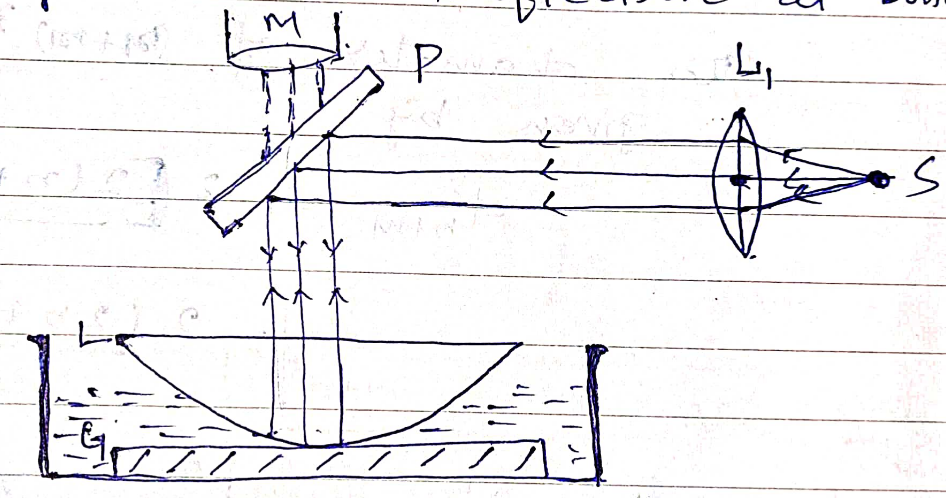
Determination of Refractive index of a liquid :

The experimental liquid is introduced between the lens and the glass plate P. The light is made to fall normally on the liquid film. Newton's rings are formed by the interference between rays reflected from the top and bottom face of liquid film. A phase change of π occurs between the two rays due to reflection at bottom.



The path difference becomes

$$\Delta = 2\mu t \cos r + \lambda/2$$

Here $r = 0^\circ$

Then $\Delta = 2\mu t + \lambda/2$

For n^{th} bright ring,

$$2\mu t + \lambda/2 = n\lambda$$

or $$2\mu t = n\lambda - \lambda/2$$

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or, $2\mu t = \frac{(2n\lambda - \lambda)}{2} = \frac{(2n-1)\lambda}{2}$

or $2t = \frac{(2n-1)\lambda}{2\mu}$

~~But~~ But we have $2t = \frac{d_n^2}{4R}$

$\therefore \frac{d_n^2}{4R} = \frac{(2n-1)\lambda}{2\mu}$

or $d_n^2 = \frac{{}^{2}\cancel{4}R(2n-1)\lambda}{\cancel{2}\mu}$

or $d_n^2 = \frac{2(2n-1)\lambda R}{\mu}$

The diameter of $(n+m)$th ring is then given by

$$d_{n+m}^2 = \frac{2[2(n+m)-1]\lambda R}{\mu}$$

$$= \frac{2(2n+2m-1)}{\mu}\lambda R$$

$$\therefore d_{n+m}^2 - d_n^2 = \frac{2(2n+2m-1)\lambda R}{\mu} - \frac{2(2n-1)\lambda R}{\mu}$$

$$= 2\frac{[2n+2m-1-(2n-1)]}{\mu}\lambda R$$

$$= 2\frac{[\cancel{2n}+2m-\cancel{1}-\cancel{2n}+\cancel{1}]}{\mu}\lambda R$$

$$= 2\times\frac{2m}{\mu}\lambda R$$

or $d_{n+m}^2 - d_n^2 = \frac{4m\lambda R}{\mu}$ —— (1)

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$\because \mu = 1$

For air films

then $(d_{n+m}^2 - d_n^2)_{air} = 4 m \lambda R$ —— (2)

Dividing eqn (2) by eqn (1)

we get

$$\frac{(d_{n+m}^2 - d_n^2)_{air}}{(d_{n+m}^2 - d_n^2)_{liquid}} = \frac{4 m \lambda R}{\frac{4 m \lambda R}{\mu}}$$

$$= \frac{\cancel{4 m \lambda R} \times \mu}{\cancel{4 m \lambda R}}$$

$$= \mu$$

or $\mu = \frac{(d_{n+m}^2 - d_n^2)_{air}}{(d_{n+m}^2 - d_n^2)_{liquid}}$ —— (3)

Hence μ can be calculated by measuring the diameters of the Newton's Ring in the liquid and air.

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