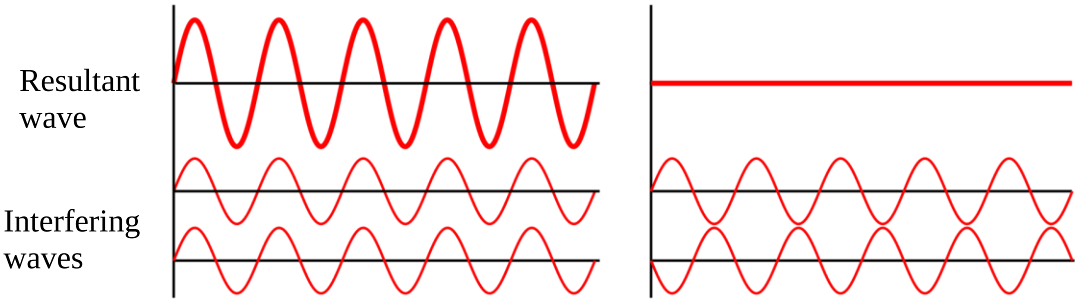
❑ Interference of light:

Waves emitted from two coherent sources having the same wavelength, equal or nearly equal amplitude when pass through a point in a medium, then superposition takes place. During superposition, if the two waves reaching the point in same phase (in phase) then the intensity will be maximum that is bright. But if the two waves reaching the point in opposite phase (out of phase) then the point will have minimum intensity that is dark. This variation of light intensity due to superposition is called interference of light.



Constructive interference   Destructive interference

The interference is said to be constructive when the resultant intensity is more than that given by one beam alone, and the interference is said to be destructive when the resultant intensity is less than that given by one beam alone.

❑ Conditions of interference:

To obtain a sustained (well-defined observable) interference pattern, the following conditions must be fulfilled:

1. The two sources of light are required and they should be very close to each other.
2. The two sources of light should be monochromatic and narrow.
3. The two sources of light must be derived from same source.
4. The two interfering sources must emit light wave having a constant phase difference between them.
5. The two interfering sources should emit light wave having same frequency or wavelength.
6. The amplitude of the two interfering waves should be equal or approximately equal.
7. The two interfering waves must be propagated along the same direction.
8. The condition to have a point bright or dark is that the path difference of the point from the sources will be respectively even or odd multiple of $\frac{\lambda}{2}$.

❑ Coherent source:

Two sources are said to be coherent if they emit light waves of the same frequency, nearly same amplitude and are always in phase with each other. It means that the two sources must emit radiations of same color (wavelength). In actual practice it is not possible to have such independent sources.

The following methods are commonly used for the production of coherent sources:

(i) Fresnel's biprism, (ii) Young's double-slit experiment, (iii) Fresnel's double mirror, (iv) Lloyd's single mirror.

❑ Young’s double-slit experiment:

In the year 1802, Young demonstrated the experiment on the interference of light. He allowed sunlight to fall on a pinhole S_o and then at some distance away on two pinholes S_1 and S_2. S_1 and S_2 are equidistant from S_o and are close to each other. Spherical waves spread out from S_o. Spherical waves also spread out from S_1 and S_2. These waves are of the same amplitude.

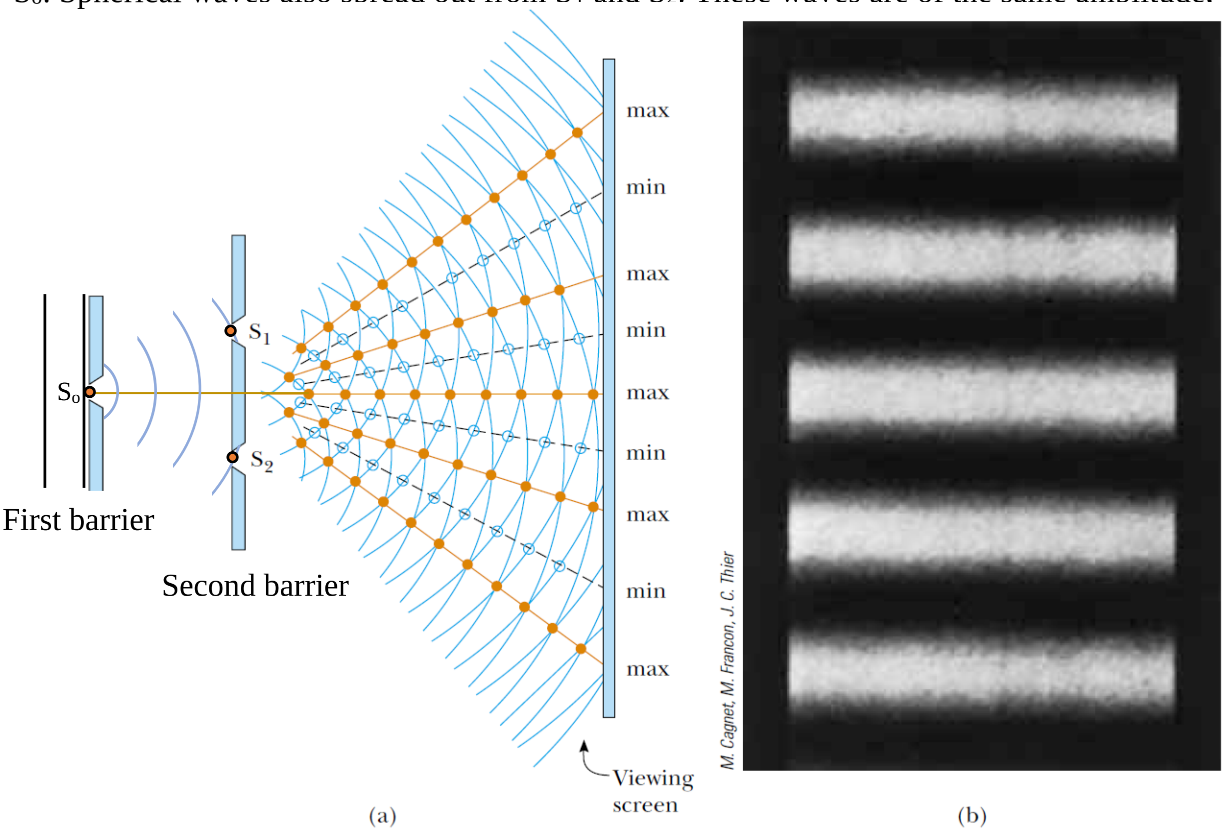


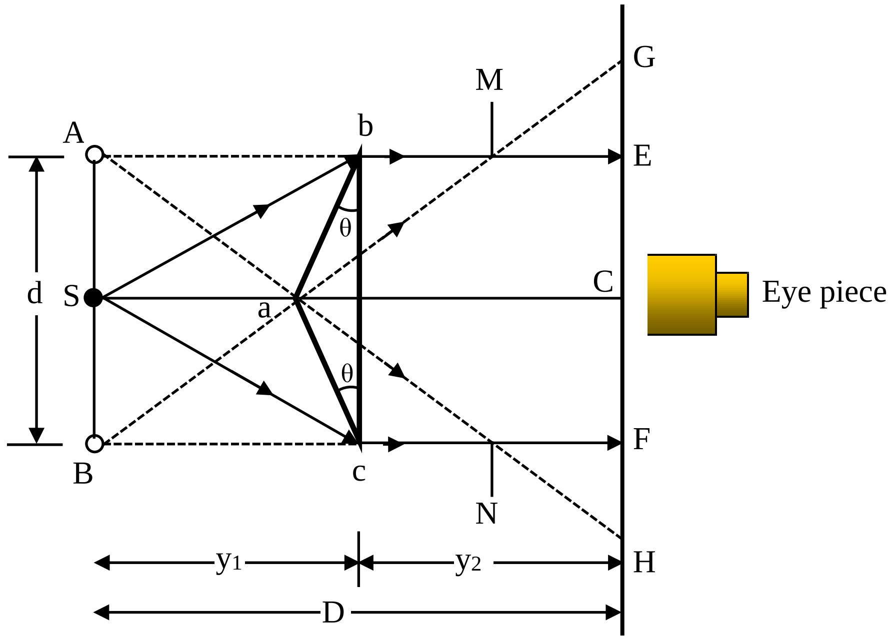
Fig. (a) Schematic diagram of Young’s double-slit experiment. Slits S_1 and S_2 behave as coherent sources of light waves that produce an interference pattern on the viewing screen. (b) An enlargement of the center of a fringe pattern formed on the viewing screen.

frequency, and wavelength. On the screen, interference bands are produced which are alternatively bright and dark. The points having maximum intensity are bright because the crest of one wave coincides with the crest of other and therefore, they reinforce with each other, it is constructive interference. The points having minimum intensity are dark because the crest of one wave falls on the trough of the other and they neutralize the effect of each other, it is destructive interference. The points where the trough of one wave falls on the trough of the other are also bright because the two waves reinforce and it is also constructive interference.

It is not possible to show interference due to two independent sources of light, because a large number of difficulties are involved. The two sources may emit light waves of largely different amplitude and wavelength and the phase difference between the two waves may change with time.

❑ Formation of fringes by Fresnel's biprism:

The biprism ‘abc’ consists of two acute angles (less than 90°). The acute angle θ on both sides is about 30°. The prism is placed with its refracting ages parallel to the line source S such that ‘Sa’ is normal to ‘bc’ of the prism. When light falls from S on the lower portion of the biprism, it is bent upwards and appears to come from the virtual source B. Similarly, when light falls from S on the upper portion of the biprism, it is bent downwards and appears to come from the virtual source A. Therefore, A and B act as two coherent sources. Let us suppose the distance between A and B is ‘d’. If a screen is placed at C, interference fringes of equal width are



produced between E and F. But beyond E and F, fringes of large width are produced which are due to diffraction. ‘MN’ is a slop limit of the rays.
To observe the fringes, the screen is replaced by an eye piece or a low power microscope and fringes are seen in the field of view. If the point C is at the principal focus of the eye piece, the fringes are observed in the field of view.
The point C is equidistance from A and B. Therefore, it has maximum intensity. On both sides of C, alternately bright and dark fringes are produced. The width of the bright or dark fringe is

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

Moreover, the point on the screen will be at the center of a bright fringe if its distance from C is

$$\beta = \frac{n\lambda D}{d} \quad \text{where, } n = 0, 1, 2, 3, \dots\dots\dots\dots \text{ etc.}$$

The point will be at the center of dark fringe if its distance from C is

$$\beta = \frac{(2n+1)\lambda D}{d} \quad \text{where, } n = 0, 1, 2, 3, \dots\dots\dots\dots \text{ etc.}$$