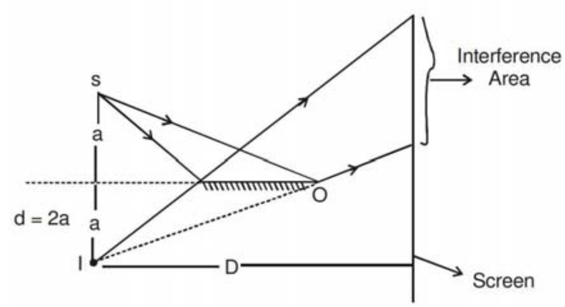
INTEREFERENCE OF WHITE LIGHT IN YDSE, LLOYD'S MIRROR AND FRESENEL'S BIPRISM

White light in YDSE

- If we drop white light in YDSE setup then there will be only one point on the entire screen where a white spot will be formed.
- If we move above the central maxima then the first maxima will be of violet and the first minima will also be of violet
- The point on the screen, where the minima of violet light is formed, at that point, the intensity of red light is maximum.
- This is because the intensity of violet light decreases at the fastest rate while the intensity of red light decreases at the slowest rate.
- Red color will appear first after central maxima.

LLOYD'S Mirror

In this experiment, the light reflected from a long mirror and the light directly from the source, without reflection, create interference on a screen, behaving like coherent sources.



A significant aspect of this experiment is that when the screen touches the end of the mirror, the edge of the mirror's reflecting surface falls at the center of a dark fringe instead of a bright one. The direct beam doesn't experience any phase change, indicating that the reflected beam undergoes a phase change of π radians.

Hence at any point P on the screen the condition for minima & maxima are

$$S_2P - S_1P = n\lambda \text{[For minima]}$$

$$S_2P - S_1P = \left(n + \frac{\lambda}{2}\right)\lambda \text{ [For maxima]}$$

Ex 9 In Lloyd's interference experiment, 10 fringes occupy a space of 1.5 mm. The distance between the source and the screen is 1.25 m. If light of wavelength 6000 Å is used, find the distance of the source from the plane minor.

Sol. Here $\beta = \frac{1.5}{10}$ mm $= 0.15 \times 10^{-3}$ m

$D = 1.25$ m, $\lambda = 600$ Å $= 6 \times 10^{-7}$ m

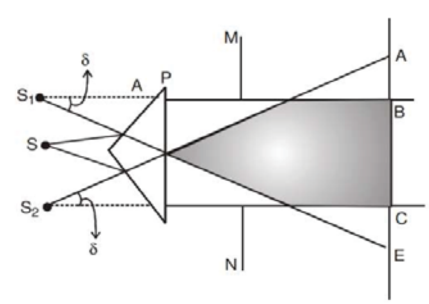
As $\beta = \frac{D\lambda}{d}$

$\therefore d = \frac{D\lambda}{\beta} = \frac{1.25 \times 6 \times 10^{-7}}{0.15 \times 10^{-3}}$ m $= 50 \times 10^{-4}$ m $= 5.0$ mm

Hence distance of source from the plane mirror $= \frac{d}{2} = 2.5$ min

Fresenel's Biprism

The diagram depicts Fresnel's biprism experiment. A slender prism labeled P bends light from the slit source S into two beams, AC and BE. When a screen labeled MN is positioned as illustrated, interference patterns are visible solely in the area BC. Removing the screen MN causes the two beams to merge across the entire area AE.



If A represents the refraction angle of the thin prism and μ denotes the refractive index of its medium, then the prism's angle of deviation is.

$$\delta = A(\mu - 1)$$

If l_1 is the distance between the source & the prism, then the separation between virtual sources is

$$d = 2\delta\ell_1 = 2\ A(\mu - 1)\ell_1$$

If l_2 is the distance between the prism & the screen, then the distance between virtual sources & the screen is given by

$$D = \ell_1 + \ell_2$$

Thus, by using the result of young's experiment, the fringe width is given by

$$\beta = \frac{\lambda D}{d} \Rightarrow \beta = \frac{\lambda(l_1 + l_2)}{2\delta l_1}$$

$$\beta = \frac{\lambda}{2\delta}[1 + \frac{l_2}{l_1}] \Rightarrow \beta = \frac{\lambda}{2\ A(\mu - 1)}[1 + \frac{l_2}{l_1}]$$

Fringes observed in the Fresnel's biprism experiment are vertical stringht lines