Half Period Zones
(Optics)

e-content for B.Sc Physics (Honours)

B.Sc Part-II
Paper-III

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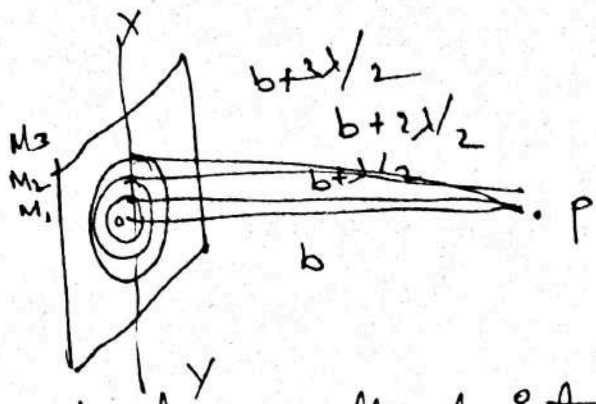
Fresnel's Half period Zones. Consider a plane wave front. To determine field at an arbitrary point P due to disturbances reaching from different portions of the wave front we drop perpendicular PO on wave front.

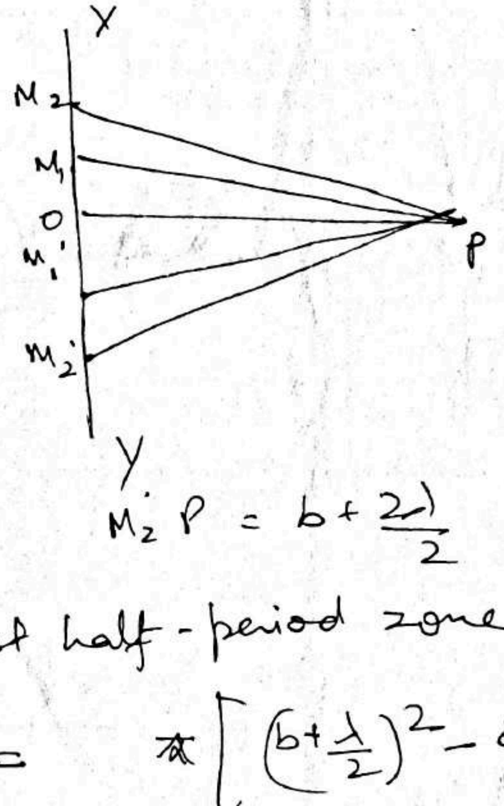


Taking P as center we draw spheres of radii $b+\lambda/2$, $b+2\lambda/2$, $b+3\lambda/2$ ... these spheres intersect the wave front in circles.

To find resultant intensity at P.

Each zone differs from its neighbouring zone by a path diff of $\lambda/2$ & phase diff of π.

These circular zones are called half period zones or half period elements.



$M_1P = b+\lambda/2 \qquad M_2P = b + \frac{2\lambda}{2}$ ...

area of first half-period zone

$$\pi OM_1^2 = \pi\left[\left(b+\frac{\lambda}{2}\right)^2 - b^2\right]$$

$$= \pi b\lambda. \qquad \lambda^2 \text{ neglected}$$

$$\therefore r_1 = \sqrt{b\lambda}$$

$$OM_2 = \sqrt{(b+\lambda)^2 - b^2}$$

$r_2 = \sqrt{2b\lambda}$. similarly radius of n^{th} circle $= \sqrt{nb\lambda}$

area of second half period zone $= \pi b\lambda$.

observe that area of each zone is $\pi b\lambda$.

$m_1, m_2 \ldots$ represent amplitudes of vibration of the other particles at P due to secondary waves from 1, 2, 3 etc half period zones.

$m_1 > m_2 > m_3 \ldots$ as obliquity increases

odd → +ve then even −ve due to phase diff of π.

∴ the amplitude of vibration at P due to any zone can be approx taken as mean of amp due to prec & succ. zone.

$$\therefore m_2 = \frac{m_1 + m_3}{2}$$

resultant

$$\therefore A = m_1 - m_2 + m_3 - m_4 + \ldots \pm m_n \text{ if } n \text{ is odd}.$$

$$\therefore A = \frac{m_1}{2} + \left[\frac{m_1}{2} - m_2 + \frac{m_3}{2}\right] + \left[\frac{m_3}{2} - m_4 + \frac{m_5}{2}\right] + \ldots$$

$$\therefore A = \frac{m_1}{2} + \frac{m_n}{2} \text{ if } n \text{ is odd}$$

$$\therefore A = \frac{m_1}{2} + \frac{m_{n-1}}{2} - m_n \text{ if } n \text{ is even}.$$

$n \to \infty$.

$$\therefore A = \frac{m_1}{2}.$$

$$I \propto \frac{m_1^2}{4}.$$

i.e only half the area of first half period zone ~~placed~~ is effective in producing illumination at P.

if a obstacle of half the area. placed at O it will screen the effect & I at P will be zero.