sin^2\beta}}$$

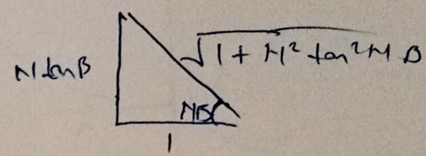
$$\frac{\sin^2 N\beta}{\cos^2 N\beta} = \frac{N\sin^2\beta}{\cos^2\beta}$$

$$\cancel{\frac{\sin^2 N\beta}{1-\sin^2 N\beta} = \frac{N\sin^2\beta}{1-\sin^2\beta}} \Rightarrow \frac{\sin^2 N\beta}{\sin^2\beta} = \frac{N(1-\sin^2 N\beta)}{1-\sin^2\beta}$$

$$\left[\frac{a}{b} = \frac{c}{d} = \frac{a+c}{b+d}\right]$$

$$\cancel{\frac{\sin^2 N\beta}{\sin^2\beta} = \frac{N+(1-N)\sin^2 N\beta}{1}}$$

$$\tan N\beta = N\tan\beta$$



$$\sin N\beta = \frac{N\tan\beta}{\sqrt{1+N^2\tan^2\beta}}$$

$$\frac{\sin^2 N\beta}{\sin^2\beta} = \frac{N^2\tan^2\beta}{(1+N^2\tan^2\beta)(\sin^2\beta)} \Rightarrow \frac{N^2}{\cos^2\beta(1+N^2\tan^2\beta)}$$

$$\Rightarrow \frac{N^2}{N^2\sin^2\beta+\cos^2\beta} \Rightarrow \frac{N^2}{(N^2-1)\sin^2\beta+1}$$

$$\text{So}\left[\frac{\sin^2 N\beta}{\sin^2\beta} = \frac{N^2}{1+(N^2-1)\sin^2\beta}\right]$$

$$I_\theta = \frac{A_0^2\sin^2\alpha}{\alpha^2}\cdot\frac{N^2}{1+(N^2-1)\sin^2\beta}$$

Summary

① Principal maxima

$$\left[I = A_0^2\frac{\sin^2\alpha}{\alpha^2}\cdot N^2\right] \qquad \beta = n\pi \qquad \frac{\pi d\sin\theta}{\lambda} = n\pi$$

$$\Rightarrow \delta/2 \qquad d\sin\theta = n\lambda$$

$$\delta = \frac{2\pi}{\lambda}d\sin\theta$$

② Minima

$$[I = 0] \qquad I = A_0^2\frac{\sin^2\alpha}{\alpha^2}\,\frac{\sin^2 N\beta}{\sin^2\beta} \qquad N\beta \longrightarrow n\pi$$

$$\beta \neq n\pi$$

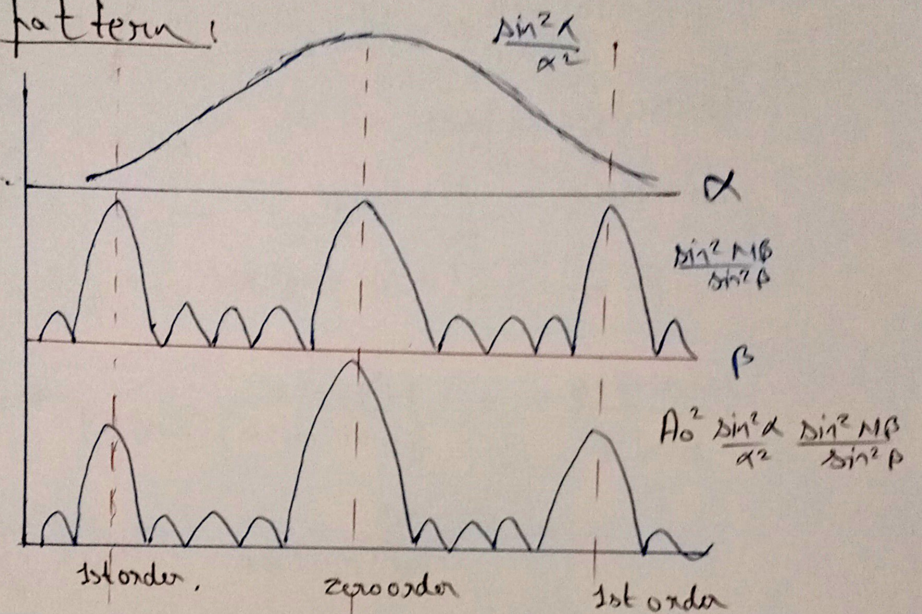
$$\frac{N\pi d\sin\theta}{\lambda} = m\pi \qquad \boxed{N d\sin\theta = m\lambda}$$

③ Secondary Maxima

$\tan N\beta = N \tan\beta$ $\left[\frac{\sin^2 N\beta}{\sin^2\beta} = \frac{N^2}{1+(N^2-1)\sin^2\beta}\right]$

$$\boxed{I_s = \frac{A_0^2 \sin^2\alpha}{\alpha^2} \frac{N^2}{1+(N^2-1)\sin^2\beta}}$$

Diffraction pattern:



Missing order fringes.

Interference max diffraction minima

$\frac{\sin^2\alpha}{\alpha^2} \to 0$ $\alpha \neq 0$ $\sin\left(\frac{\pi a \sin\theta}{\lambda}\right) \to 0$

$\frac{\pi a \sin\theta}{\lambda} = m\pi$

$$\boxed{a\sin\theta = \mp m\lambda}$$

Interference max

$\frac{\sin N\beta}{\sin\beta}$ $(a+b)\sin\theta = \mp n\lambda$

$\frac{a+b}{a} = \frac{n}{m}$ $\boxed{1 + \frac{b}{a} = \frac{n}{m}}$

if $b = d$

$n = 2m$

2, 4, 6, 8th ... order Intreference fringes will absent.

Angular width of Principal maxima :

$$\left[\, 2d\theta_n = \frac{2\lambda}{N(b+d)\cos\theta_n} \,\right]$$

* $n\lambda = (b+d)\sin\theta$

$$\boxed{\lambda = \frac{(b+d)\sin\theta}{n}}$$

Dispersive power of a plane diffraction grating :

dispersive power of a diffraction grating is defined as the rate of change of the angle of diffraction with the wavelength of light. It is denoted by $\frac{d\theta}{d\lambda}$.

$$(b+d)\sin\theta = n\lambda$$

$$(b+d)\cos\theta \frac{d\theta}{d\lambda} = n$$

$$\boxed{\frac{d\theta}{d\lambda} = \frac{n}{(b+d)\cos\theta}}$$

Resolving power :

$$\left[\, \frac{\lambda}{d\lambda} = nN \,\right]$$