ANNAI WOMEN'S COLLEGE,

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SUBJECT : OPTICS

2.7. Wedge-shaped Film

Consider a wedge-shaped film of refractive index n enclosed by two plane surfaces OP and OQ inclined at an angle θ (Fig.2.9). The thickness of the film increases from O to P. When the film is illuminated by a parallel beam of monochromatic light, interference occurs between the rays reflected at the upper and lower surfaces of the film. So equidistant alternate dark and bright fringes are observed. The fringes are parallel to the line of intersection of the two surfaces. The interfering rays are AB and DE, both originating from the same incident ray SA.

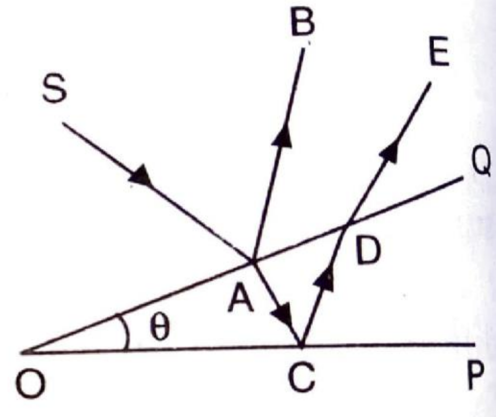

Fig. 2.9.

Expression for the fringe width : The condition for a dark fringe is $2nt \cos r = m\lambda$. Here for air $n = 1$. For normal incidence $\cos r = \cos 0 = 1$.

Suppose the mth dark fringe is formed where the thickness of the air film is t_m (Fig. 2.10). Then,

$$2 \times 1 \times t_m \times 1 = m\lambda$$

or

$$2t_m = m\lambda \qquad ...(1)$$

Suppose the $(m+1)$ th dark fringe is formed where the thickness of the air film is t_{m+1}. Then,

$$2t_{m+1} = (m+1)\lambda \qquad ...(2)$$

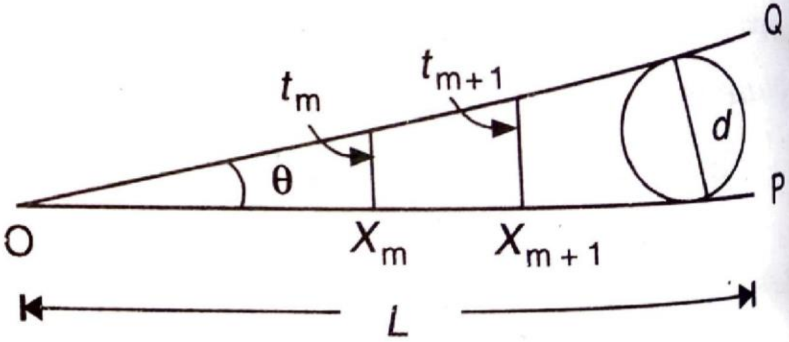

Fig. 2.10.

Subtracting (1) from (2), $2(t_{m+1} - t_m) = \lambda$ ....(3)

Let x_{m+1} and x_m be the distances of the $(m+1)$ th and mth dark fringes from O.

d = diameter of the wire; L = distance between O and the wire. Then,

$$\frac{t_{m+1}}{x_{m+1}} = \frac{t_m}{x_m} = \frac{d}{L} = \theta$$

$$\therefore \qquad t_{m+1} = \frac{d}{L} x_{m+1}; \quad t_m = \frac{d}{L} x_m$$

Substituting these values in Eq. (3), we get

$$2\frac{d}{L}(x_{m+1} - x_m) = \lambda$$

But $x_{m+1} - x_m = \beta$ = fringe width.

or $$2\frac{d}{L}\beta = \lambda$$

$$\therefore \qquad \beta = \frac{\lambda L}{2d} = \frac{\lambda}{2\theta}$$

d, λ and L are constants. Therefore, fringe width β is constant. Similarly, if we consider two consecutive bright fringes, the fringe width β will be the same.

Experiment to measure the diameter of a thin wire : An air wedge is formed by inserting the wire between two glass plates. Monochromatic light is reflected vertically downwards on to the wedge by the inclined glass plate G (Fig. 2.11). A travelling microscope M with its axis vertical is placed above G. The microscope is focused to get clear dark and bright fringes. The fringe width (β) is measured. The length (L) of the wedge also is measured. Knowing λ, the diameter (d) of the wire is calculated using the formula,

$$d = \frac{\lambda L}{2\beta}.$$

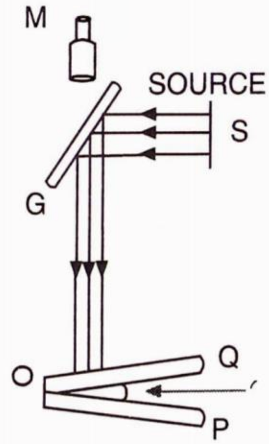

Fig. 2.11.

Testing a surface for planeness : A wedge shaped air film is formed between an optically plane glass plate (OP) and the surface under test (OQ). The fringes will be *straight* if the surface under test is *perfectly plane*. If the surface OQ is not *perfectly plane*, the fringes will be *irregular in shape*. In practice, perfectly plane surfaces are produced by polishing the surfaces and testing them from time to time, until the fringes are straight. In testing for planeness, an extended source of light should be used.

2.9. Determination of Wavelength of Sodium Light by Newton's Rings

Experimental arrangement : Fig. 2.14 shows an experimental arrangement for producing Newton's rings by reflected light. S is an extended source of monochromatic light. The light from S is rendered parallel by a convex lens L_1. These horizontal parallel rays fall on a glass plate G at 45°, and are partly reflected from it. This reflected beam falls normally on the lens L placed on the glass plate PQ. Interference occurs between the rays reflected from the upper and lower surfaces of the film. The interference rings are viewed with a microscope M focused on the air film.

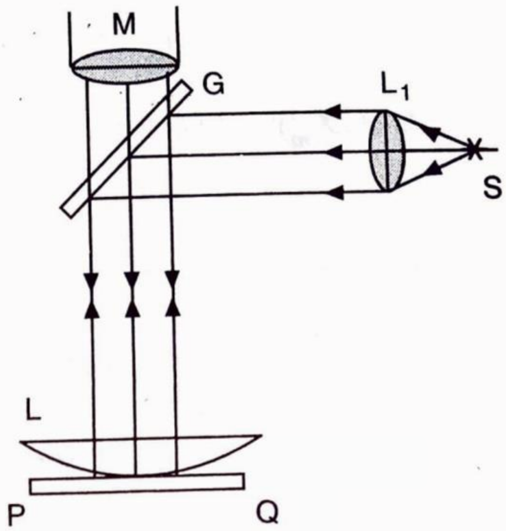

Fig. 2.14.

Procedure : With the help of the travelling microscope the diameters of a number of *dark rings* are measured. The position of the microscope is adjusted to get the centre of Newton's rings at the point of intersection of the cross-wires. The microscope is moved until one cross wire is tangential to the 16th dark ring. The microscope reading is taken. Then the microscope is moved such that the cross-wire is successively tangential to 12th, 8th and 4th dark rings respectively. The readings are noted in each case. Readings corresponding to the same rings are taken on the other side of the centre. The readings are tabulated as follows :

No. of ring	Reading of travelling microscope		Diameter of ring $D = a \sim b$	D^2	$D_m^2 - D_p^2$
	Left (a)	Right (b)			
16					
12					
8					
4					

Average $(D_m^2 - D_p^2) =$

The average value of $(D_m^2 - D_p^2)$ is found.

For an air film $n = 1$.

The diameters of pth and mth dark rings are given by

$$D_p^2 = 4pR\lambda \text{ and } D_m^2 = 4mR\lambda.$$

$$D_m^2 - D_p^2 = 4(m-p)R\lambda$$

$$\therefore \qquad \lambda = \frac{D_m^2 - D_p^2}{4(m-p)R}.$$

The radius of curvature R of the lower surface of the lens is found by Boys' method. Substituting this value of R and the average value of $(D_m^2 - D_p^2)$ with $(m - p) = 8$ in the above equation, λ is calculated.

2.11. Michelson's Interferometer

Principle : Here, the two interfering beams are formed by *division of amplitude*. The amplitude of the light beam from an extended source is divided into two parts of equal intensity by partial reflection and refraction. These beams are sent in two perpendicular directions. The two beams are finally brought together after reflection from plane mirrors to produce interference fringes.

Apparatus : M_1 and M_2 are *front silvered plane mirrors* (Fig. 2.16). The two mirrors are mounted vertically on two arms at right angles to each other. The planes of the mirrors can be slightly tilted with the fine screws at their backs. The mirror M_2 is fixed. The mirror M_1 can be moved parallel to itself by means of a very sensitive micrometer screw. G_1 and G_2 are two plane parallel glass plates of equal thickness. The plate G_1 is semi-silvered on the back side. G_1 is a *beam splitter; i.e.*, a beam incident on G_1 is partially reflected and partially transmitted. G_1 is inclined at an angle of 45° to the incident beam. G_2 is called the *compensating plate*. S is a light source.

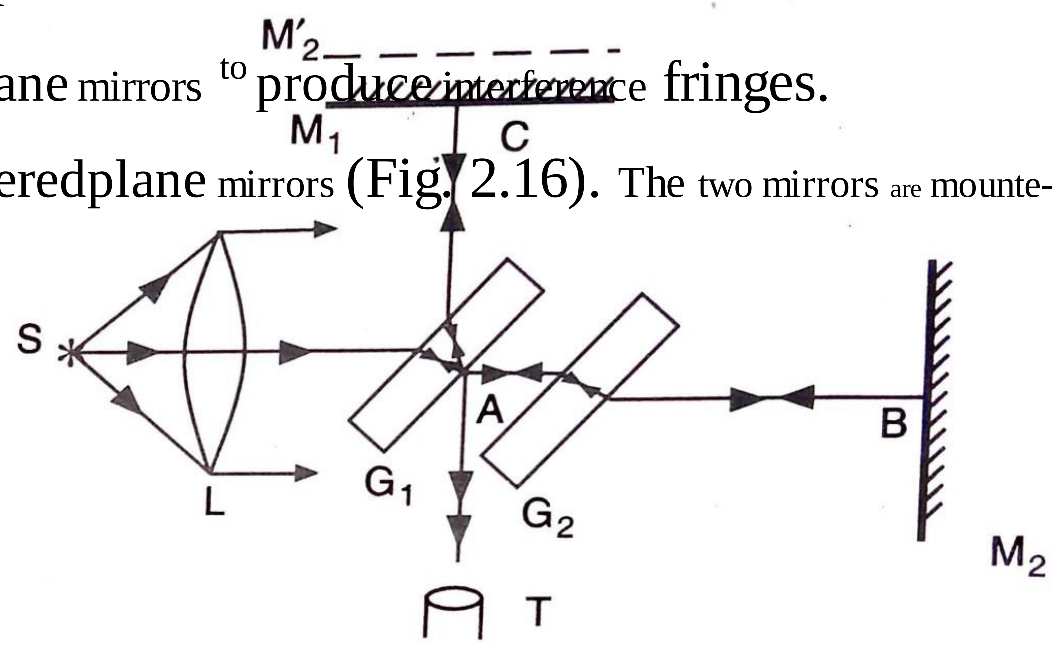

Fig. 2.16.

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tilted with the fine screws at their backs. The M C mirror M, is fixed. The mirror M, can be moved

parallel to itself by means of a very sensitive

micrometer screw. G, and G, are two plane S

parallel glass plates of equal thickness. The

plate G, is semi-silvered on the back side. G B is a beam splitter; i.e., a beam incident on G, G1 G2

is partially reflected and partially transmitted. M2

G, is inclined at an angle of 45° to the incident AT beam. G, is called the compensating plate. S is a light source. Fig. 2.16.

Working : Light from the source S is rendered parallel by a lens L and falls on the glass plate G_1 at an angle of 45°. At the back surface of G_1, it is partly reflected along AC and partly transmitted along AB. The reflected beam moves towards mirror M_1 and falls normally on it. It is reflected back along the same path and emerges out along AT. The transmitted ray AB falls normally on the mirror M_2. It is reflected back along the same path. After reflection at the back surface of G_1, it moves along AT. The two emergent beams have been derived from a single incident beam and are, therefore, *coherent*. The two beams produce interference under suitable conditions.

Function of the compensating plate G_2 : The reflected ray AC passes through G_1 thrice. But the transmitted ray AB passes through G_1 only once. That is why a second plate G_2 of the same thickness and inclination as G_1 is introduced. Thus the function of the plate G_2 is only to equalise the optical paths traversed by both the beams.

Types of Fringes

***(i)* Circular fringes :** Concentric circular fringes are obtained when both the mirrors M_1 and M_2 are mutually perpendicular. The image of M_2 is at M_2' parallel to M_1 (Fig. 2.17). Hence, M_2' and M_1 form the equivalent of a parallel air film. The effective thickness of the air film is varied by moving mirror M_1 parallel to itself. Let the eye or the telescope be set along a direction making an angle r with the normal to M_1.

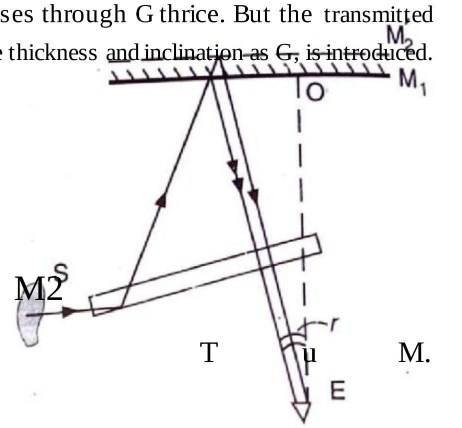

Fig. 2.17.

Then the path difference between the two coherent beams is $2t \cos r$. The condition for a bright ring is $2t \cos r = m\lambda$ where m is an integer.

The condition for a dark ring is

$$2t \cos r = (2m-1)\lambda/2.$$

In either case, r will be constant for given values of t, n and λ. Hence the loci of maxima of intensity will be concentric circles having their centre on the perpendicular from the eye or telescope on M_1. The circular fringes will be situated at infinity. Therefore they can be observed by a telescope focused for infinity. Thus we get *circular fringes of equal inclination* or *Haidinger's fringes*.

If a dark circle appears at the centre of the pattern, the two rays interfere destructively. If the mirror M_1 is then moved by a distance of $\lambda/4$, the path difference changes by $\lambda/2$ (twice the separation between M_1 and M_2'). The two rays will now interfere constructively, giving a bright circle in the middle. As M_1 is moved an additional distance $\lambda/4$, a dark circle will appear once again. Thus, we see that successive dark and bright circles are formed each time M_1 is moved a distance of $\lambda/4$.

***(ii)* Straight fringes :** If M_1 and M_2 are not exactly perpendicular, a wedge shaped air film is formed between M_1 and M_2'. The fringes become practically straight (Fig. 2.18) when M_1 actually intersects M_2' in the middle. The fringes are of equal thickness. The fringes are localized in the airfilm itself. Hence the telescope has to be focused on the film to observe these fringes.

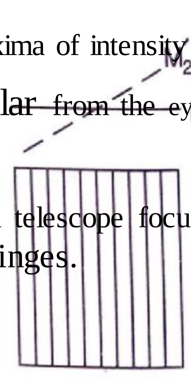

Fig. 2.18.

***(iii)* White light fringes :** If white light is used, the central fringe will be dark and others will be coloured. With white light, fringes are observed only when the path difference is small. These fringes are important because they are used to locate the position of zero path difference.

2.12. Uses of Michelson's Interferometer

1. Determination of wavelength of monochromatic light :

(i) Using monochromatic radiation of unknown wavelength λ, the interf

If a dark cirecle appears at the centre of the pattern, the two rays interfere destructively. If the miror M is thén moved by a distance of W4, the path difference changes by /2 (twice the separation between, and M^). The two rays will now interfere constructively, giving a bright circle in the middle. As M, is moved an additional distance /4, a dark circle will appear once arain. Thus, we see that successive dark and bright circles are formed each time M, is moved a distance of /4.

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2.12. Uses of Michelson's Interferometer

Fig. 2.18.

1. Determination of wavelength of monochromatic light:

() Using monochromatic radiation of unknown wavelength A, the interferometer is adjusted for circular fringes.

(*ii*) With any ring at the centre, the reading of micrometer is noted. Let it be x_1.

(*iii*) Now the mirror M_1 is moved with the help of micrometer screw. The fringes appear to sink or rise due to the change of path difference. Let N fringes move and x_2 be the new reading of the micrometer. When the mirror moves through a distance $\lambda/2$, one fringe shifts. Hence,

$$x_2 - x_1 = x = N\frac{\lambda}{2} \quad \ldots(i)$$

$$\therefore \quad \lambda = \frac{2(x_2 - x_1)}{N} = \frac{2x}{N} \quad \ldots(ii)$$

Example 1: *When the movable mirror of a Michelson interferometer is moved by 0.0589 mm, a shift of 200 fringes is observed. What is the wavelength of light used?*

Solution : When the mirror M_1 is moved through a distance x, the total path difference introduced between the two beams $= 2x$. If N fringes move across the field, then $2x = N\lambda$.

Here, $x = 0.0589$ mm $= 5.89 \times 10^{-5}$ m, $N = 200$; $\lambda = ?$

$$\lambda = \frac{2x}{N} = \frac{2 \times (5.89 \times 10^{-5})}{200} = 5.89 \times 10^{-7} \text{ m} = 589 \text{ nm}.$$

Example 2 : *The initial and final readings of a Michelson interferometer screw are 10.7347 mm and 10.6903 mm as 150 fringes pass. Calculate the wavelength of light used.*

Solution : Here, $x = 10.7347 - 10.6903 = 0.0444$ mm $= 4.44 \times 10^{-5}$ m; $N = 150$;

$$\lambda = \frac{2x}{N} = \frac{2 \times (4.44 \times 10^{-5})}{150} = 5.92 \times 10^{-7} \text{ m} = 592 \text{ nm}.$$

2. Determination of difference in wavelength between two neighbouring lines : Let the source of light emit two close wavelengths λ_1 and λ_2 (like sodium D lines), $\lambda_1 > \lambda_2$. The apparatus is adjusted to form circular rings. Each spectral line produces its own system of rings. We have to consider the superposed fringe-systems. If the bright rings due to λ_1 exactly coincide with bright rings due to λ_2, then the rings are *very distinct* and well defined. This is called *consonance*. If, however, the bright rings due to λ_1 coincide with dark rings due to λ_2, the ring system would disappear producing uniform illumination. This is called *dissonance*. This is the position of maximum *indistinctness*.

Circular rings are formed by adjusting the interferometer using sodium light. The mirror M_1 is gradually moved to obtain dissonance and its position noted. The movement of M_1 is continued in the same direction and successive positions of dissonance are noted. The mean distance x between two successive dissonances is determined. When x is the distance moved by the mirror for two consecutive positions of maximum indistinctness, the path difference is $2x$. During this movement if N fringes are formed of the longer wavelength λ_1 at the centre of the field, then $(N+1)$ will be the number of wavelength λ_2 at the centre. Therefore, for dissonance

$$2x = N\lambda_1 = (N+1)\lambda_2$$

or $$N = \frac{2x}{\lambda_1} \text{ and } (N+1) = \frac{2x}{\lambda_2} \quad \therefore \quad \frac{2x}{\lambda_2} - \frac{2x}{\lambda_1} = 1$$

or $$2x\frac{(\lambda_1 - \lambda_2)}{\lambda_1\lambda_2} = 1. \quad \text{or} \quad \lambda_1 - \lambda_2 = \frac{\lambda_1\lambda_2}{2x}$$

$$d\lambda = \frac{\lambda^2}{2x}$$

Put $\lambda_1 - \lambda_2 = d\lambda$ and $\lambda_1\lambda_2 = \lambda^2$ where λ = mean wavelength.

$d\lambda$ can be Calculated

During this movement if Nis the change in order of the longer wavelength , at the centre of the field, then (N+ 1) will be the change in order of wavelength A at the centre. Therefore, for dissonance

2x M(N+ 1)2

2x

Or N=and (N+1)= or 2A)-l. x or -,

="

Put A-A,= dh. and A,a,=* where = mean wavelength. be Calculätd

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d

The inner surfaces of A and B are *thinly silvered* so as to reflect 80–90% of the incident light.

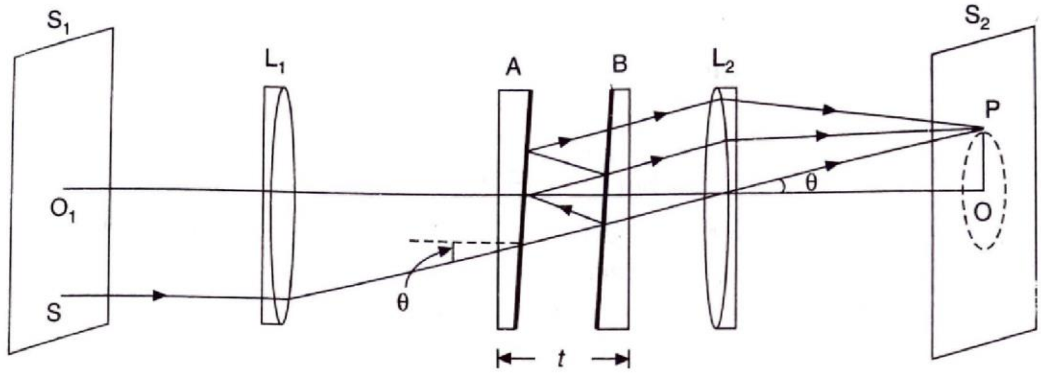

Fig. 2.26

- The plate B facing the observer is fixed. It is provided with screws with which the reflecting surface of B can be made parallel to that of A.
- The plate A is mounted on a carriage. The carriage can be moved in a direction perpendicular to the reflecting surfaces by means of an accurate screw so that the thickness of air film between the coated surfaces of the plates A and B can be varied.
- Light from monochromatic extended source S is rendered parallel by collimating lens.

Working: Monochromatic light from a broad source S_1 is made parallel by the collimating lens L_1. Each parallel ray suffers multiple reflections successively at the two silvered surfaces. At each reflection, a small fraction of light is also transmitted so that each incident ray produces a group of coherent, parallel transmitted rays. There is a constant path difference between any two successive transmitted rays. A telescopic lens L_2 brings these rays to focus at P in its focal plane where they interfere. Thus, the rays from all points of the source produce an interference pattern on a screen S_2 at the *focal plane* of L_2. This is known as ***multiple beam interference***.

2.19. Formation of Circular Fringes

- t is the separation between the plates.
- θ is the inclination of a particular ray with the normal to the silvered surface of A.

For an air film, the optical path difference between two successive transmitted rays corresponding to the incident one is given by

$$\Delta = 2t \cos\theta \quad \text{...(1)}$$

For the maxima, $2t \cos\theta = m\lambda \ (m = 0, 1, 2, ...)$ ...(2)

Here, m is the order of interference and λ is the wavelength of light used.

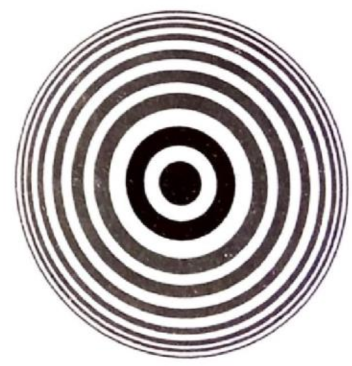

Fig. 2.27.

The locus of points in the source giving rays of constant inclination θ is a *circle*. Thus, with an extended source, *the interference pattern will be a series of bright concentric rings* (Fig. 2.27) *on a dark background*. Each of the rings will correspond to a particular θ-value.

Linear separation of successive order:

$$m = \frac{2t}{\lambda}\cos\theta = \frac{2t}{\lambda}\left(1 - \frac{\theta^2}{2}\right)$$

f is the focal length of the lens L_2.

$\therefore$ Radius of the mth order bright ring is $r_m = f\theta$.

$$\therefore \qquad m = \frac{2t}{\lambda}\left(1 - \frac{\theta^2}{2}\right) = \frac{2t}{\lambda}\left(1 - \frac{r_m^2}{2f^2}\right)$$

$$\Rightarrow \qquad dm = -\frac{2t}{\lambda}\cdot\frac{r_m}{f^2}\,dr$$

Taking $dm = -1$, the change in the radii dr between two successive maxima is

$$\boxed{dr = \frac{\lambda f^2}{2r_m t}} \qquad ...(3)$$

Eq. (3) indicates that *for larger radii, consecutive circles are closer together. Near to the centre, the rings are widely separated but in the outer field rings are closer together.*

The closer the two plates, the broader and more widely separated will be the fringes.

The Fabry Perot fringes arising due to interference of infinite number of light waves of constant inclination to the axis are called *Haidinger fringes*. Path difference of several centimetres may be used without loss of visibility of fringes. Hence very high order of rings may be examined.

Example 1 : *In a Fabry-Perot interferometer, the separation between the plates is 4×10^{-4} cm. Light of wavelength 5000 Å falls normally on the plates. Find the order of the maximum at the centre.* (Nagpur University, 2010)

Solution : In a Fabry Perot interferometer, $2t = m\lambda$.

The order of the maximum at the centre of the interference pattern, is given by

$$m_0 = \frac{2t}{\lambda} = \frac{2\times(4\times10^{-6})}{5000\times10^{-10}} = 16$$

Example 2 : *White light is incident normally on a Fabry-Perot interferometer with plate separation of 4×10^{-6} m. Calculate the wavelengths for which there are interference maxima in the transmitted beam in the range 4000Å to 5000Å.* (Delhi 2006, Kanpur 80)

Solution : For a Fabry-Perot interferometer, the condition of maxima in the transmitted beam is

$$2t\cos\theta = m\lambda,$$

where t is plate separation. For normal incidence $\theta = 0°$, so that

$$2t = m\lambda.$$

$$\therefore \qquad \lambda = \frac{2t}{m} = \frac{2\times(4\times10^{-6})}{m}\ \text{m}$$

For 4000 Å (4×10^{-7} m) wavelength, the order at the centre is

$$m = \frac{2\times(4\times10^{-6})}{4\times10^{-7}} = 20.$$

For 5000 Å, $m = \dfrac{2\times(4\times10^{-6})}{5\times10^{-7}} = 16.$

For intermediate wavelengths, the orders shall be 19, 18 and 17.

The relevant wavelengths that correspond to m = 16 to 20 (16, 17, 18, 19, 20) are:

$$\lambda_1 = \frac{2\times(4\times10^{-6})}{16} = 5\times10^{-7}\ \text{m} = 5000\ \text{Å}$$

$$\lambda_2 = \frac{2\times(4\times10^{-6})}{17} = 4.706\times10^{-7}\ \text{m} = 4706\ \text{Å}$$

$$\lambda_3 = \frac{2\times(4\times10^{-6})}{18} = 4.444\times10^{-7}\ \text{m} = 4444\ \text{Å}$$

$$\lambda_4 = \frac{2\times(4\times10^{-6})}{19} = 4.211\times10^{-7}\ \text{m} = 4211\ \text{Å}$$

$$\lambda_5 = \frac{2\times(4\times10^{-6})}{20} = 4\times10^{-7}\text{ m} = 4000\text{ Å}$$

∴ The required wavelengths are 4000 Å, 4211 Å, 4444 Å, 4706 Å and 5000 Å.

2.20. Determination of Wavelength

- The Fabry-Perot interferometer is adjusted to produce concentric circular fringes of the monochromatic light of wavelength λ, which we have to determine. For this, the reflecting surfaces of A and B must be parallel.
- Let m be the order of bright fringe at the centre of the fringe system. As at the centre $\theta = 0$, we have

$$2t = m\lambda.$$

If the movable plate is moved a distance $\lambda/2$, $2t$ changes by λ. Hence a bright fringe of next order appears at the centre.

- The movable mirror is moved from one position corresponding to micrometer reading, say, x_1, when there is a bright fringe in the centre to another position corresponding to screw reading, say x_2, when there is again a bright fringe in the centre. The number N of bright fringes which cross the centre of field in this process is counted.

∴ $$N\cdot\frac{\lambda}{2} = x_2 - x_1$$

or $$\lambda = \frac{2(x_2 - x_1)}{N}$$

From this relation, we can determine the value of λ.

Example 1 : *A shift of 100 fringes is observed when movable mirror of Fabry-Perot interferometer is shifted through 0.0295 mm. Calculate the wave length of light used.* (P.U. 2005)

Solution : Here, $x_2 - x_1 = 0.0295\text{ mm} = 0.0295\times10^{-3}\text{ m}$; $N = 100$;

∴ $$\lambda = \frac{2(x_2 - x_1)}{N} = \frac{2\times(0.0295\times10^{-3})}{100} = 5900\times10^{-10}\text{ m} = 5900\text{ Å}$$

2.21. Etalon and Interferometer

The F.P. instruments are made of two types.

(*i*) In one type, the *separation between two plates is kept fixed.* **It is called F. P. etalon.** Etalons with definite spacing are available in market. Etalons are supplied with a variety of spacers of lengths ranging from 1 to 200 mm for use in the investigation of hyperfine structure of spectral lines. The *etalon* is now invariably used for research.

Construction: In the *etalon*, two semi-silvered plates are mounted in a framework (Fig. 2.28).

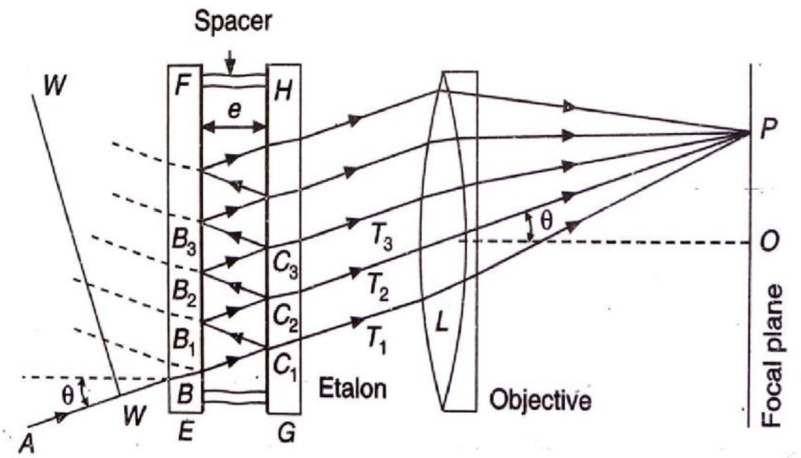

Fig. 2.28.

Their coated faces are kept in constant parallel position, a fixed distance apart, by a fixed spacer. The spacer is commonly a hollow cylinder of invar or silica with three projecting studs at each end. The plates are kept in place slightly pressed against the spacers by the pressure of adjustable springs attached in a proper way to the etalon housing.

e is the separation between the F. P. plates.

Working: Fig. 2.28 shows *formation of multiple reflection fringes by Fabry Perot etalon.* EF and GH are two plane parallel lightly silvered surfaces of the Fabry Perot etalon. Light from a broad source of monochromatic light is incident on the plates at all angles. Consider a plane wave travelling along AB and incident on EF at an angle θ to the normal. The series of parallel transmitted waves C_1T_1, C_2T_2, C_3T_3 ... arise from the same incident wave by its internal multiple partial reflections and refractions between EF and GH. These waves being coherent interfere when brought to a focus at P in the focal plane of an achromatic lens L. *The interference pattern will appear in the form of concentric circles (or rings) where each ring will correspond to one particular value of* θ.

(ii) In 2nd, a screw is provided with either plate by which separation between plates can be attached in a proper way to the etilon housing.

e is the separation between the F. P. plates.

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EF and GH are two plane parallel lightlv incident on surfaces the plates of the at all angles. Consider a plane Wav ave broad source of monochromatic light is the or parallel transmited

travelling along AB and incident arise from on EF the at same an angle incident e to wave normal. by its internal The series

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waves Cl1, C2T2. CT.. coherent interfere when brought to a focus and refractions between EF and GH, These waves being at P in the focal plane of an achromatic lens L. The interference pattern will appear in the form of concentric circles (or rings) where each ring will correspond to one particular value of 0.

(ii) In 2nd, a screw is provided with either plate by which separation between plates can be changed. It is then called F. P. interferometer.

13.3. Interference Filters

Interference filters work on the principle of Fabry-Perot interferometer. When a parallel beam of white light is incident normally on a pair of plane parallel plates silvered on the inner surfaces (just like in Febry-Perot etalon), multiple reflections take place and interference occurs for all the monochromatic components of incident light. Maxima of different orders are formed in the transmitted beam corresponding to wavelengths given by

$$2nt = m\lambda$$

where n is the refractive index of the medium, t is the plate separation and $m = 1, 2, 3, \ldots$

If t is large, a large number of maxima will be observed in the visible region. But when t is reduced considerably, only one or two maxima are observed in the visible region. For example, if $t = 500 \times 10^{-9}$ m and $n = 1$ (for air), the transmitted wavelengths for $m = 1, 2, 3, \ldots$ are 1000 nm, 500 nm, 333.3 nm, ... Out of these only 500 nm lies in the visible region. Thus a particular wavelength can be filtered out of a white light beam. Such an arrangement is known as interference filter.

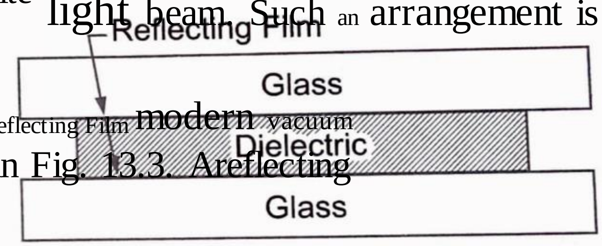

Fig. 13.3.

Interference filters using this principle can be prepared by modern vacuum deposition techniques. The interference filter is shown in Fig. 13.3. A reflecting metal film is first evaporated on a glass plate. Now a thin film of dielectric material (like quartz or MgF_2) is evaporated on the top of reflecting metal film. Further, the dielectric layer is coated with another similar film of reflecting material. Finally, a glass plate is placed over the thin film for protection. Thus a Fabry-Perot structure is formed between the two glass plates. By varying the thickness of the dielectric film, one can filter out any particular wavelength. However, the filtered light will have a finite width, that is, it will have a narrow spectrum sharply peaked about one wavelength. The sharpness of the transmitted spectrum is determined by the reflectivity of the metallic surfaces. The larger the reflectivity, the sharper is the transmitted spectrum. But it is not possible to increase the thickness of metallic films indefinitely as absorption will reduce the intensity of the transmitted light. To overcome this difficulty, metallic films are replaced by all dielectric structures.

In an all-dielectric structure, a $\lambda/4$ thick film of titanium oxide ($n = 2.8$) is deposited on a glass substrate. Then a thin layer of dielectric material with lower refractive index (such as cryolite or a finite width, that is, it will have a narrow spectrum sharply peaked about one wavelength. The sharpness of the transmitted spectrum is determined by the reflectivity of the metallic surfaces. The larger the reflectivity, the narrower is the transmitted spectrum. But it is not possible to increase the thickness of metallic films indefinitely as absorption will reduce the intensity of the transmitted light. To overcome this difficulty, metallic films are replaced by all dielectric structures.

In an all-dielectric structure, a /4 thick film of titanium oxide (n =2.8) is deposited on a glass Substrate. Then a thin layer of dielectric material with lower refractive index (such as cryolite or trouble of overheating.

magnésium fuoride) is deposited. On this is again deposited a /4 thick layer of a material of higher refractive itndex. To increase the reflectivity, multilayer structures of alternate higher and lower refractive index materials are used. In this way, it is possible to achieve a reflectivity of more than 90% for any particular wavelength. Such filters are capable of transmitting over a bandwidth as small as 1.1 nm or even less with peak at any wavelength within the visible region.

Interference filters are used in spectroscopic work for studying the spectra in a narrow range of wavelengths. Furthermore, such filters absorb practically no energy and so they are free from the trouble of overheating.