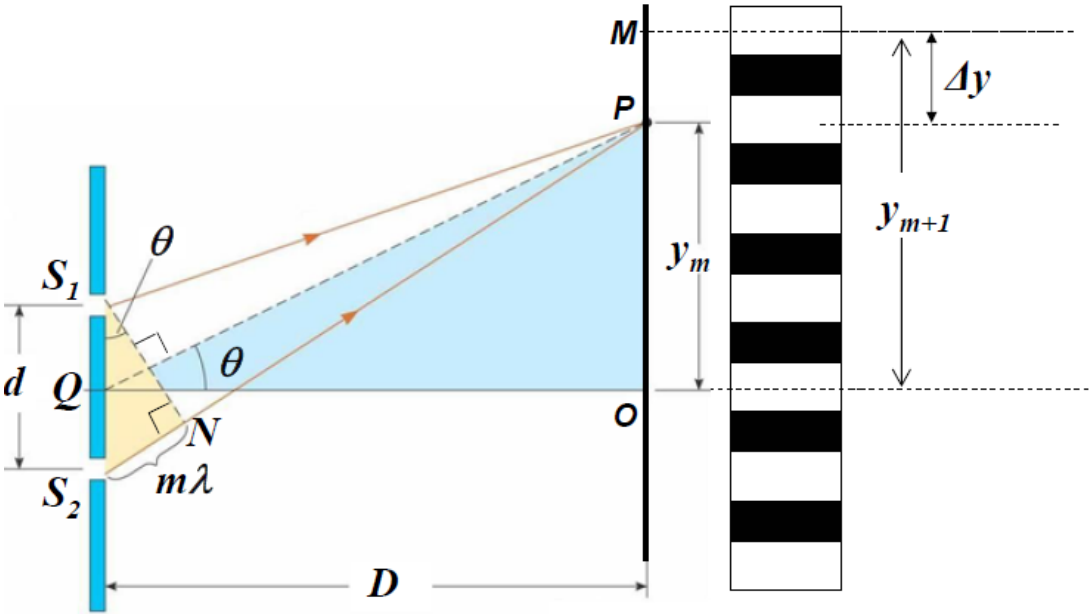
- S_1 and S_2 are two new sources of coherent waves in phase because they originate from the same source S_O.
- An interference pattern is formed on the screen.

1.10. Equation of Young's Double- Slit Experiment



- Suppose P as shown in figure is the m[th] bright fringe, so that

$$S_2P - S_1P = m\lambda$$

- Let OP = y_m = distance from P to O .
- If $NP = S_1P$ then $S_2N = S_2P - NP = m\lambda$.
- In practice d is very small (<1mm) and $D >> d$, then S_1N meets PQ at right angle. Therefore,

angle PQO = angle $S_2S_1N = \theta$

- From the figure,

$$\Delta S_2S_1N \Rightarrow \sin\theta = \frac{S_2N}{S_2S_1} = \frac{m\lambda}{d}$$

$$\Delta PQO \Rightarrow \tan\theta = \frac{PO}{QO} = \frac{y_m}{D}$$

Since θ is small, $\tan\theta = \sin\theta$

$$\therefore \frac{y_m}{D} = \frac{m\lambda}{d}$$

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- Therefore, the separation between central bright fringe with mth and (m+1)th bright fringe is given by

  For the **mth bright fringe** :

$$y_m = \frac{m\lambda D}{d}$$

  For the **(m+1)th bright fringe** :

$$y_{m+1} = \frac{(m+1)\lambda D}{d}$$

- The **separation between successive (consecutive) bright or dark fringes, Δy** is given by

$$\Delta y = y_{m+1} - y_m = \frac{(m+1)\lambda D}{d} - \frac{m\lambda D}{d}$$

$$\Delta y = \frac{\lambda D}{d}$$

where

m : order $= 0,1,2,.....$

λ : wavelength

D : distance between double - slits and the screen

d : separation between double - slits

- The separation between **mth dark fringe and central bright fringe** is given by

$$x_m = (m + \tfrac{1}{2})\frac{\lambda D}{d}$$

where

m : order $= 0,1,2,.....$

- From the equation below,

$$\Delta y = \frac{\lambda D}{d}$$

- Δy depends on :
  i) the wavelength of light, λ
  ii) the distance apart, d of the double slits,
  iii) distance between slits and the screen, D
- Explanation for the above factors:

  (a) if λ is short and hence Δy decreases for fixed D and d. The interference fringes are closer to each other and vice-versa.

  (b) if the distance apart d of the slits diminished, Δy increased for fixed D and λ and vice-versa.