Conditions necessary for steady Interference Pattern

>> *The two sources of light should be coherent* : Coherent means having a constant phase difference between them at all times. Best achievable by deriving the two sources from a single source

>>*The two sources must be monochromatic* : The position as well as width of the fringes depends on wavelength of light. Hence fringes with different colours will not be coinciding.

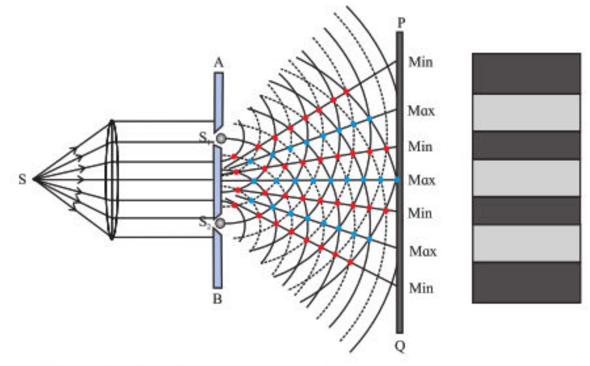
>> *The two interfering wave must have same amplitude :* Only then will the dark be of zero intensity

>> *The separation between the two slits must be small in comparison to the distance between the slits and the screen*

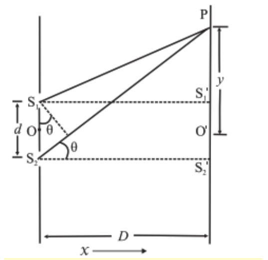
>> *The two slits should be narrow :* else will cause blurring

>> *The two waves should be in the same state of polarization*

Youngs Double Slit Experiment:



S1 and S2 are two coherent source (same frequency and constant phase difference at all times) equidistant from S. Where crest meets crest or trough meets trough and we observe high intensity bright fringe. Where a crest of one coincides with trough of the other we get dark fringe on the screen PQ. We get alternate dark and bright fringes called interference pattern



Analytical Study

d: distance between the slits

D: distance between slit and screen

At O' distance travelled by the secondary wavelets from S1 and S2 is equal, hence O' is a central bright fringe.

Now consider a point P on the screen.

$(S_2P)^2 = D^2 + (y + d/2)^2$

$(S_1P)^2 = D^2 + (y - d/2)^2$

Thus $(S_2P)^2 - (S_1P)^2 = 2yd$

Therefore, $(S_2P - S_1P)(S_2P + S_1P) = 2yd$

since d<<D, we assume $S_2P = S_1P \approx D$

Thus, path difference $\Delta p = S_2P - S_1P = 2yd / 2D = yd/D$

For constructive interference, $\Delta p = n\lambda$

$yd/D = n\lambda$, Thus $y = n\lambda D/d$ for n=0,1,2,3.....

For destructive interference, $\Delta p = (2n - 1)\lambda/2$

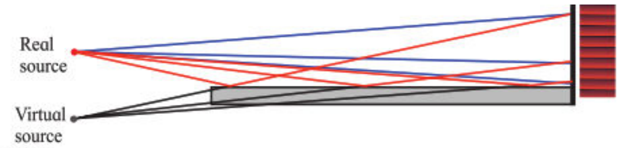
$yd/D = (2n - 1)\lambda/2$, Thus $y = (2n - 1)\lambda D/2d$ for n=1,2,3.....

Fringe Width = distance between two consecutive bright bands or two consecutive darks bands = $\lambda D/d$

Thus, both dark and bright fringes are of equal width and are alternately placed on both sides of the central bright band

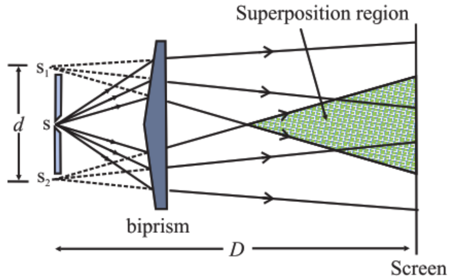
Methods of obtaining the two coherent source:

Lloyd's mirror: A light source is made to fall at a grazing angle on a plane mirror.



Some light falls directly on the screen while some reflects before hitting the screen. The reflected light appears to come from a virtual source. Since it derived from the same source, the two source are coherent.

Fresnel biprism:



Vertex angle nearly 180°. Very small refracting angle of 30' to 1° with the base. The refracting edge parallel to the slits. The biprism produces S_1 and S_2 as the two virtual sources from the same source S, hence they both are coherent.

INCOMPLETE NOTES
DIFFRACTION YET TO COME

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