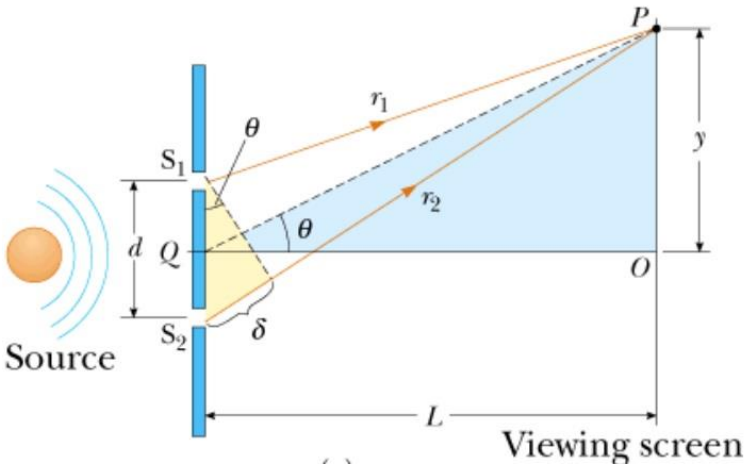
Answer on Question #61774, Physics / Optics

What will be the change in fringe pattern in young double slit experiment even if two mica foils having same refracting indices and thickness L1 and L2 (L1>L2) are placed in the path of interfering raise

Solution:

Consider the light rays from the two coherent point sources made from *infinitesimal* slits a distance d apart. We assume that the sources are emitting monochromatic light of wavelength λ.

The rays are emitted in all forward directions, but let us concentrate on only the rays that are emitted in a direction θ toward a distant screen (θ measured from the normal to the screen, diagram below). One of these rays has further to travel to reach the screen, and the *path difference* is given by $d\sin\theta$. If this path difference is exactly one wavelength λ or an integer number of wavelengths, then the two waves arrive at the screen in phase and there is constructive interference, resulting in a bright area on the screen.



$$y_{bright} = \frac{\lambda L}{d} m$$

Our case equal to situation, when a transparent foil of thickness (L1-L2) and refractive index *n* is placed in one of the incoming wave path, due to the increase of the path by (n-1)(L1-L2), the interference pattern undergoes a shift *s*.

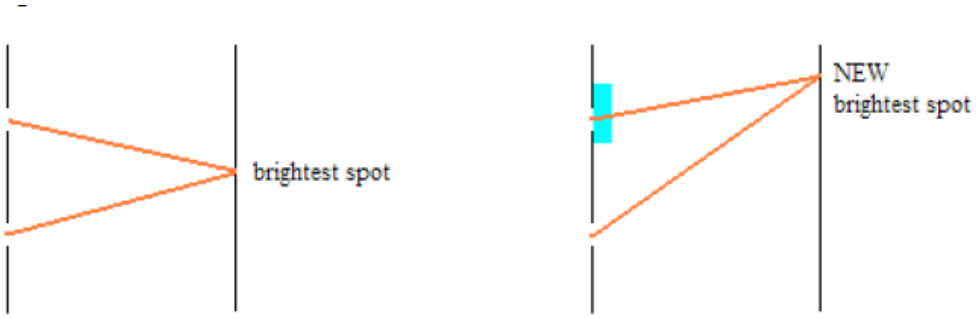


Fig. Equal effective path lengths without (left) and with (right) mica foil.

If the foil has an effective thickness (L1-L2), then there are $\frac{L_1-L_2}{\lambda/_n}$ complete wavelengths that travel through it, while there are $\frac{L_1-L_2}{\lambda/_1}$ wavelengths that travel through the same thickness of air.

The number of fringes shifted is

$$m = \left|\frac{L_1 - L_2}{\lambda/_n} - \frac{L_1 - L_2}{\lambda}\right| = \frac{L_1 - L_2}{\lambda}(n-1)$$

Shift of pattern $s = y_{bright} = \frac{\lambda L}{d}m = \frac{\lambda L}{d}\frac{L_1-L_2}{\lambda}(n-1) = \frac{L}{d}(n-1)(L_1 - L_2).$

Answer: Due to the increase of the path by *(n-1)(L1-L2)*, the fringe system shifts on the side of the thicker (L1) mica foil.