MICHELSON’s INTERFEROMETER

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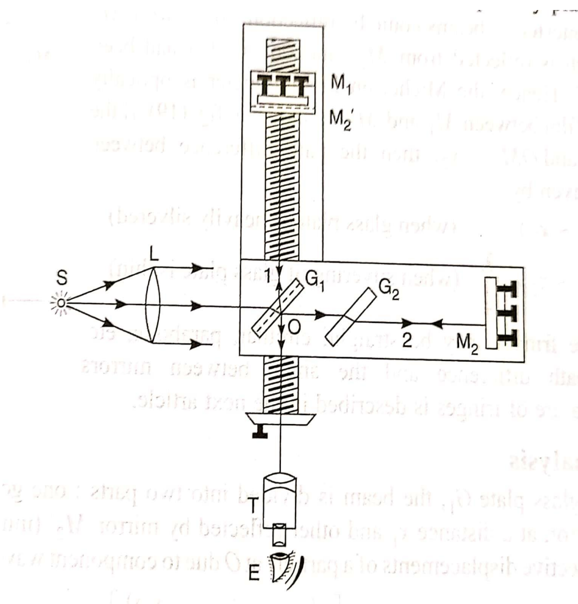
MICHELSON's INTERFEROMETER :

- Michelson's Interferometer is an instrument in which light from an extended source is divided into two parts of equal intensities by parallel reflection and transmission (Division of amplitude).
- These two rays sent in two directions at right angles to each other and are again brought together after reflection from plane mirrors to form interference fringes.

Construction :

- Michelson's Interferometer consists of two highly polished plane mirrors M_1 & M_2 which are at right angles to each other.
- There are two optically flat Glass plates G_1 & G_2 of same thickness and of same material placed parallel to each other.
- They are also inclined at an angle of 45° with the mirrors M_1 & M_2. The surface of G_1 towards G_2 is semi silvered. The mirror M_1 is fixed on a carriage and can be moved with help of handi heels.
- The mirrors are provided with micrometer screws. 'T' is a Telescope which receives the reflected light from mirrors M_1 & M_2 .



Working :

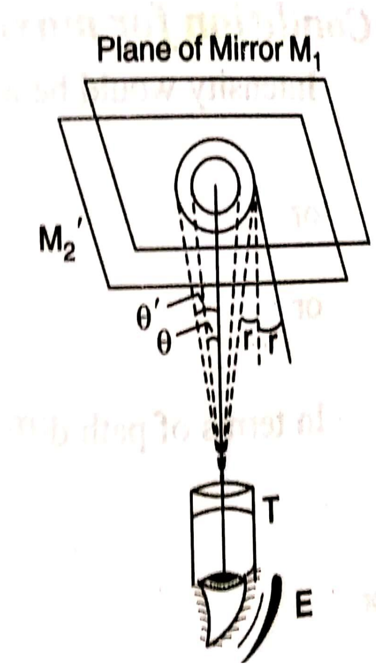
- The light from monochromatic sources is made parallel by means of a convex lens L. This light falls on the semi silvered glass plate G_1 .
- It is partly reflected at the semi silvered surface of G_1 and proceeds towards M_1 and partly transmitted towards M_2.
- These two rays falls normally on the mirrors M_1 and M_2 respectively and are reflected back along their original paths.
- The beam reflected back by M_1 is transmitted through the glass plate M_1 and the beam reflected back by M_2 is reflected by the glass plate G_1 towards the telescope T .
- These two rays are derived from the same incident ray and have travelled over different paths. So they are in a condition to interfere and interference fringes are observed.
- The beam going towards M_1 has to pass twice through the glass plate G_1. To Compensate this a similar glass plate G_2 is introduced in the path of the second ray parallel to G_1.

- If the mirrors M_1 and M_2 are perfectly perpendicular, the observer's eye will see the images of mirrors M_1 and M_2 through G.
- There will be an air film between the two images and the distance can be varied with the help hand H. Then the fringes will be circular. If the total path travelled by the two rays is exactly same the field of view will be completely dark.
- If the two images of M_1 and M_2 are inclined(when they are not perpendicular to each other). The enclose air film will be wedge shaped and straight line fringes will be observed.
- If M_1 is moved to a distance by $\lambda/2$, one fringe will lose the field of view.

Types of Fringes

I) **Circular Fringes:**

In Michelson's Interferometer, circular fringes are produced when the mirros are exactly perpendicular to each other i.e., the mirror M_1 and virtual Mirror M'_2 which is the image of M_2 must be parallel to each other.



The sources S_1 and S_2 are the virtual images of Source S, due to M_1 and M'_2. If the distance between M_1 and M'_2 is equal to d, the distance between S_1 and S_2 = 2t. The path difference between two rays is equal to 2tcosr.

If $2t\cos r = n\lambda$ we get maximum

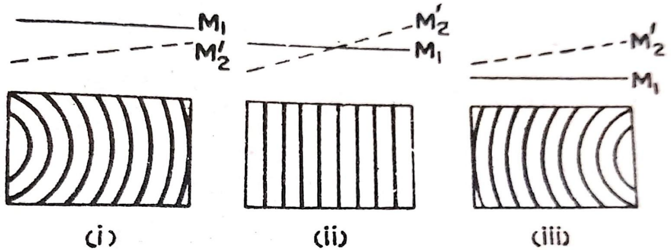
The circular fringes which are due to interference with a phase difference determined by r are known as the fringes of equal inclination or Haidinger's fringes.

When M_1 and M'_2 coincides with each other the field of view is dark.

Types of Fringes

<u>Localized Fringes:</u>

When the mirror M_1 and virtual mirror M'_2 are inclined the air film enclosed is wedge shaped and a straight line fringes are observed. The fringes are perfectly straight when M_1 intersects M'_2 in the middle. In the other positions the shape of the fringes is shown in the figure.



They are curved and are always towards the thin edge of the wedge. These fringes are not observed for the large path differences.

Types of Fringes

White Light Fringes:

With white light the fringes are observed only when the path differences is small. The first few coloured fringes are visible. After that due to overlapping of colours the fringes are not visible. The central fringe is Dark. The white light fringes are used for the determination of central fringe($\lambda/2$ path difference)

Uses of Interferometer

Michelson's interferometer is used

1. To determine the wavelength of given monochromatic source of light
2. To determine the difference between two neighbouring wave lengths
3. The refractive index and the thickness of various thin transparent materials like glass, mica etc.

Determination of wavelength of monochromatic light

First of all the mitchelsons interferometer is adjusted so that circular fringes are visible in the field of view.

If M_1 and M_2 are equidistant from the glass plate G, the field of view will be completely dark. The mirror M_2 is kept fixed and the mirror M_1 will be moved with the handle H. Then the no of fringes that lose the field of view is counted.

If t is the distance moved and the number of fringes that cross the center of the field of view is equal to 'n'

Then $t = n\lambda/2 \Rightarrow \lambda = 2t/n$

Because for one fringe shift the mirror moves a distance equal to half wave length($\lambda/2$).
Hence $\lambda = 2t/n$