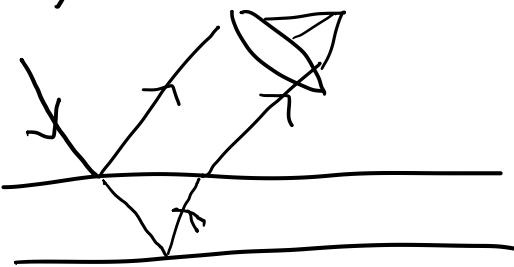
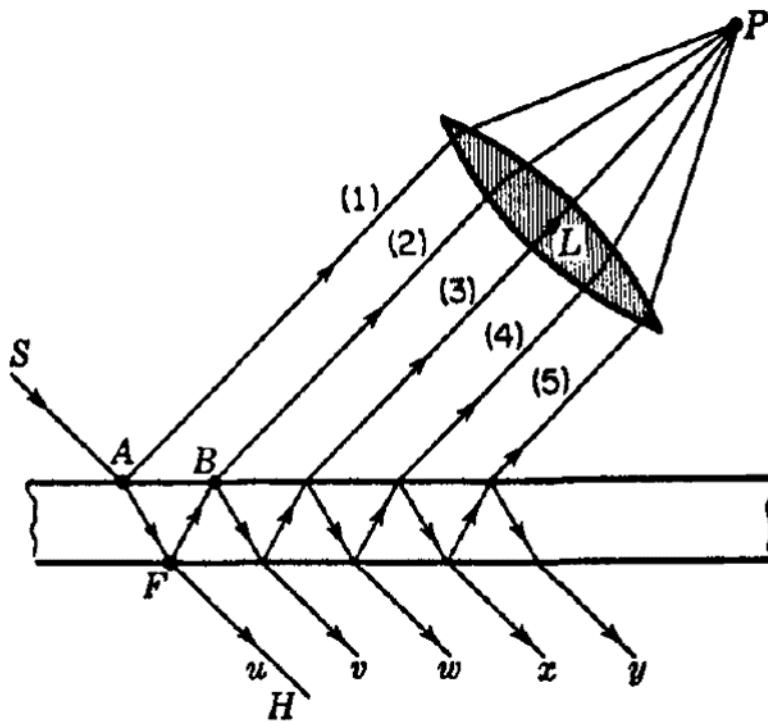


Interference in thin films



- phase change of π occurs for reflection from rarer to denser medium
- No phase change for denser to rarer medium



1,2 out of phase
 2,3,4... in phase
 wrt phase change of
 reflection

$$2dn \cos\phi' = m\lambda \quad \text{minima}$$

$$2nd \cos\phi' = \left(m + \frac{1}{2}\right)\lambda \quad \text{maxima}$$

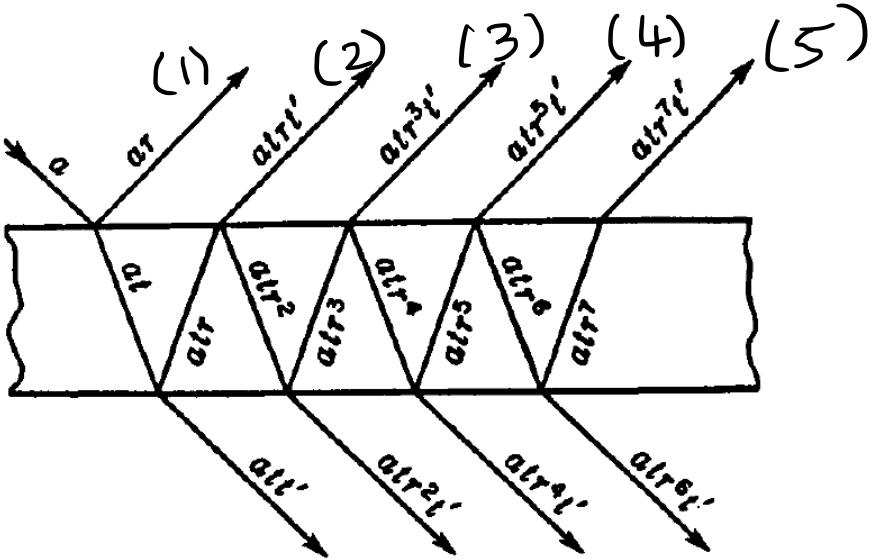
For minima ray 2 is out of phase with ray 1.

but 1 has greater amplitude than ray 2.

So the two won't cancel completely.

Will we see a complete dark fringe?

$$|r| = (r')$$



$$A = atrt' + atr^3t' + atr^5t' + atr^7t' + \dots$$

$$= atrt' (1 + r^2 + r^4 + r^6 + \dots)$$

$$= atrt' \times \frac{1}{1 - r^2} ; \text{ Recall from Stokes' principle}$$

$$tt' = 1 - r^2$$

$A = ar$

\rightarrow complete darkness at minimum

o need extended source to see fringes

• each bright fringe $\rightarrow m$ integer

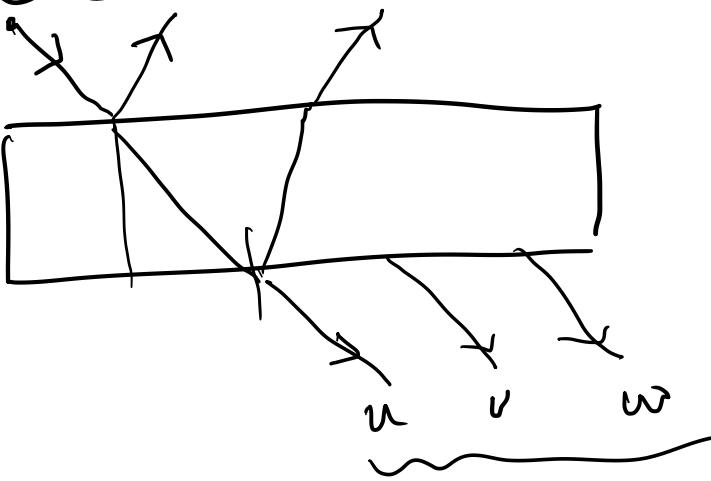
$$2nd \cos\phi' = \left(m + \frac{1}{2}\right) \lambda$$

\downarrow ϕ value is fixed

fringes have shape of arc of a circle

• dark fringe $2nd \cos\phi' = m \lambda$

Interference from transmission



combine to interfere

→ no phase change due to reflection

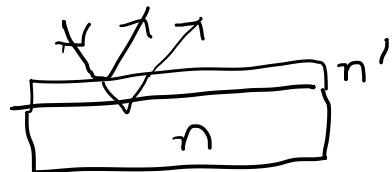
$$2nd \cos\phi' = m\lambda \Rightarrow \text{maxima}$$

$$2nd \cos\phi' = \left(m + \frac{1}{2}\right)\lambda \Rightarrow \text{minima} .$$

Non-reflecting films

film of transparent substance deposited on glass

of r.i. n' \rightarrow < r.i. of glass.



normal incidence {

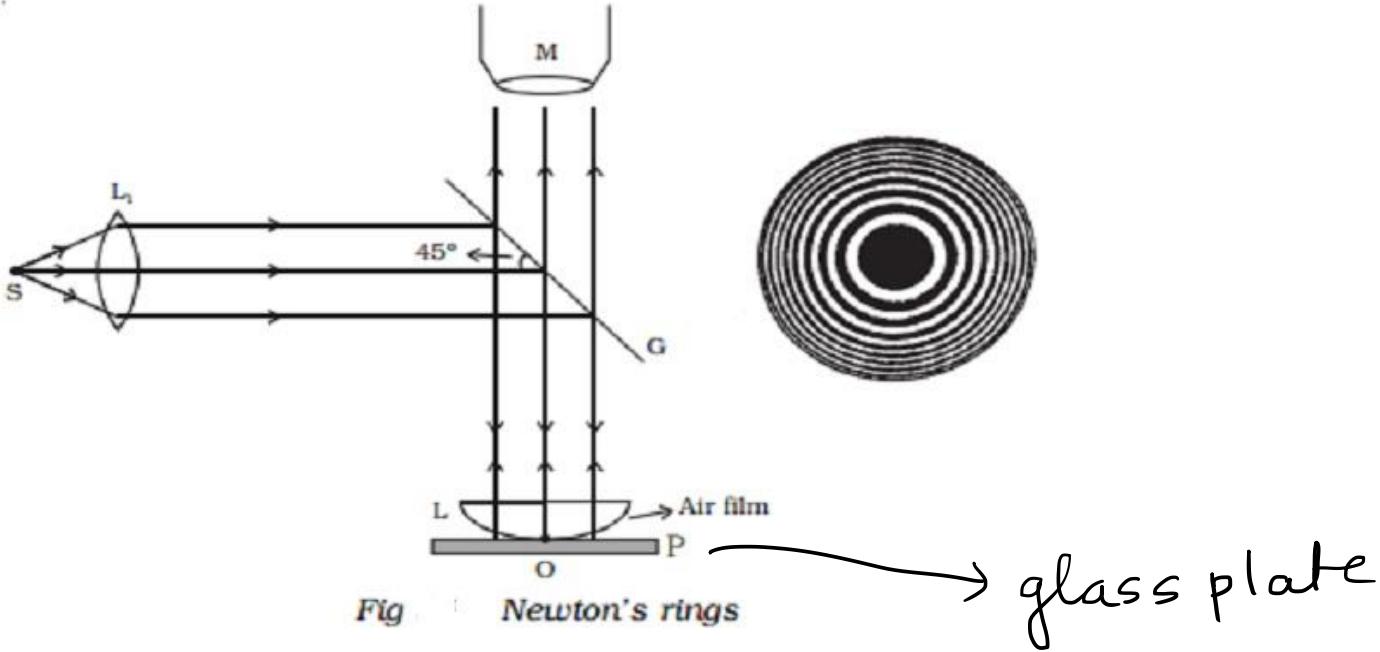
$$2n'd = m\lambda \Rightarrow \text{maxima}$$
$$2n'd = \left(m + \frac{1}{2}\right)\lambda \Rightarrow \text{minimum}$$

$$m=0$$

$$2n'd = \frac{\lambda}{2}$$

$$d = \frac{\lambda}{4n'}$$

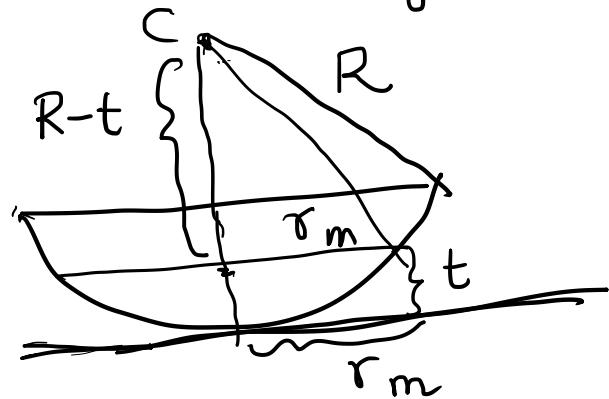
Newton's Rings



Air film between plate and plane convex lens

reflected rays interfere

Thin film of varying thickness
 d is zero at point of contact and increases as we move away



radii of rings

$$r_m^2 = R^2 - (R-t)^2$$

$$\approx 2Rt$$

Near normal incidence ($\phi' = 0$)

$$2nt = \left(m + \frac{1}{2}\right)\lambda \quad \{ m=0, 1, 2, \dots \}$$

(phase change on reflection at glass plate) \rightarrow maxima

$$2nt = m\lambda \Rightarrow \text{minimum}$$

Point of contact \Rightarrow dark

Symmetry \rightarrow fringes will be circular

$$\tau_m^2 = 2Rt$$

$n = 1$ air film

$$2t = \frac{\tau_m^2}{R}$$

Minimum \Rightarrow

$$2t = m\lambda$$

$$\boxed{\tau_m = \sqrt{m\lambda R}}$$

$$\tau_m \propto \sqrt{m}$$

Max \Rightarrow

$$\boxed{\tau_m = \sqrt{(m + \frac{1}{2})\lambda R}}$$

If a liquid of r.i. n is introduced between lens and glass plate

$$r_m = \sqrt{\frac{m\lambda R}{n}} \Rightarrow \text{minimum}$$

$$r_m = \sqrt{\frac{(m+\frac{1}{2})\lambda R}{n}} \Rightarrow \text{maximum}$$

if $n_{\text{lens}} < n < n_{\text{plate}}$

central spot will turn bright

$$r_m = \sqrt{\frac{(m+\frac{1}{2})\lambda R}{n}} \Rightarrow \text{dark}$$

$$r_m = \sqrt{\frac{m\lambda R}{n}} \Rightarrow \text{bright}$$

