Zone Plate
(Optics)

e-content for B.Sc Physics (Honours)

B.Sc Part-II
Paper-III

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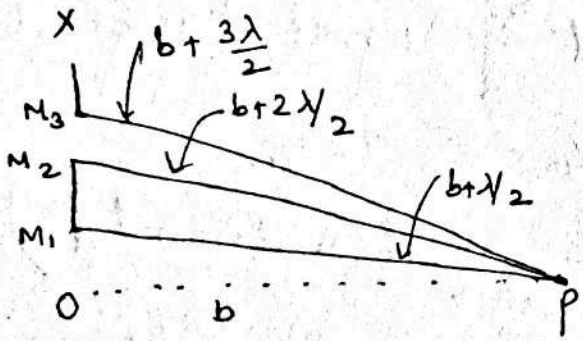
Zone Plates.

A zone plate is a specially constructed screen such that light is obstructed from every alternate zone. It is designed so as to cut off light due to the even numbered zones or that due to the odd numbered zones.

Concentric circles are drawn on white paper such that the radii are proportional to the square roots of natural nos. The odd numbered zones (1^{st}, 3^{rd}, 5^{th} etc) are covered with black ink and a reduced photograph is taken.



When such a plate is held perpendicular to an incident beam of light & a screen is moved on the other side to get the image, it will be observed that maximum brightness is possible at some position of the screen say b cm from zone plate.

Let XO be the upper half of the incident plane wavefront. P is the point at which the light intensity is to be considered.

$OM_1 = r_1$ & $OM_2 = r_2$

$r_1 = \sqrt{b\lambda}$, $r_2 = \sqrt{2b\lambda}$

$r_n = \sqrt{nb\lambda}$

$\Rightarrow b = \frac{r_n^2}{n\lambda}$

If a source is at a large distance from the zone plate As the distance of the source is large, the incident wavefront can be taken as a plane one w.r.t small area of the zone plate.

$$f_n = b = \frac{r_n^2}{n\lambda}$$

Hence a zone plate has different foci for different wavelengths.

When the even numbered zones are opaque, the intensity at P is much greater than that when the whole wavefront is exposed to the point P.

then

$$A = m_1 + m_3 + m_5 + \ldots + m_n \ldots (n \text{ is odd})$$

when whole wavefront is unobstructed.

$$A = m_1 - m_2 + m_3 - m_4 - \ldots + m_n$$

$$= \frac{m_1}{2} \quad (\text{if } n \text{ is large and } n \text{ is odd})$$

When white light is incident on zone plate, different colours come to focus at different points along the line OP.

The f" of a zone plate is similar to that of a convex lens. ~~and a focmula~~