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# Mean Free Path Lec -03

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$$= \quad 16\pi^3 a^6 \, (I_1 + I_2)$$

Where $I_1 = \int_0^\infty c_1^{\,2} \; c_1^2 \, dc_1 \int_0^{c_1} 3\, c_1^2 + c_2^2 \; / \, 3\, c_1 \; e^{-bc_2^2} \; c_2^2 \, dc_2$

$I_2 \quad = \int_0^\infty c_1^{\,2} \quad e^{-bc_1^2} \; c_1^2 \, dc_1 \int_{c_1}^\infty 3\, c_2^2 + c_1^2 \; / \, 3\, c_2 \; e^{-bc_2^2} \; c_2^2 \, dc_2$

$I_1 = I_2 = 1/8\sqrt{2}\,(\pi/b^7)^{1/2}$ and $a = \sqrt{b/\pi}$

$\therefore \quad r = c\sqrt{2}$

So, $c/r = 1/\sqrt{2}$

$\therefore \quad \lambda = 1/\sqrt{2}n\,\pi d^2 \quad (8)$

## Experimental determination of mean free path :

For the determination of mean freepath Max Born employed the apparatus shown in fig .

When silver S is heated . The evaporated silver passes through a narrow slit $P_1$,

$P_2$ ,$P_3$ and $P_4$ . The discs are cooled by liquid air or cooling mixture . The discs are placed one above the other and at a distance 1cm and carry a glass quadrant on which silver atoms are deposited on cooling . The arrangement is such that it receives $1/4^{th}$ of the incident beam . The gas is pumped off from the tube such that the free path is equal to the length of the chamber.

According to the law of distribution of free paths

We have , $d_1 = d_{10} e^{-x}{}_1 / \lambda$ (1)

Where $x_1$ is the distance of the plate from the slit B , $d_{10}$ is the density deposited on the plate on $P_1$ , $d_1$ is the density deposited on the upper plate at the same time .

For the 2nd plate , $d_2 = d_{20} e^{-x}{}_2 / \lambda$ (2)

From (1) and (2) ,we get

$$d_1 / d_2 = d_{10} / d_{20} \; e^{-x_1} / \lambda \; e^{+x_2} / \lambda$$

$$d_1 / d_2 \times d_{20} / d_{10} = e^{x_2 - x_1} / \lambda$$

or , $\log d_1 / d_2 \times d_{20} / d_{10} = x_2 - x_1 / \lambda$

$$\lambda = x_2 - x_1 / \log d_1 / d_2 \times d_{20} / d_{10} \qquad (3)$$

In the apparatus , $x_2 - x_1 = 1$ cm , $\lambda = 1.9$ cm . $p = 5.8 \times 10^{-3}$ mm

In both the cases $p\lambda$ comes out to be the same as predicted by the theory .