DEPARTMENT OF PHYSICS AND NANOTECHNOLOGY
SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

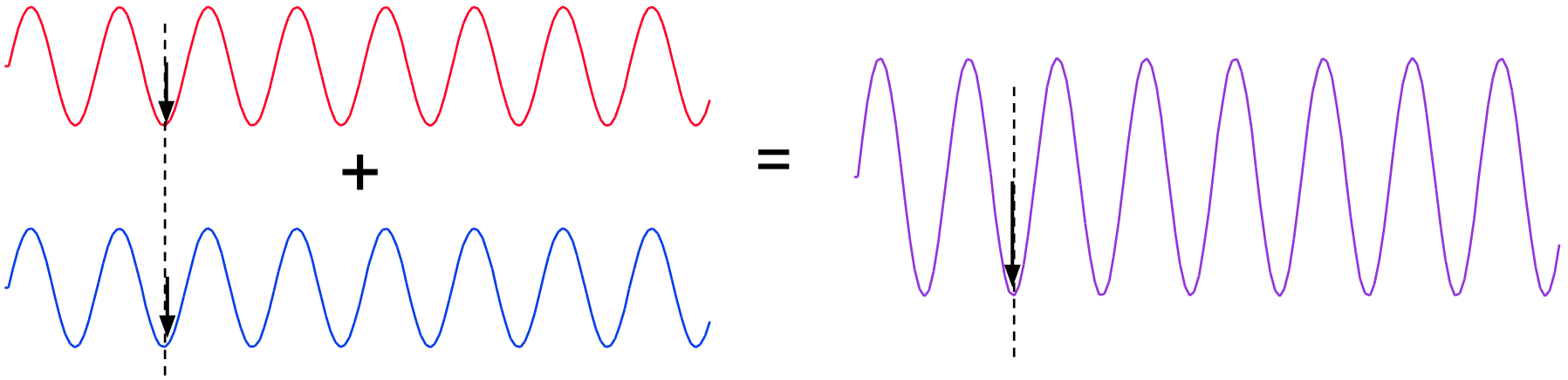
18PYB101J - Electromagnetic Theory, Quantum Mechanics, Waves and Optics
Module-IV (Waves and Optics) Lecture-1

Interference and Diffraction

Superposition of Waves

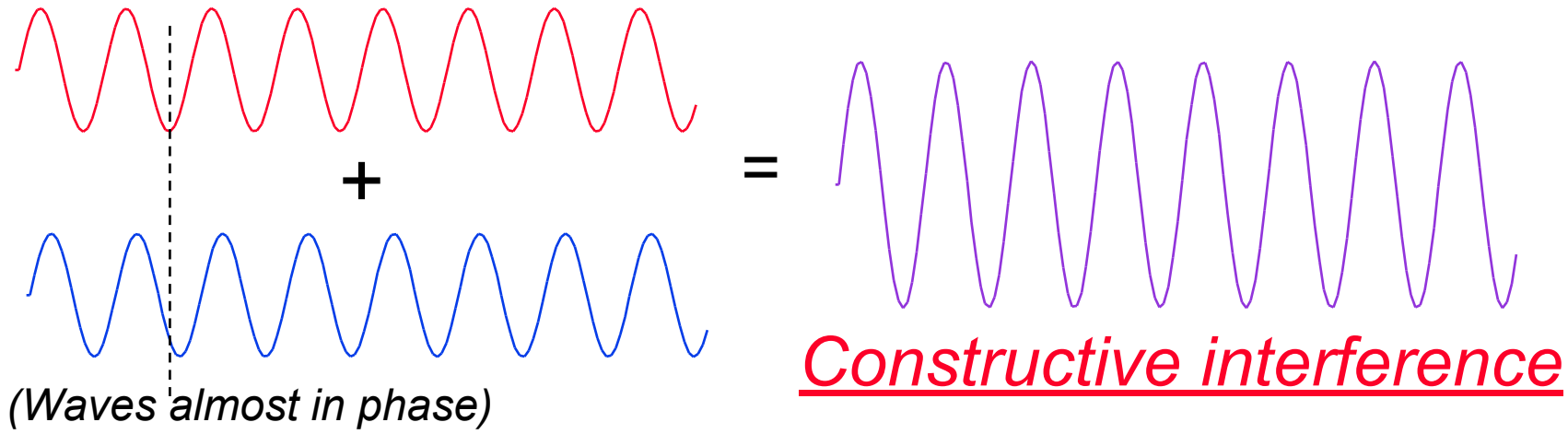
In general, when we combine two waves to form a composite wave, the composite wave is the algebraic sum of the two original waves, point by point in space [Superposition Principle].

When we add the two waves we need to take into account their:
Direction
Amplitude
Phase



Superposition of Waves

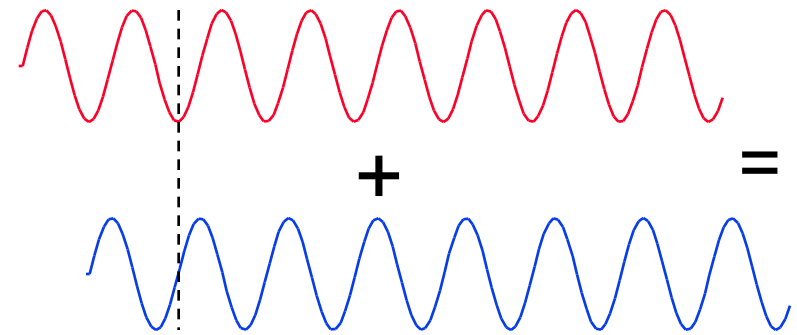
Interference of light wave is the phenomena whereby two light waves superpose to form a resultant wave of greater, lower or same amplitude.



The interference is constructive, if the waves reinforce each other.

Superposition of Waves

The combining of two waves to form a composite wave is called:
Interference



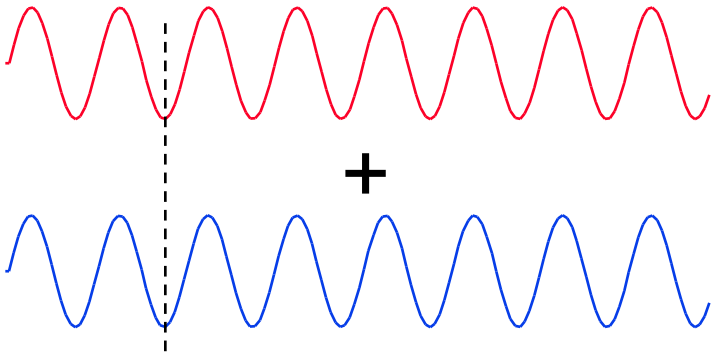
(Close to π out of phase)

(Waves almost cancel.)

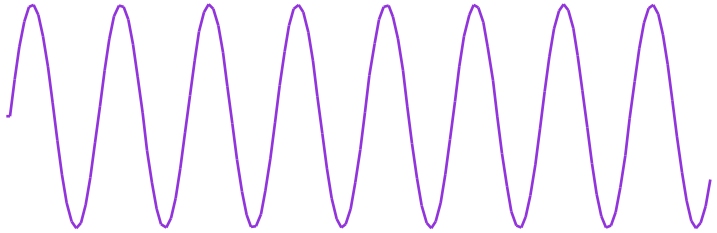
Destructive interference

The interference is destructive, if the waves tend to cancel each other.

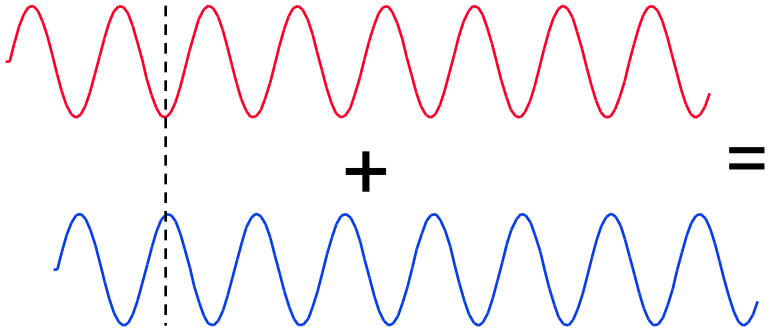
Interference of Waves



(In phase)



Constructive interference



(π out of phase)

(Waves cancel)

Destructive interference

Conditions for interference

When waves come together they can interfere constructively or destructively. To set up a stable and clear interference pattern, two conditions must be met:

- The sources of the waves must be coherent, which means they emit identical waves with a constant phase difference.

- The waves should be monochromatic - they should be of a single wavelength.

Conditions for interference

Let's say we have two sources sending out identical waves in phase. Whether constructive or destructive interference occurs at a point near the sources depends on the path-length difference, d, which is the distance from the point to one source minus the distance from the point to the other source.

- Condition for constructive interference:

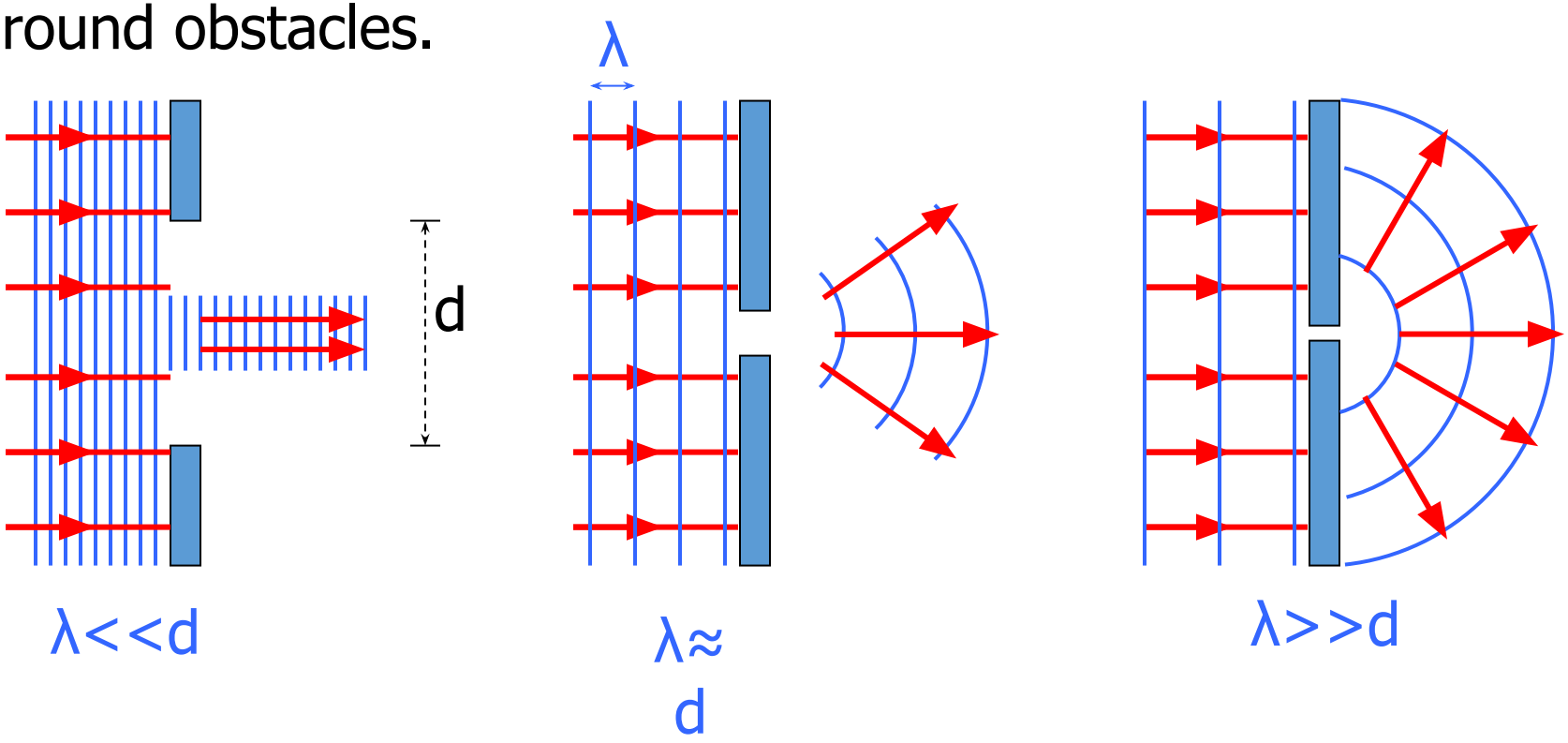
(path-length difference) $\boldsymbol{d = 2n\lambda/2}$, where n is any integer.

- Condition for destructive interference:

(path-length difference) $\boldsymbol{d = (2n+1)\lambda/2}$, where n is any integer.

Diffraction

Light is an electromagnetic wave, and like all waves, "bends" around obstacles.



most noticeable when the dimension of the obstacle is close to the wavelength of the light

Diffraction

- Diffraction of light is the phenomenon of bending of light waves around the corners and their spreading into the geometrical shadows.

- Fresnel explained that the diffraction phenomenon was the result of mutual interference between the secondary wavelets from the same wave front.