Fresnel's Biprism

The Fresnel's biprism is a prism which has one of it's angles slightly less than two right angles and two small base angles.

It acts like two very thin prisms placed base to base.

The theory for the Fresnel's Biprism is smaller to double-slit

experiment. A point source is shone through the fresnel's biprism which consists of two prisms joint at their bases to form an isosceles triangle. the resulting refraction causes the light appear as if it is coming from two point sources and similar interference pattern is created .

Other apparatus depending on division of the wave front

1-Fresnel's mirrors:-It is an arrangement in which the light from a slit is reflected in two plane mirrors slightly inclined to each other .the mirrors produce two virtual images of the slit.

2-Liyod's mirrors:-It is a mirror used to reflect part of a direct light source so that the reflection interferes with the direct source, producing fringes.

3-split lens: other ways for dividing the wave front into two segments and subsequently recombining these at a small angles with each other.

Coherent sources

Coherent sources are those sources of light which emit continuous light waves of same wavelength, same frequency and are in same phase or have a constant phase difference. These sources produced by an oscillator.

Division of amplitude (Michelson interferometer)

Interference apparatus may be conveniently divided into two main classes:

1-based on division of wave front.

2-based on division of amplitude.

The first in which the wave front is divided laterally into segments by mirrors or diaghrams.

The second in which the wave is divided by partial reflection, the Michelson interferometer is an important example of the second class.

The Michelson int .is a device that produces interference between two beams of light. A diagram of the apparatus is shown in fig.(5).the basic operation of the interferometer is as follows:

Light from a light source is split into two parts.one part of the light travels a different path length than the other.After traversing these different path lengths, the two parts of light are brought together to interfere with each other .the interference pattern can be seen on a screen.

Light from the source strikes the beam splitter (designated by s).the beam splitter allows 50%of the radiation to be transmitted to the translatable mirror M.$_1$the other 50%of the radiation is reflected to the fixed mirror path have the same optical path length when $M_1$and M_2 at the same distance from beam splitter. After returning from M_1,50%of the light is reflected toward the frosted glass screen. likewise, 50% of the light returning from M_2 is transmitted to the glass screen.at the screen, the two beams are superposed and one can observe the interference between them.

Circular fringes

To understand the fringe pattern away from the center of the screen we must distinguish between two cases:

-1when the light source is a point source and the mirrors are in exact adjustment ,we will see circular fringes.

-2if we feed the interferometer with a parallel beam then we will observe fringes of equal thickness.

Visibility of fringes

There are three principal types of measurement that can be made with the interferometer:

-1width and fine structure of spectrum lines.

-2length or displacement in terms of wavelength of light.

-3refractive indices.

For the measurements of length, Michelson tested the lines from various sources and concluded that a certain red line in the spectrum of cadimium was the most satisfactory. The measured the visibility, defined as:

$$V=I_{max}-I_{min}/\ I_{max}+I_{min}$$

Where I_{max} and I_{min} are the intensities at the maxima and minima of the fringe pattern.

Interferometric measurements of length

The principal advantage of michelson's form of interferometer over the other methods of producing interference lies in the fact that the two beams are here widely separated and the path difference can be varied at will by moving the mirror or by introducing a refracting material in one of the beams.

In Michelson int., when the top mirror is moved slowly from one position to another, counting the number of fringes in monochromatic light which cross the center of the field of view will give the measure of the distance the mirror has moved in terms of λ.

For the position of $d_1$corresponing to bright fringe of order m_1

$$2d_1 = m_1\lambda$$

And for d_2, giving a bright fringe of order m_2

$$2d_2 = m_2\lambda$$

Subtracting these two eqns. We find:

$$(d_2 - d_1) = (m_1 - m_2)\lambda/2$$

Hence the distance moved equals the number of fringes counted, multiplied by a half wavelength.

Twyman and Green Interferometer

It is a variant of the Michelson interferometer, principally used to test optical components. The setup of the twyman-green int. is similar to that of the Michelson int. .

There are two differences between the michelson int. and twyman int:

1-the fixed mirror in the Michelson int. is rotatable in the twyman– green int.

2-while the light source is usually an extended source in a Michelson int. , the light source is always a point source.

The rotation of one mirror results in straight fringes appearing in the interference pattern, a fringing which is used to test the quality of optical components by observing changes in the fringe pattern when the component is placed in one arm of the intereferometer.

Index of refraction by interferometric methods

If a thickness t of a substance having an index of refraction n is introduced into the path of one of the interfering beams in the interferometer, the optical path in this beam is increased because of the fact that light travels more slowly in the substance and consequently has a shorter wavelength.

The optical path is now (nt) through the medium, whereas it was practically t through the corresponding thickness of air (n=1)

Thus the increase in optical path due to insertion of the substance is $(n-1)t$ .this will introduce $(n-1)t/\lambda$ extra waves in the path of one beam; so if we call Δm the number of fringes by which the fringe system is displaced when the substance is placed in the beam, we have:

$$(n-1)t=\Delta m(\lambda)$$

In principle a measure of Δm, and λ thus gives a determination of n.

There are several forms of refractometes have been devised especially for this purpose, for example :Jamin ,Mach-zehnder ,Raleigh refractometers.