Interference on thin film

Lecture 6

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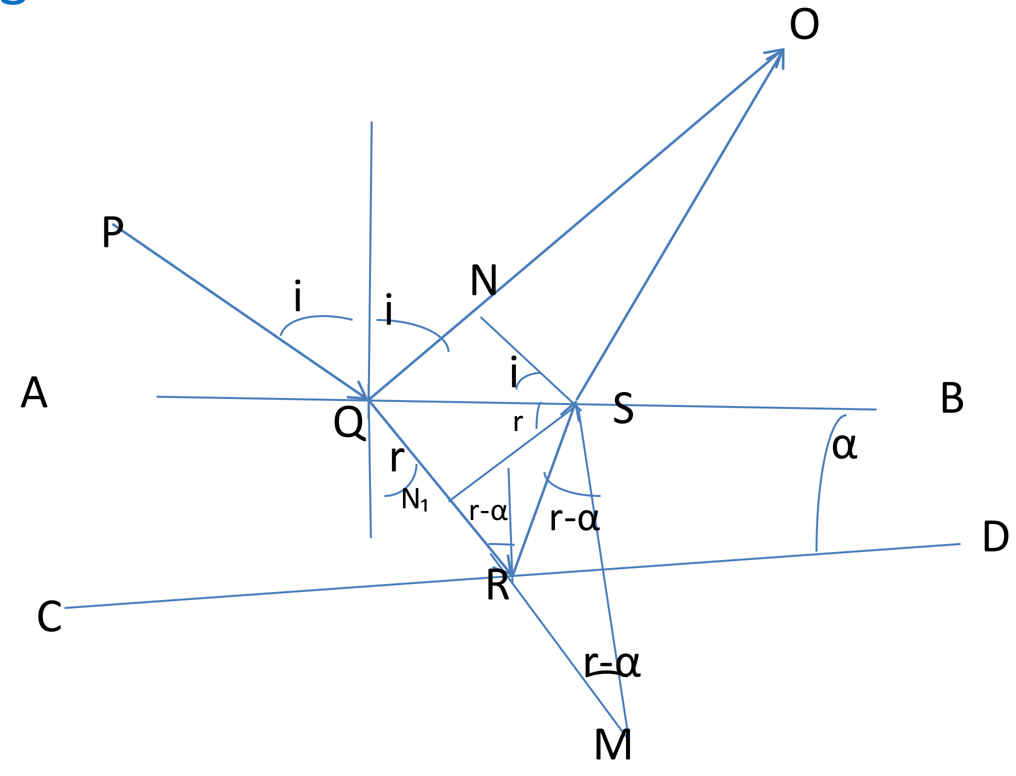
Interference on thin film (for reflected system):

ABCD is a wedge shaped film enclosing an angle α. PQ is a monochromatic light of wave length λ. i is the angle of incident and r angle of refraction inside the thin film . r-α is the angle of incidence for the 2nd surface.



The reflected light from surface AB and CD ultimately meet at point O . The intensity at point O depends on the path difference between the two light rays.

If n be the refractive index of the film then path difference

$$l = n\,(QN_1 + N_1R + RS) - QN \quad \ldots\ldots\ldots\ldots\ldots(1)$$

From the geometry RS=RM and SL =LM= d (d thickness of the film at point S)

Now from Snell's law $n = \sin i / \sin r = \frac{QN/QS}{QN_1/QS}$

$$QN = n.QN_1$$

Putting the value of QN in equation 1 we get

$$l = n\,(N_1R + RS)$$

$$= n\,(N_1R + RM) = n.\,N_1M$$

$$= n.\,2d\cos(r-\alpha) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Since the light ray suffering reflection from the surface 1 backed by denser medium it suffers a phase difference π and corresponding path difference λ/2 hence total path difference between the two interfering wave is

$$l = 2nd\cos(r-\alpha) + \lambda/2$$

Conditions for maxima and minima:

We know that the condition for **bright fringe** at O

$$2nd\cos(r-\alpha) + \lambda/2 = \text{even multiple of } \lambda/2$$

$$2nd\cos(r-\alpha) = \text{odd multiple of } \lambda/2 = (2m+1)\lambda/2$$

where m = 0,1,2,3………

Similarly for **dark fringe**

$$2nd\cos(r-\alpha) = \text{even multiple of } \lambda/2$$

$$= (2m)\lambda/2$$

Note that for a parallel film $\alpha = 0$

Fringes with monochromatic light :

Since n ,r, α, λ are constants so order no of bright and dark fringe only depend on the value of d. Where d is practically zero, the path difference between the two rays is λ/2. Hence we get dark fringe there.

If the film is extremely thin then d= 0 for the whole film, then the film surface will be perfectly dark even for white light also.

If α =0, then for oblique incidence film surface will be dark bright and dark according as the value of angle r . If a parallel beam incident normally on the film , then the whole surface will be bright or dark depending upon the value of d.

Fringes with white light :

For parallel beam of white light the value of n,λ, r are different for different colours . Where d is practically zero we get dark fringe for all colours for the path difference λ/2. Since λ for violet light is smaller than the red light the first order bright fringe will be formed at a smaller thickness than the red colour. Thus we get coloured fringes at different thickness.

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