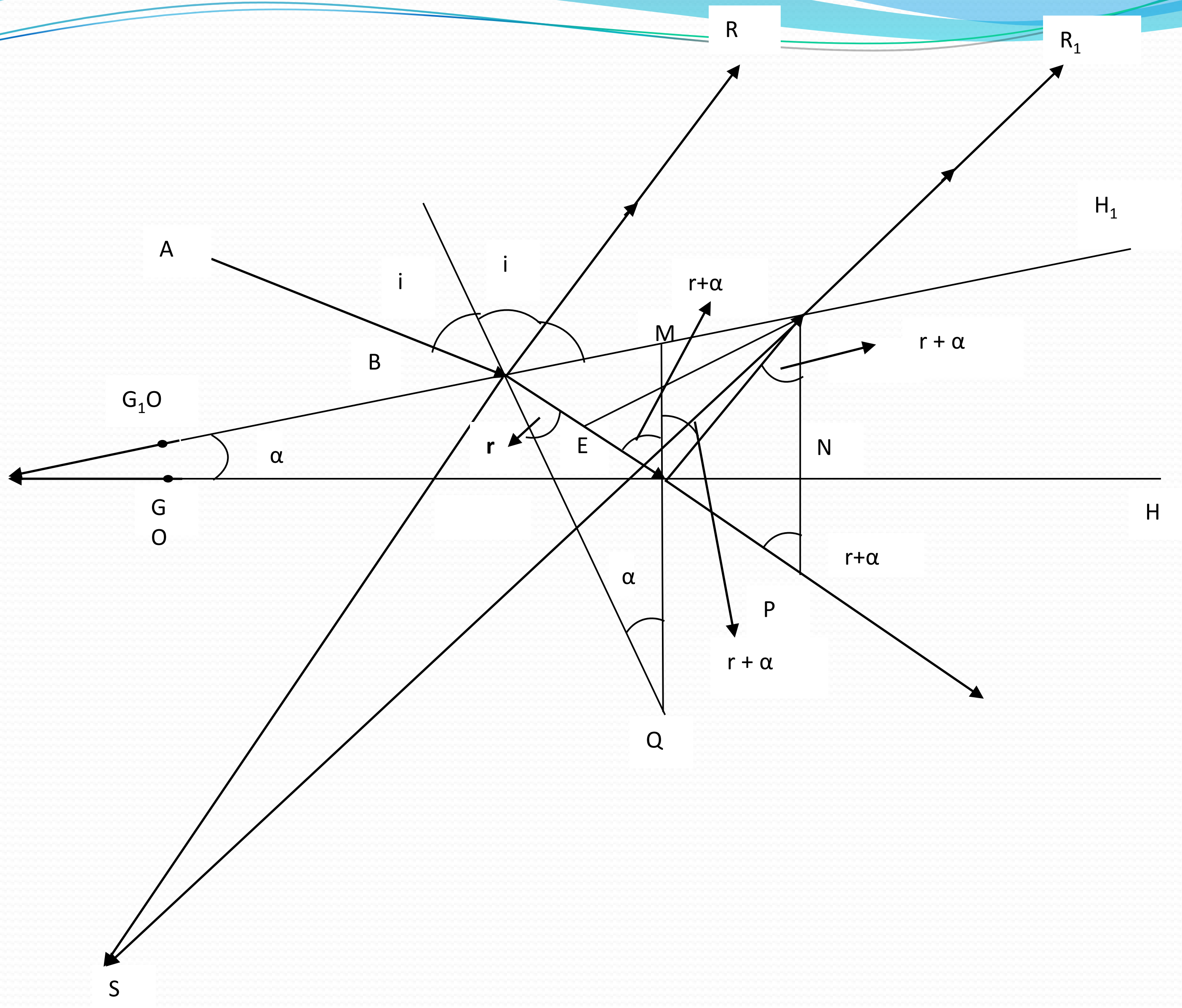
INTERFERENCE ON WEDGE SHAPE FILM

- Introduction.
- Path Difference.
- Condition for maxima and minima.

Consider two plane glass surfaces **GH** and $\mathbf{G_1H_1}$, both are inclined at angle at an angle **(α),** so that air film of increasing thickness is formed between both of two surfaces. Let **(μ)** be the refractive index of the material film. Interference in wedge shape film can be studied only when this film is illuminated by source of monochromatic light. Suppose a beam of monochromatic light AB incident at an angle **(i)** at a point (B) on the upper surface $\mathbf{G_1H_1}$ .Then a part of this light will be reflected in the direction **BR** and a part of this light be refracted in a direction **BC,** this refracted ray will be incident at an angle **(r+ α)** at a point **(C).** Then a part of this refracted will be reflected at the denser surface in the direction **CD** and comes out in the form of ray $\mathbf{DR_1}$**.** Our aim is to be study interference between two reflected ray **BR** and $\mathbf{DR_1}$**.** From the fig. it is observed that ray **BR** and $\mathbf{DR_1}$ are not parallel so that they appear to diverge from a point **(S)** means interference take place at **S** which is virtual. So that intensity at a point **S** is maximum or minimum depend upon the path difference between the two reflected ray **BR** and $\mathbf{DR_1}$ that is

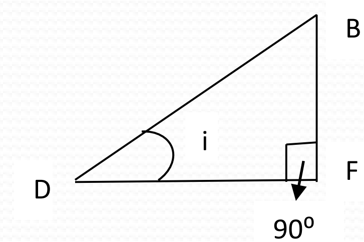


R
R1
H1
A
i
i
r+α
M
B
r + α
G1O
r
E
N
α
G
O
H
α
r+α
P
r + α
Q
S

$$(BC + CD)\mu - BF(\mu = 1) - - - - - - - - - - - - - -(1)$$

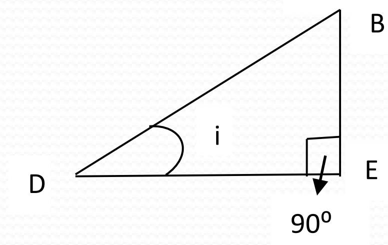
First of all find out value of **BF**,

We know $\mu = \frac{\sin i}{\sin r}$, calculate value of $\sin i$ and $\sin r$



Take right angle triangle DFB $\sin i = \frac{BF}{BD}$

Similarly find out value of $\sin r$ by taking Right angle triangle **DEB** (by draw perpendicular from the point from the point **D** on the ray **BC**) $\sin r = \frac{BE}{BD}$



Putting value of we get value of μ

$$\mu = \frac{\sin i}{\sin r} = \frac{\frac{BF}{BD}}{\frac{BE}{BD}} = \frac{BF}{BD} x \frac{BD}{BE} = \frac{BF}{BE} \quad or\ BF = \mu BE$$

Putting value of **BF** in equation (1) we get

$$(BC + CD)\mu - \mu BE = \mu(BC + CD - BE) - - - - - - - - - - - - -(2)$$

From the fig (1.2) value of **BC** can be written as $BC = BE + EC$ putting value BC in equation (2) we get

$$\mu(BC + CD - BE) = \mu(BE + EC + CD - BE) = \mu(EC + CD) - - - -(3)$$

First of all find out angle of incidence of refracted ray at a point **C** on the surface **GH** by taking the right angle triangle **OMC** In fig (1.2.) that $\angle MCD = 90^0$ & $\angle MOC = \alpha$ then $\angle OMC = 90^0 - C$,consider the triangle **BQM** in that $\angle B = 90^0 \,\&\, \angle M = 90^0 - \alpha \;\; then \; \angle Q = 180^0 - (90^0 + 90^0 - \alpha) = \alpha$

Consider the triangle BQC in that $\angle B = 90^0 \;\&\; \angle Q = \alpha \;\; then \; \angle C = r + \alpha$ Consider the triangle **DNC** in that

Consider the triangle **DNC** in that $\angle N = 90^0 \;\&\; \angle C = 90^0 - r + \alpha \;\; then \; \angle D = r + \alpha$ Consider the triangle **DPC** in that $\angle C = 180^0 - 2(r + \alpha) \;\&\; \angle D = r + \alpha \;\; then \; \angle P = r + \alpha$

Consider the triangle **DNC** and **PNC** in both of them $\angle D = \angle P$, $\angle N = \angle N$and $NC = common\; base\; in\; both\; them$

When two angle and one side is common then such type of triangle **(AAS)** is congruent triangle thus in these triangle

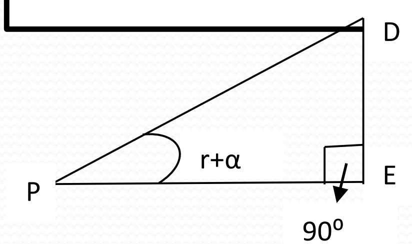
$DN = NP \;\&\; CD = CP \; and \; NC = common$

Thus value of can be written in equation (3) we get

$$\mu(EC + CD) = \mu(EC + CP) = \mu(EP) - - - - - - - - - - - - - (4)$$

$$\cos(r + \alpha) = \frac{PE}{PD} = \frac{PE}{2t}$$

Value of EP can be finding out by taking right angle triangle **DEP**



Putting value of EP in equation (4) we get Path-difference between two reflected rays will be

$$2\mu t \cos(r + \alpha) - - - - - - - - - - - - - - - (5)$$

But according to principle of reversibility when wave reflected from the surface of optically denser medium then it suffer a phase change of **π** if phase change **π** occurs then path-difference $\frac{\lambda}{2}$ introduce in it. Thus total path-difference between two reflected rays will be: $2\mu t\cos(r+\alpha)+\frac{\lambda}{2}$ ------------------ (6)

So intensity ay a point S will be maximum only when path difference between the two reflected rays will be equal to **nλ.** Thus

$$2\mu t\cos(r+\alpha)+\frac{\lambda}{2}=n\lambda \quad where\ n=1,2,3,4,5 \text{ --------}$$

So intensity ay a point S will be mini-mum only when path difference between the two reflected rays will be equal to $(2\boldsymbol{n}+\mathbf{1})\frac{\lambda}{2}$ Thus

$$2\mu t\cos(r+\alpha)+\frac{\lambda}{2}=(2\boldsymbol{n}+\mathbf{1})\frac{\lambda}{2} \quad where\ n=1,2,3,4,5 \text{ -----}$$