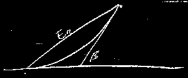
Single slit diffraction pattern

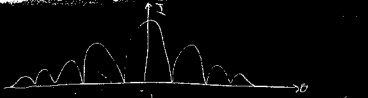


arc length = E_0

last time: $E_R = E_0 \left[\sin(\beta/2) / (\beta/2) \right]$

$I = E_R^2 = E_0^2 \left(\frac{\sin \beta/2}{\beta/2} \right)^2$

use $\beta = \frac{2\pi}{\lambda} a \sin\theta$: $I = I_{max} \left[\frac{\sin(\pi a \sin\theta/\lambda)}{\pi a \sin\theta/\lambda} \right]^2$



minima when

$\frac{\pi a \sin\theta_{dark}}{\lambda} = m\pi$ (as before)

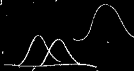
m = integer

look at width of 1st maximum.

distance between center of bright spot + 1st minimum given by

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

small θ: $\theta = \lambda/a$



To resolve 2 different sources, need angular separation big enough so that spots don't overlap.

need $\theta > \lambda/a$

Diffraction

condition for constructive interference depends on λ

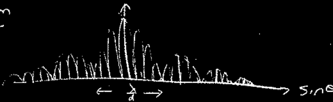
constructive interference: $d\sin\theta = m\lambda$

2 slits: Intensity vs position

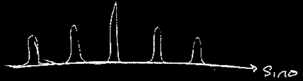
$$I = I_{max}\cos^2\left(\frac{\pi d \sin\theta}{\lambda}\right)\left[\frac{\sin(\pi a \sin\theta/\lambda)}{\pi a \sin\theta/\lambda}\right]^2$$

d = slit separation

a = slit extent



lots of slits:



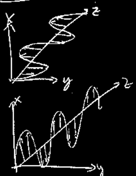
Resolving power of a grating

$$R = \frac{(\lambda_1+\lambda_2)/2}{\lambda_1-\lambda_2} = \frac{\lambda}{\Delta\lambda}$$

if N slits
looking at m^{th} maxima

$R = Nm$.

Polarization



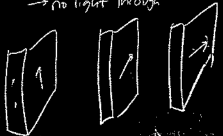
$\vec{E}$ field is a vector
if propagating along $\hat{z}$
$\vec{E}$ could point either along $\hat{x}$ or along $\hat{y}$

linearly polarized light

Circularly polarized light — sum of 2 linearly polarized waves $\pi/2$ out of phase

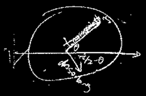
linearly polarized light

crossed polarizers -
→ no light through



Selective absorption

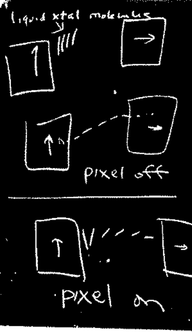
If light is polarized along x axis,
and material absorbs light along an axis that is angle θ to x



Intensity that comes through is $I_0 \cos^2\theta$

$(E = E_0 \cos\theta)$

 transmission = $\left(\frac{1}{2}\right)\left(\frac{1}{2}\right) = \frac{1}{4}$



Polarization by reflection:

amount reflected
depends on polarization

Angle where reflected beam is completely polarized
Brewster's angle θ_p determined by

$$\tan \theta_p = n$$

at Brewster's angle, angle between reflected and refracted beams is $\pi/2$

Polarization by scattering:

Polarization by double refraction.

2 polarizations have different indices of refraction

Birefringence - material rotates light polarization.