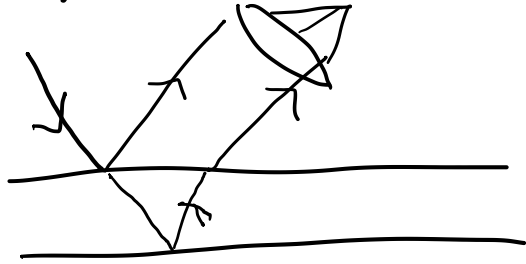
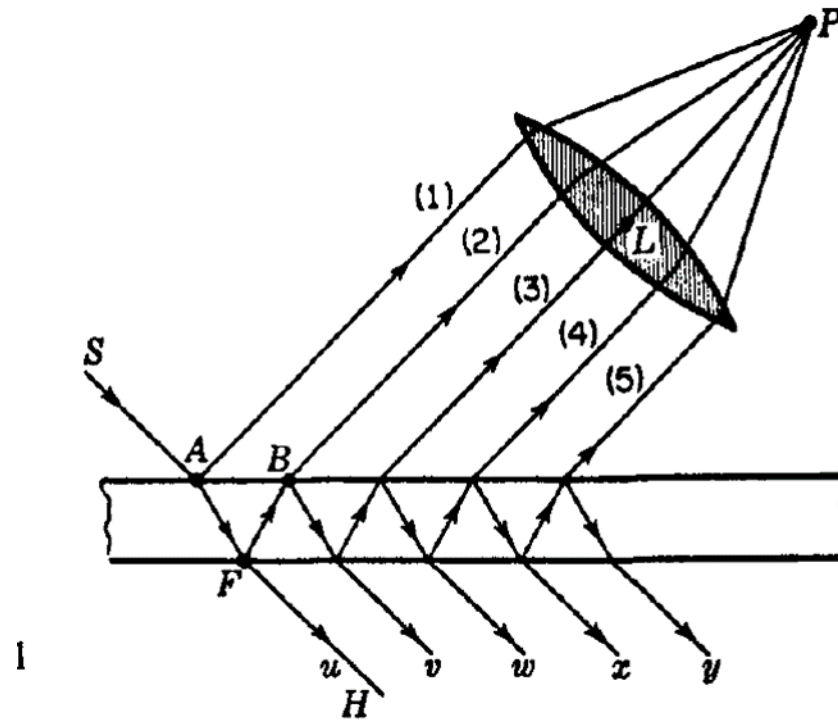


## Interference in thin films.



- phase change of  $\pi$  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

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

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

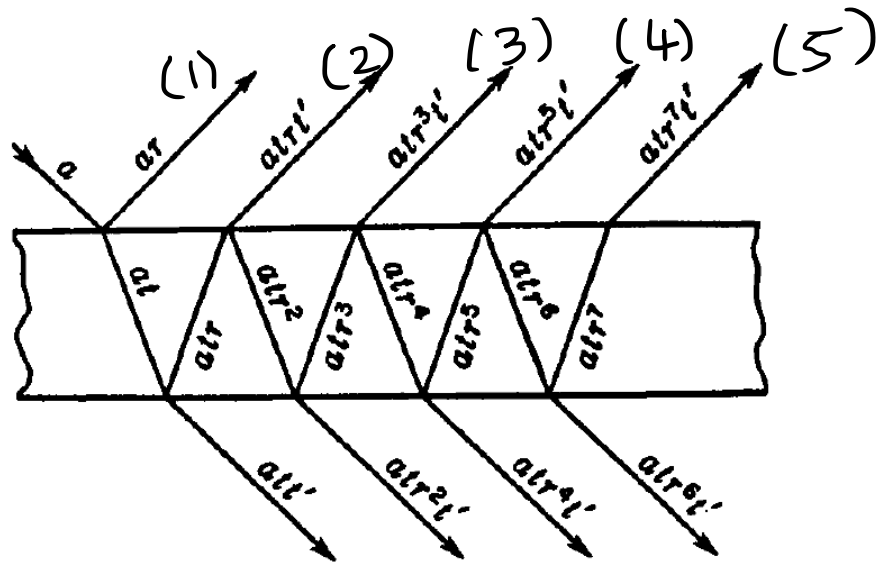
For minima ray 2 is out of phase with ray 1.

but 1 has greater amplitude than ray 2.

So the two won't cancel completely.

Will we see a complete dark fringe?

$$|r| = |r'|$$



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

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

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

$$A = ar$$

→ complete darkness at minimum

- need extended source to see fringes

- each bright fringe  $\rightarrow m$  integer

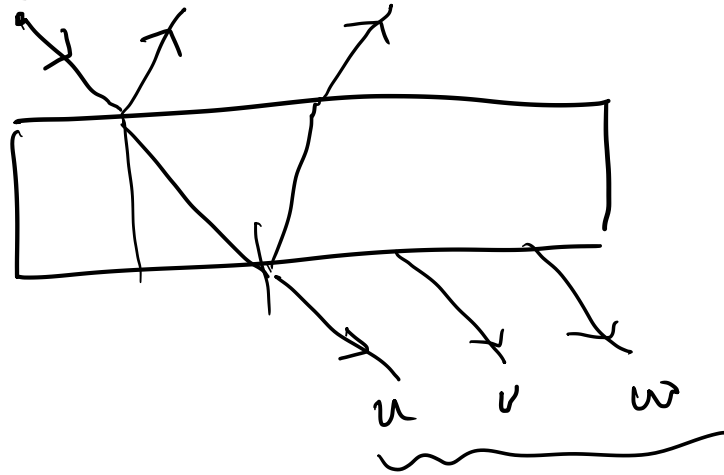
$$2nd \cos \phi' = \left(m + \frac{1}{2}\right) \lambda$$

$\swarrow$   $\phi$  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

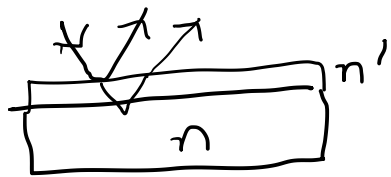
$$2nd \cos \phi' = m\lambda \Rightarrow \text{maxima}$$

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

## Non-reflecting films

film of transparent substance deposited on glass.

of r.i  $n'$   $<$  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

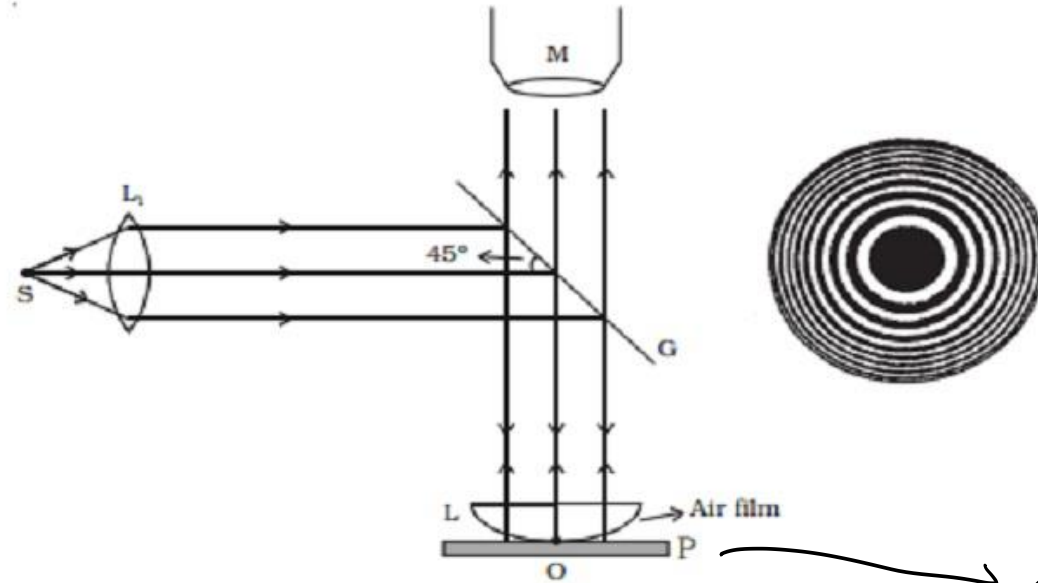


Fig. Newton's rings

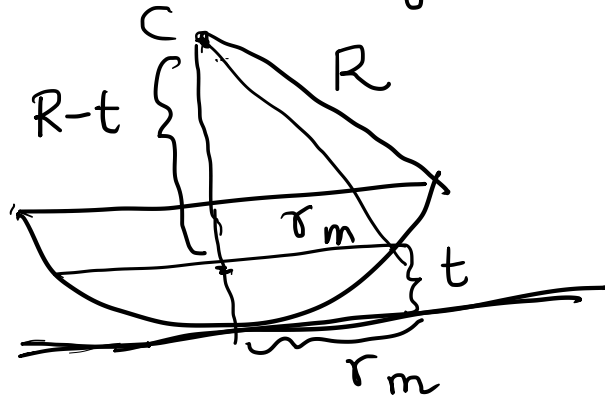
→ glass plate

Air film between plate and plano 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

$$r_m^2 = 2Rt$$

$n = 1$  air film

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

Minimum  $\Rightarrow 2t = m\lambda$

$$r_m = \sqrt{m\lambda R}$$

$$r_m \propto \sqrt{m}$$

Max  $\Rightarrow$

$$r_m = \sqrt{\left(m + \frac{1}{2}\right)\lambda R}$$

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

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

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

