

TITLE :- USES OF MICHELSON'S INTERFEROMETER

There are mainly two uses of Michelson's interferometer as

- (i) measure of wavelength of monochromatic light
- (ii) determine the refractive index or the thickness of thin transparent film.

(i) Measure the wavelength of monochromatic light :-

Let us suppose that the interferometer is adjusted for circular fringes and a bright spot is obtained at the centre of the field of view. If d be the thickness of the air-film enclosed between M_1 and M_2' and n the order of the spot obtained, we have

$$2d \cos \theta = n\lambda$$

But at the centre $\theta = 0$, so that $\cos \theta = 1$ Therefore

$$2d = n\lambda \quad \text{--- (1)}$$

If now M_1 be moved away from M_2' by $\lambda/2$, the $2d$ increase by λ .

Therefore $(n+1)$ replaces n in equation (1). Hence $(n+1)$ st bright spot now appears at the centre. Thus each time M_1 moves through a distance $\lambda/2$, next bright spot appears at the centre.

Let us suppose the during the movement of M_1 through a distance x , N new fringes appear at the centre of the field. Then we have

$$x = N \lambda/2$$

$$\lambda = \frac{2x}{N} \quad \text{--- (2)}$$

Thus measuring the distance x with the micrometer screw and counting the number of fringes N that appear at the centre, the wavelength λ can be determined.

the value of λ can be calculated.

The determination of λ by this method is more accurate because x can be measured to an accuracy of 10^{-4} and the value of N can be differentially increased as the circular fringes can be obtained upto large path difference.

(ii) Determination of thickness (or refractive index) of a thin plate.

The interferometer is adjusted to produce straight white light fringes and the cross-wire is set on the achromatic fringes which is perfectly straight. The straight given plate is now inserted in the path of one of the interfering waves. This increase the optical path of the beam by $(\mu - 1)t$ where μ is the refractive index and t the ^{thickness} of the plate. Since the beam transverse the plate μ times, an extra path difference of $(\mu - 1)t$ is introduced between the two interfering beams. The fringes are therefore shifted. The movable mirror M_1 is moved till the fringes are brought back to their initial position so that the achromatic fringes are coincides with cross wire. If displacement of M_1 is x , then

$$2x = 2(\mu - 1)t$$

$$\text{or } x = (\mu - 1)t$$

Thus measuring x , t may be calculated if μ is known or μ may be calculated if t is known.

This method can be used to find the refractive index of a gas.

← x — x — x ←