Lloyds single mirror experiment

Lecture 4

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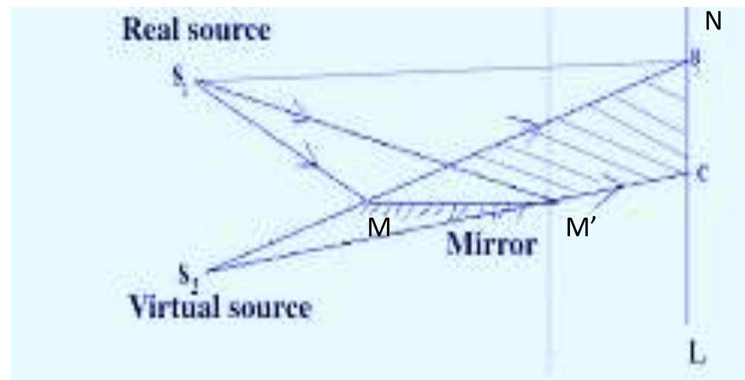
Lloyds single mirror experiment:

Lloyd’s Mirror is used to produce two-source interference patterns. Let S is a diverging source of light, strikes at front surface of a mirror at a low angle. Some of the beam reflects from the mirror to the screen, and some shines directly on the screen.



The reflected beam coming form a virtual source S_2, superpose with the direct beam coming from source S_1.

As a result of this we get interference pattern at BC on the screen LN.

In this experiment, the central fringe at C (where $CS_1 = CS_2$) is not formed because this point receives light only coming from source S_1.

However if we placed the screen touching the end point M', the central fringe would come into view but it is found to be a dark fringe.

This indicates that the reflected light suffers a sudden phase change of π when it reflects from a surface backed by a denser medium.

Difference between Fresnel's biprism and Lloyd's single mirror experiment:

i) In Fresnel's biprism experiment fringes are obtained on both sides of the central fringe but in Lloyd's mirror experiment we get fringes only at one side of the centrl fringe.

ii) In biprism central fringe is bright but in Lloyd's mirror it is dark.

iii) In biprism every pair of corresponding points of the sources are same but in Lloyd's mirror due to lateral inversion in the mirror d , the separation between the sources are different, so fringe width is not same for all parts of the source.

Measurement of wavelength:

Fringe width β is given by

$$\beta = \lambda D/d$$

$$\text{or} \quad \lambda = \beta d/D$$

here d is the separation of the two sources , D is the separation between the sources and the screen.

Measuring β, d and D we can measure the value of λ.

To measure the value of d a convex lens of suitable focal length is used. The procedure of measuring d is same as the biprism experiment.

$$\text{where } d = (d_1 d_2)^{1/2}$$

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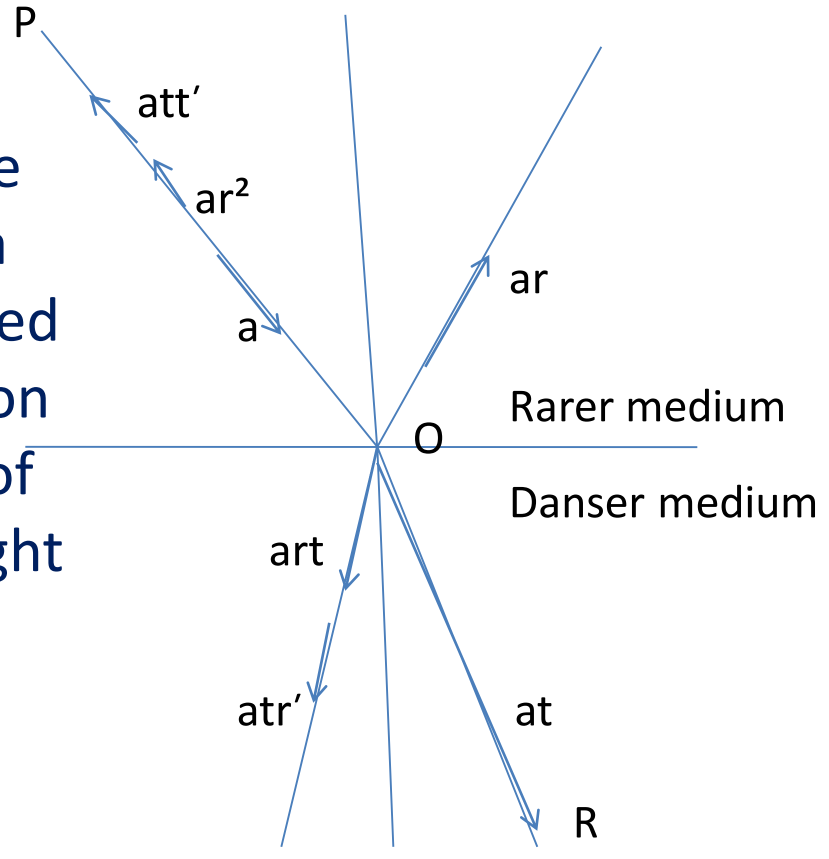
Phase change on reflection, Stoke's treatment:

Let a be the amplitude of the incident wave. Let ar and at be the fraction of the amplitude a of the reflected and transmitted wave. Here r and t are reflection and transmission coefficients of light amplitudes , when the light incident on denser medium.
If there is no absorption of energy, then the wave motion is a reversible phenomenon.



If r' and t' are the amplitudes reflection and transmission coefficients when light incident on the rarer medium then from the figure we can write,

$$a = att' + ar^2$$

$$tt' = 1 - r^2 \qquad \text{................(1)}$$

$$art + atr' = 0$$

$$r' = -r \qquad \text{............... ..(2)}$$

Relation (2) indicates a phase change of π between reflections in denser and rarer medium.

Lloyd's mirror experiment shows a phase change of π when light reflects from a surface backed by a denser medium. Hence it can be concluded that no abrupt phase change takes place when light reflects from a rarer medium.

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