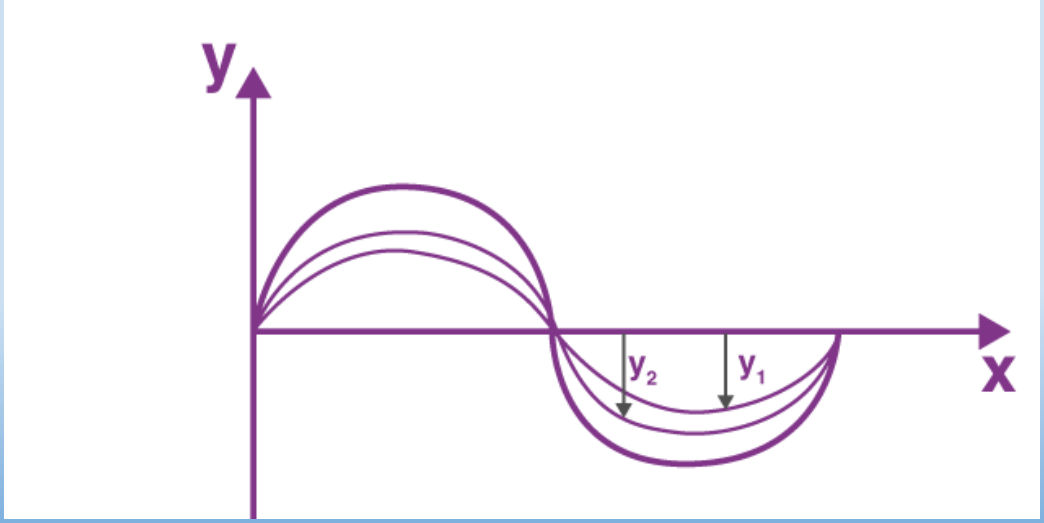
FUNDAMENTALS OF INTERFERENCE

INDEX

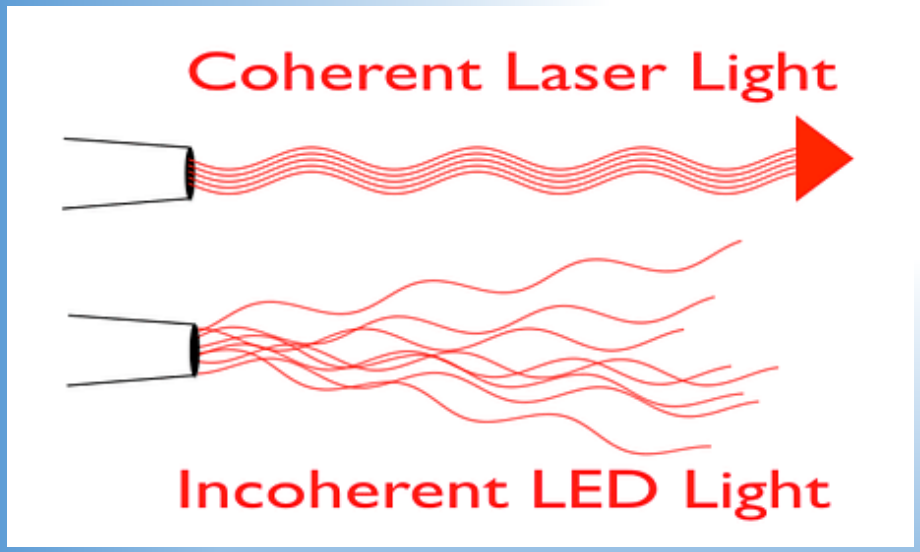
Superposition Principle

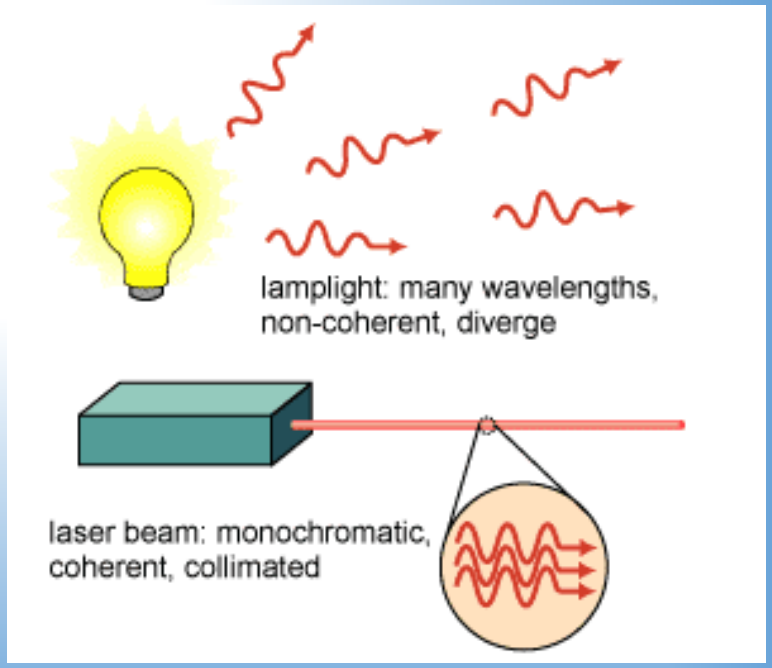
When two or more waves meet at a point, the displacement at that point is equal to the sum of the displacement of individual waves.



COHERENT SOURCES

- **Coherent sources are those which emit light waves of same wavelength or frequency and have a constant phase difference with time.**
- **It is the ideal property of waves which enables interference.**





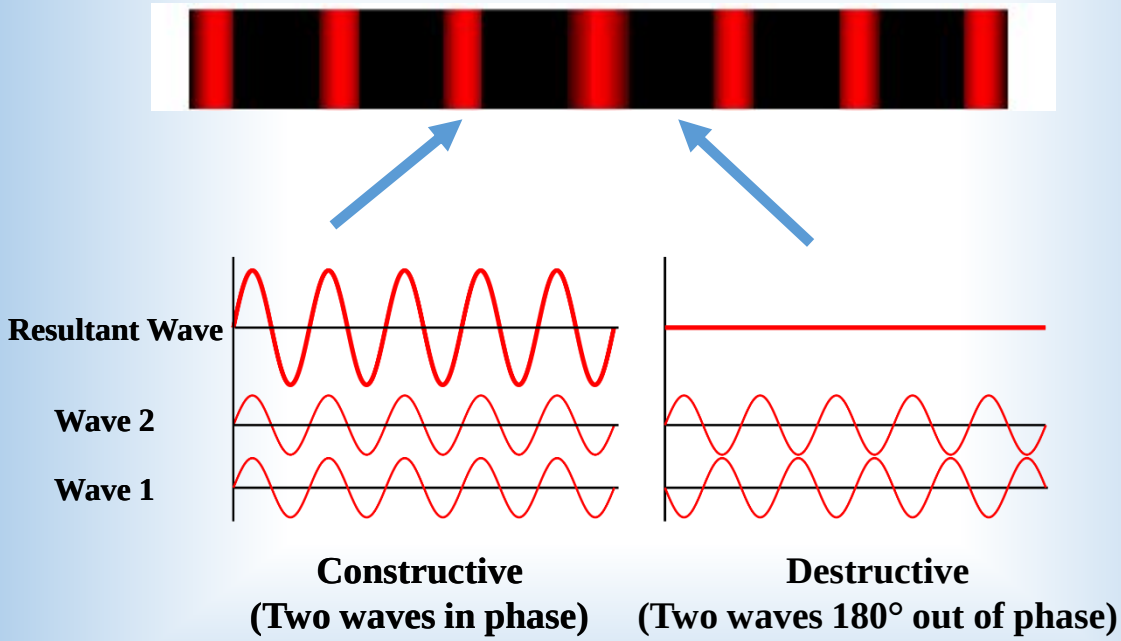
CONDITIONS FOR COHERENT SOURCES

- Coherent sources are obtained from single source.
- Phase difference would be constant with time.
- The source must emit monochromatic light.
- The path difference between light sources must be very small.

Why can't two sources behave as coherent sources?

INTERFERENCE OF LIGHT

Interference is the phenomenon of redistribution of energy due to superposition of two waves from two coherent sources to form a resultant wave of the lower or higher amplitude.



- For constructive interference, the amplitude of the resultant wave is greater than that of individual wave.
- For destructive interference, the amplitude of the resultant wave is smaller than that of individual wave.

SUSTAINED INTERFERENCE

The interference pattern in which dark and bright fringes positions are fixed on the screen is known as sustained interference.

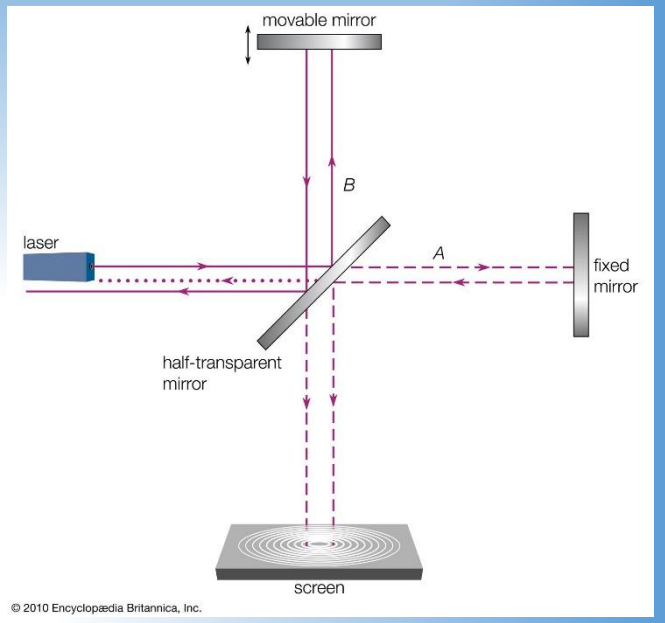
CONDITIONS:

- ✓ The sources must be monochromatic.
- ✓ The two sources must emit waves of same frequency.
- ✓ The two sources must be coherent.
- ✓ The two coherent sources must be very close to each other.
- ✓ Reasonable distance must be maintained between the source and screen.
- ✓ The amplitudes of the two interfering waves must be equal.
- ✓ The coherent sources must be narrow.

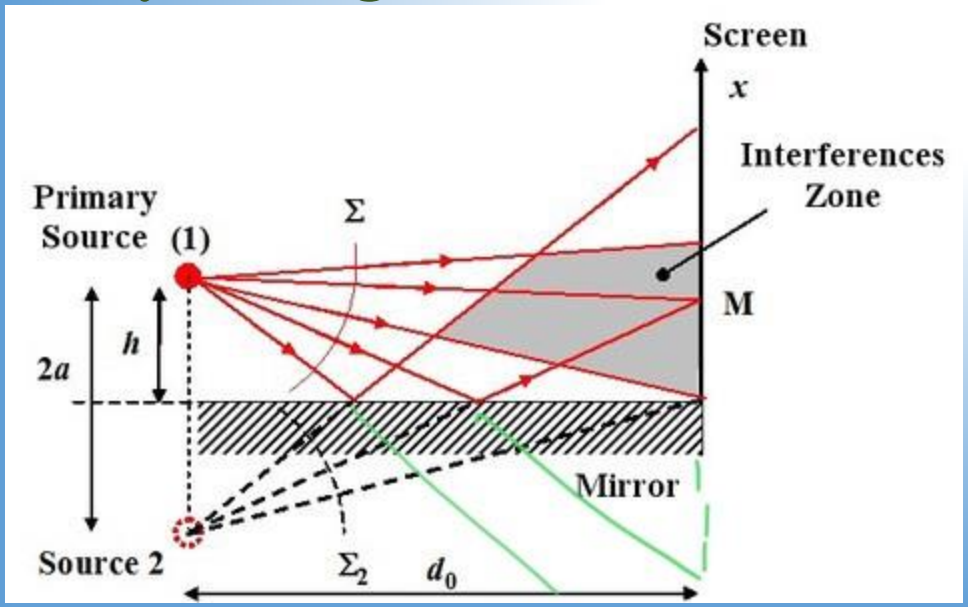
TYPES OF INTERFERENCE

- Division of Wave Front
- Division of Amplitude

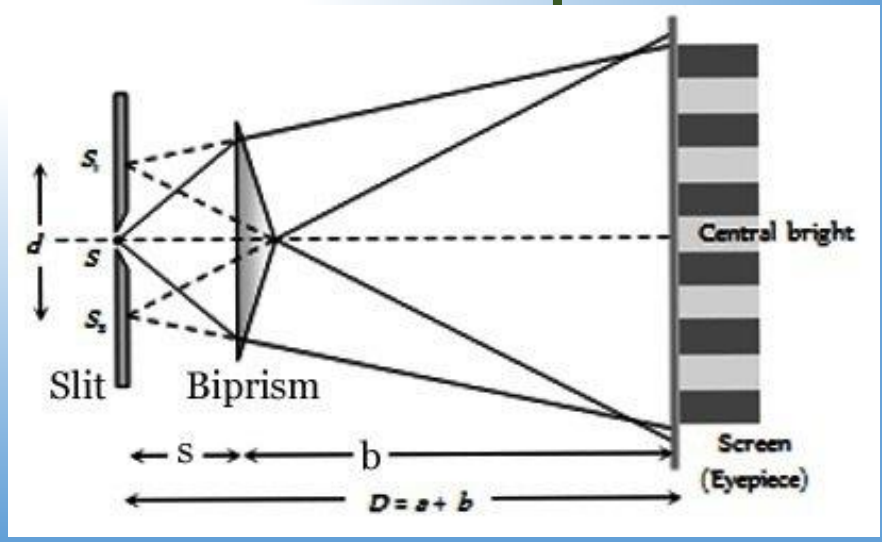
Michelson Interferometer



Lloyd's Single Mirror



Fresnel's Biprism



TYPES OF INTERFERENCE

- **Division of Wave Front**

✓ This method uses multiple slits, lenses, prisms or mirrors for dividing a single wave front laterally to form two smaller segments that can interfere with each other.

✓ This method is useful with small sources.

✓ Young's Double slit experiment, Fresnel's biprism are excellent example of interference by division of wave front.

TYPES OF INTERFERENCE

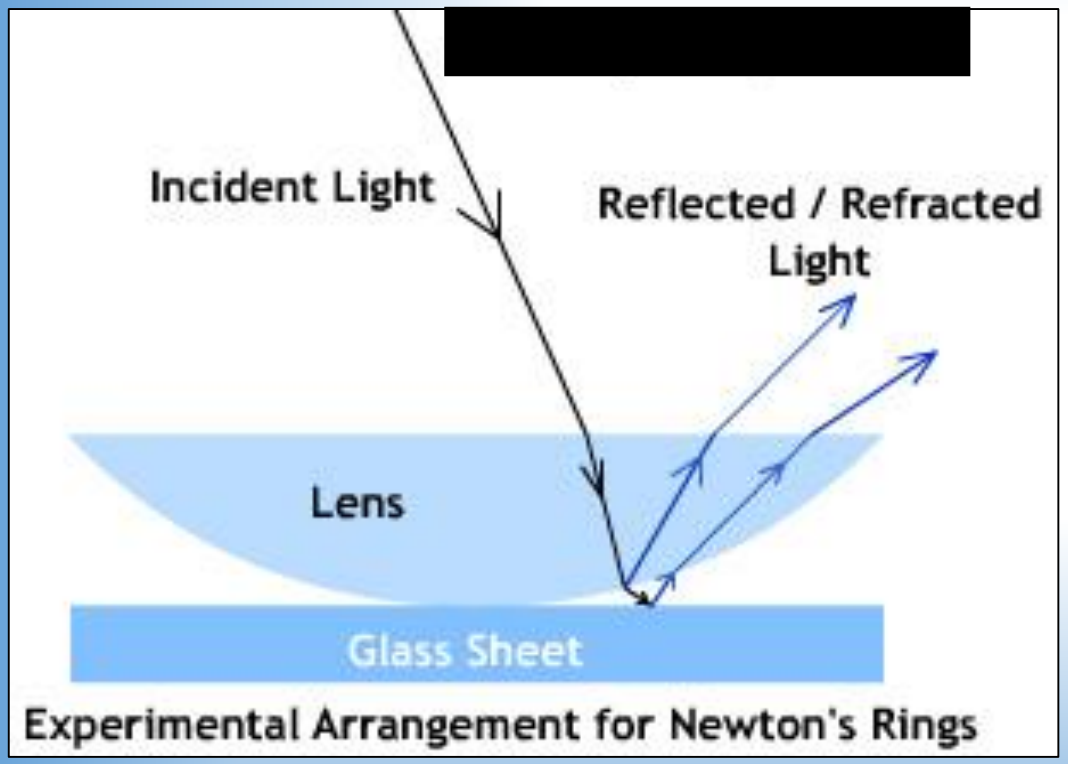
- **Division of Amplitude**

✓ In this class, the amplitude of the incident beam is divided into two parts by partial reflection or refraction to produce two coherent interfering beams.

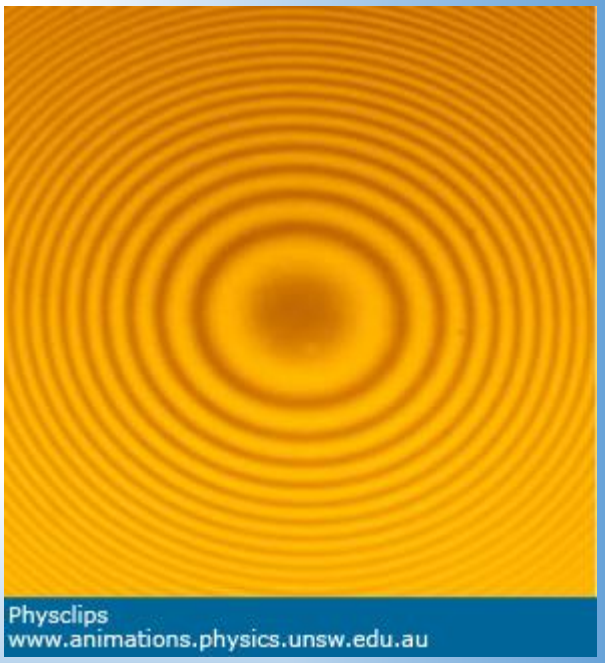
✓ This method can be used with extended sources.

✓ Newton's Ring, Michelson interferometer, Fabry-Perot Interferometer, etc. example of interference by division of amplitude.

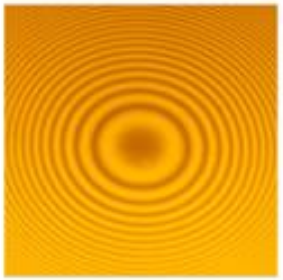
NEWTON'S RINGS



Experimental Arrangement for Newton's Rings



Newton's Rings



Newton's rings pattern

Traveling microscope

Screen with a wide slit

Glass plate

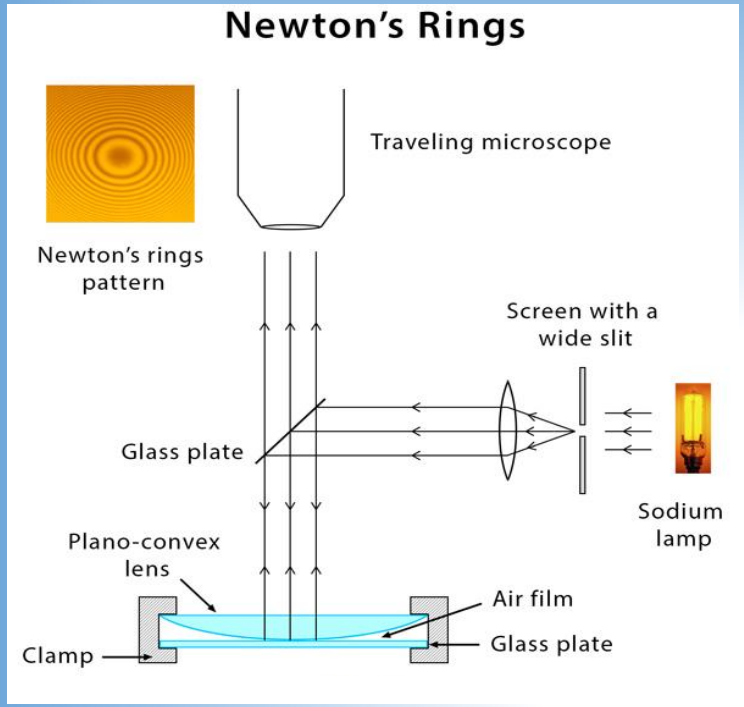
Sodium lamp

Plano-convex lens

Air film

Glass plate

Clamp



maxima:

Path diff. $= 2\mu t\cos(\theta + r) = \left(n - \frac{1}{2}\right)\lambda$

minima:

Path diff. $= 2\mu t\cos\theta = n\lambda$

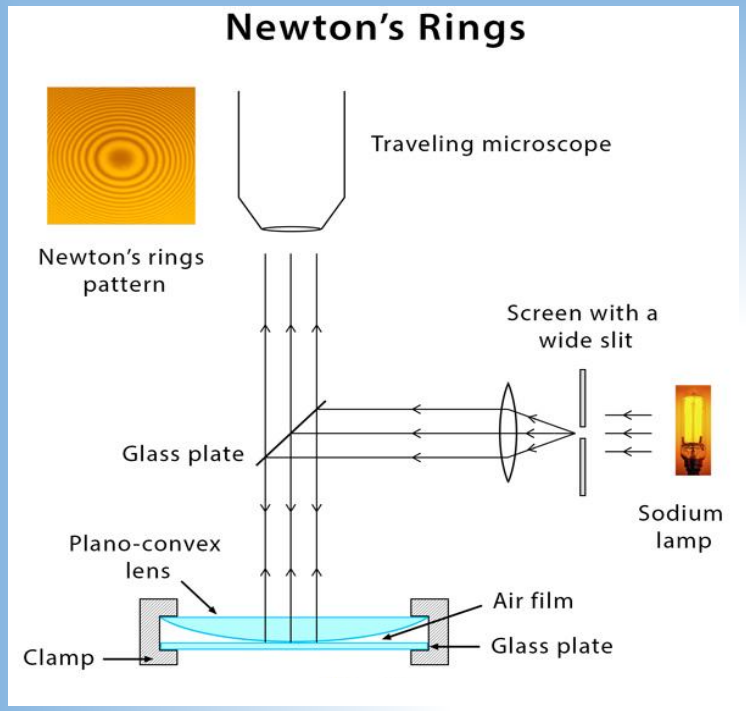
For normal incidence, $i = r = 0$, μ=1 in air and small θ

maxima:

$$2t = \left(n - \frac{1}{2}\right)\lambda$$

minima:

$$2t = n\lambda$$



maxima:

$$2t = \left(n - \frac{1}{2}\right)\lambda$$

minima:

$$2t = n\lambda$$

At the contact, i.e. centre, we have $t = 0$,

Hence, the minima condition will be satisfied at the point of contact

The central spot will always be dark

A fringe of given order (m) will be along the loci of points of equal film thickness (t), and hence the fringe will be circular.