(PO2-5) Interference in Air Wedge

Aim of experiment

Determination of thickness of a paper sheet and angle of air wedge

Apparatus

2 Microscope Glass Slides, Monochromatic Light Source; Sodium Lamp, Traveling Microscope, Sheet of Paper, Convex Lens

Theory of experiment

A small air wedge is formed with the help of two microscope slides kept in contact at one edge and separated by a sheet of paper at the other. A parallel beam of monochromatic rays is made normally incident on the upper plate.

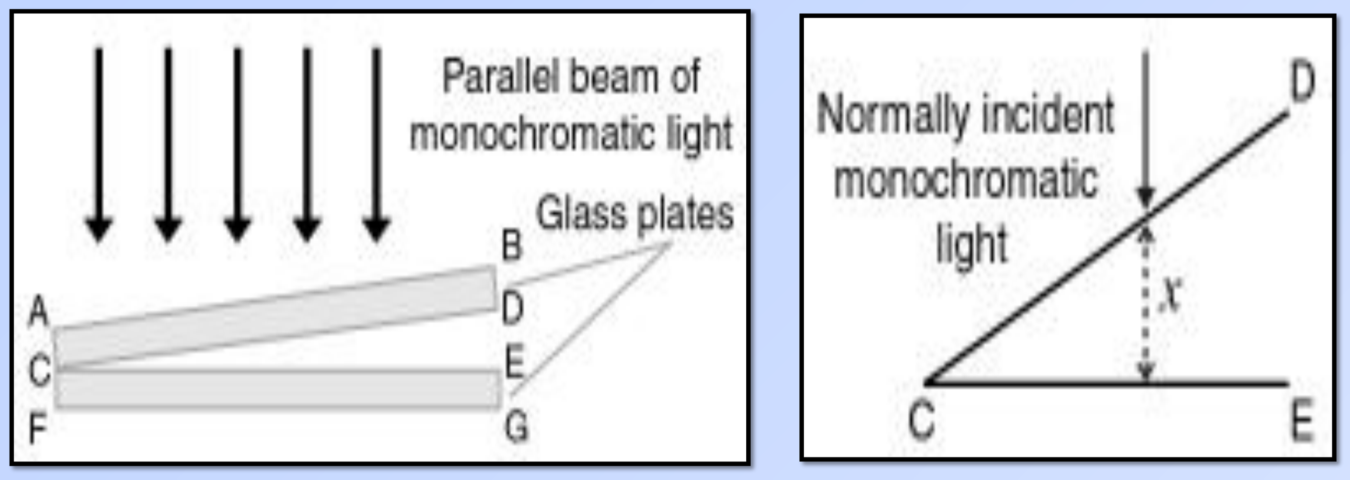

Figure 1. An air wedge geometry

From each incident ray there will normally be four reflected rays from the surfaces AB, CD, CE and FG. The rays reflected from the surfaces AB may be eliminated by coating the surface with a transparent medium of correct thickness. Rays reflected from FG are eliminated by blackening the surface.

The two rays reflected from the surfaces CD and CE travel unequal paths. If x is the thickness of the air film, then the geometric path difference between the two rays is 2x and the effective difference between them due to phase change at the surface CE is given by

$$2x+\frac{\lambda}{2}$$

This is a variable quantity since the thickness x varies. If this path difference is a whole number of wavelengths at a particular value of x, then a bright fringe will be visible at that thickness due to constructive interference. If this path difference is half a wavelength more (or less) than a whole number of wavelengths then there will be darkness at that thickness due to destructive interference. The conditions for interference are therefore:

$$Constructive\quad : 2x+\frac{\lambda}{2}=n\lambda$$

$$Or\qquad 2x=(n-\frac{1}{2})\lambda$$

$$Destructive\quad : 2x+\frac{\lambda}{2}=n\lambda+\frac{\lambda}{2}$$

$$Or\qquad 2x=n\lambda$$

As the film is wedge shaped, its thickness x varies from point to point, *figure 2*, increasing continuously from the end C to the end D of the film. This change of thickness gives rise to alternate bands of brightness and darkness when the upper plate is viewed. At the edge C, the extra path actually traversed by the ray reflected from the surface CE is zero. But there is a phase reversal incurred at reflection for this ray. The ray reflected from the upper surface CD of the air wedge incurs no such phase reversal. Thus the two rays arising out of the same incident ray differ in phase by half a cycle. A dark fringe occurs here due to destructive interference between the rays. This is the zeroth dark fringe.

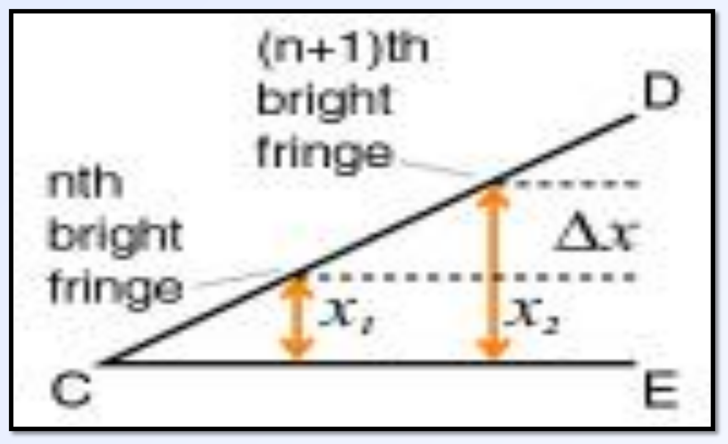

Figure 2. The thickness x of wedge shaped varies from point to point,

Where the thickness $x_1 = \lambda/4$, the effective path difference is given by

$$x_{eff}= 2\,\lambda/4 + \lambda/2= 1\,\lambda$$

At every point having this thickness x_1 therefore, there will be constructive interference producing the first bright fringe. Similarly, there will be bright fringes at thicknesses 3 λ/4, 5 λ/4, 7 λ/4 etc. Note that the difference Δx in film thickness between two successive fringes of the same type is given by Δ x = λ/2

Each bright fringe consistently follows a particular thickness of the air film. Thus if the two plates are of smooth surface, the fringes are straight lines parallel to the line of contact of the plates. If the plates are not smooth then the lines are irregular, *figure 3*, each line being the locus of all points having the same thickness of air film between the plates.

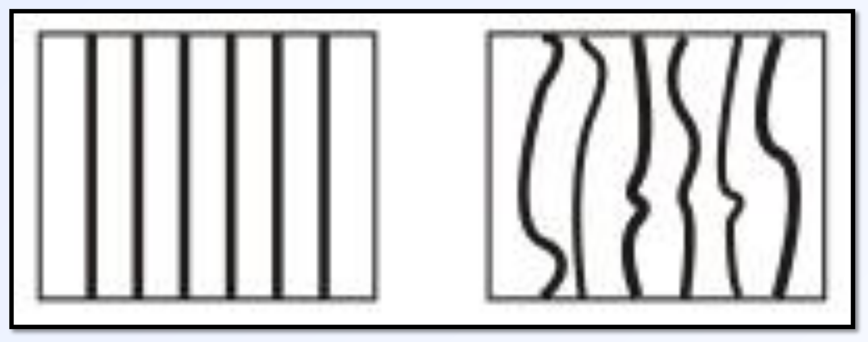

Figure 3 . Regular And irregular fringes

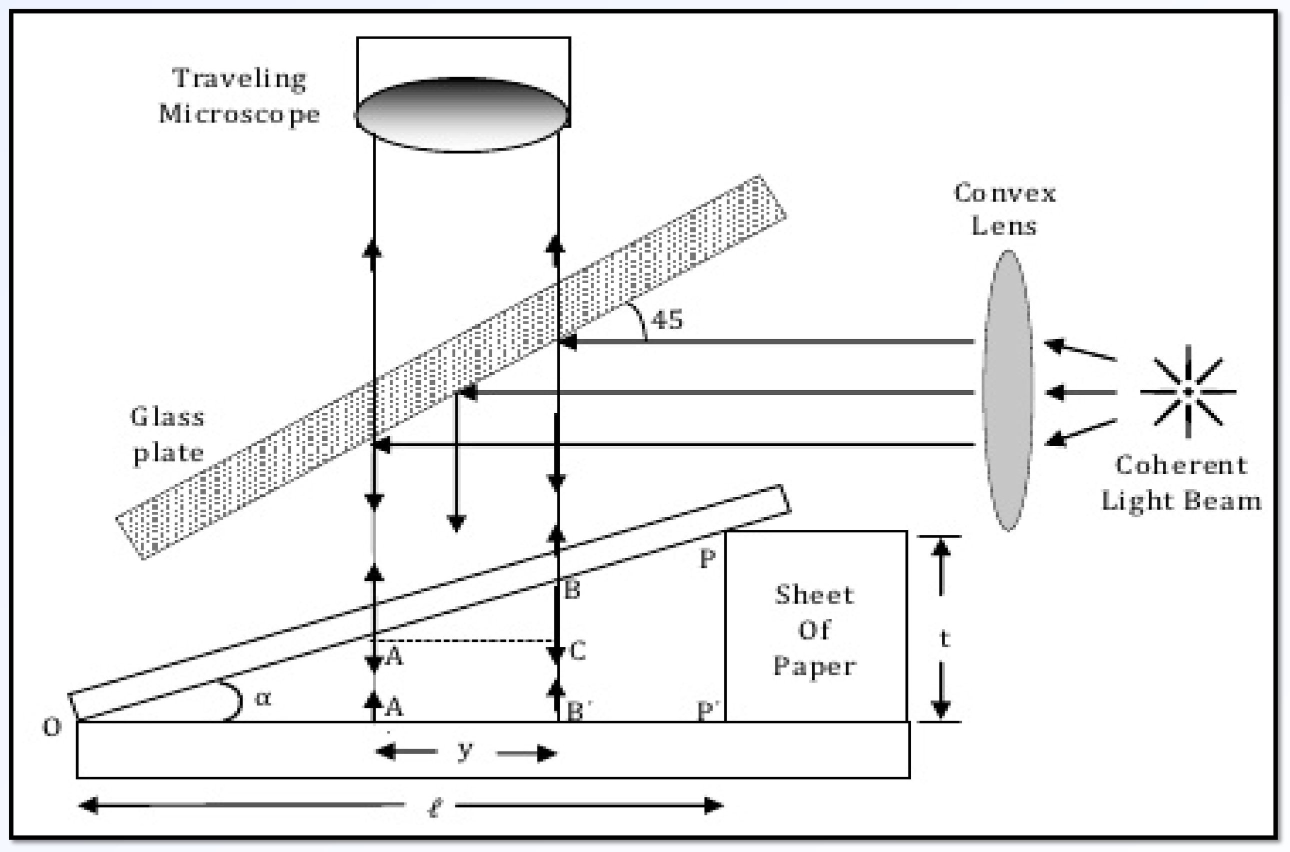

Figure4. Experimental set- up for air wedge interference

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(PO2-4)Newton's Rings

Over a distance *d*, the change in thickness of the wedge is *d tan* α, where α is the angle of the wedge. Calculate the value of *tan* α from the equation

$$x = n\Delta x = n\lambda/2 = d \tan \alpha$$

where n is the number of dark fringes, and λ is the wavelength Calculate the thickness of the foil *t* from the equation:

$$t = l \tan \alpha = \ldots.mm$$

where l *is the wedge length*

Procedure

1. Thoroughly clean the glass blocks G, H, and place them together with a small slip of tin foil or paper, T, under one end. Arrange the sodium lamp F beside the block, and focus the traveling microscope on the upper surface of G, *figure 4.*
2. Introduce the glass plate P, and alter its position and angle so that the field of view is as bright as possible. Adjust the focus of the microscope so that fringes are visible; they should be straight lines perpendicular to the length of the air film.
3. Turn the microscope stand until the direction of traverse of the microscope is along the air film, and set the crosswire on a dark fringe near one end; read the vernier.
3. Repeat step 4 and 5 two more times.
4. Plot the relation between *d* and *N* from its slope produce the angle of air wedge and then the paper thickness.
5. Traverse the microscope along the air film, for 1 mm counting the number of dark fringes, *n.*
6. Continue counting next 1mm traverse the microscope along the air film and so on till travese 1cm.

Results

1^{st}vernier reading =

Distance *d* *cm*	No. of fringes			
	Trial 1	Trial 2	Trial 3	$n_{av} \pm \Delta n$

λ= 589.617 nm

Length of air film, l = 30 mm

Slope=

α=

T=

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